

Mixing of Vulcanisable Rubbers and Thermoplastic Elastomers

P.R. Wood

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*Expert overviews covering the
science and technology of rubber
and plastics*

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Source of original article	→	<i>Item 1</i> Macromolecules 33, No.6, 21st March 2000, p.2171-83	
Title	→	EFFECT OF THERMAL HISTORY ON THE RHEOLOGICAL BEHAVIOR OF THERMOPLASTIC POLYURETHANES Pil Joong Yoon; Chang Dae Han Akron, University	← Authors and affiliation
		The effect of thermal history on the rheological behaviour of ester- and ether-based commercial thermoplastic PUs (Estane 5701, 5707 and 5714 from B.F.Goodrich) was investigated. It was found that the injection moulding temp. used for specimen preparation had a marked effect on the variations of dynamic storage and loss moduli of specimens with time observed during isothermal annealing. Analysis of FTIR spectra indicated that variations in hydrogen bonding with time during isothermal annealing very much resembled variations of dynamic storage modulus with time during isothermal annealing. Isochronal dynamic temp. sweep experiments indicated that the thermoplastic PUs exhibited a hysteresis effect in the heating and cooling processes. It was concluded that the microphase separation transition or order-disorder transition in thermoplastic PUs could not be determined from the isochronal dynamic temp. sweep experiment. The plots of log dynamic storage modulus versus log loss modulus varied with temp. over the entire range of temps. (110-190C) investigated. 57 refs.	← Abstract
Location	→	GOODRICH B.F. USA <i>Accession no.771897</i>	← Companies or organisations mentioned

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Mixing of Vulcanisable Rubbers and Thermoplastic Elastomers

P.R. Wood

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1 Introduction

Since the last review of this subject (355), there have been many developments in mixing machinery and some departures of companies long established in the manufacture of rubber mixing equipment. There have also been significant reductions in the use of curable rubber, particularly in the motor industry, and also in domestic areas where the demands of recycling are favouring to an ever-greater degree the use of thermoplastic materials.

Developments that have taken place in mixing equipment over the last eight or nine years have been significant, with almost all major machinery makers having made innovations of one type or another. Some developments have been as small as re-profiling rotors of relatively conventional design. Others have been the introduction of completely new rotor designs, both intermeshing and tangential. Where possible, the potential advantages of various designs are discussed, particularly where these are developments of existing rotor shapes. In some cases these advantages are as indicated by the various manufacturing companies; in other cases comments are made from this writer's experience and should be regarded as his own personal opinion.

Material developments in the rubber industry are outside the scope of this report, other than where they may affect the mixing of rubbers. Where material developments impinge on mixer design, for instance where one particular design is favoured for technical reasons over another, then reference may be made to particular materials.

As indicated in the last report, significant reduction in cycle times with consequent increase in productivity has not been seen, nor is expected. But in terms of choice of equipment features and designs for delivering the quality a company requires, the wider range of designs available presents both a challenge and an opportunity.

For those interested in deeper technical discussions on the mixing process, including mixing mechanisms in mixers and post mixing processes, including extruders and injection moulding, the book *Science and Practice of Rubber Mixing* published by Rapra will be of interest (178). Sections on model mixing mechanisms, material changes during mixing, energy aspects of rubber mixing, material characteristics, rheological characteristics of gums and compounds, viscoelastic characteristics and models of filled compounds under shear and at rest are included.

Finally, I must express my thanks to those companies who have so generously assisted in the preparation of this review, allowing the use of various illustrations from scientific papers prepared by them, for their comments given in discussions with them, and for their trust in me not to insult their products in comparison to others. In strict alphabetical order, these include Berstorff UK, Haaglunds Drives AB, John Waterhouse Ltd., Kobe Steel Ltd., Techint Pomini and ThyssenKrupp Elastomertechnik GmbH.

2 History

A summary of developments was made in the last review report on rubber mixing (355) and mention was made of the development of rubber mixers by Fernley H. Banbury. One rotor design which was developed in the Werner, Pfleiderer and Perkins company in Peterborough should, however, perhaps be given more prominence than it so far has. That design was illustrated in a British patent (a.1, **Figure 1**) and was slightly modified in an American patent taken out in 1915 by J.E. Pointon (a.2, **Figure 2**). Examination of the sketches of these rotors in the patents indicates a rotor profile remarkably similar to that used by Banbury in his 1916 patent for the Banbury mixer (a.3), and in the case of the British patent featuring the same method of driving compound to the middle of the mixing chamber, albeit with a single wing. It is recorded (a.4) that Banbury worked in Peterborough at around the time when Pointon was developing his ideas, and probably saw the advantages of that rotor profile and the way the Pointon rotor moved material around the mixing chamber. The principle of sweeping rubber from

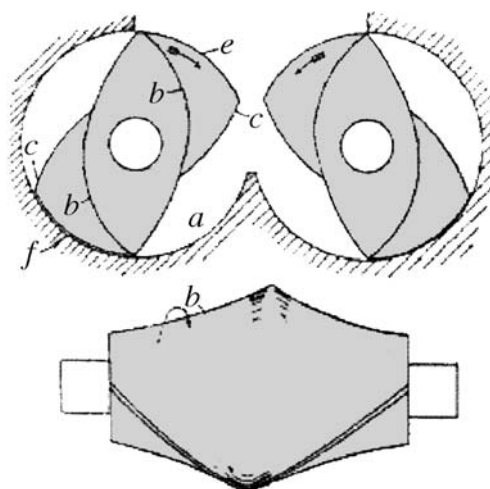


Figure 1

Pointon's rotors - UK patent (a.1)

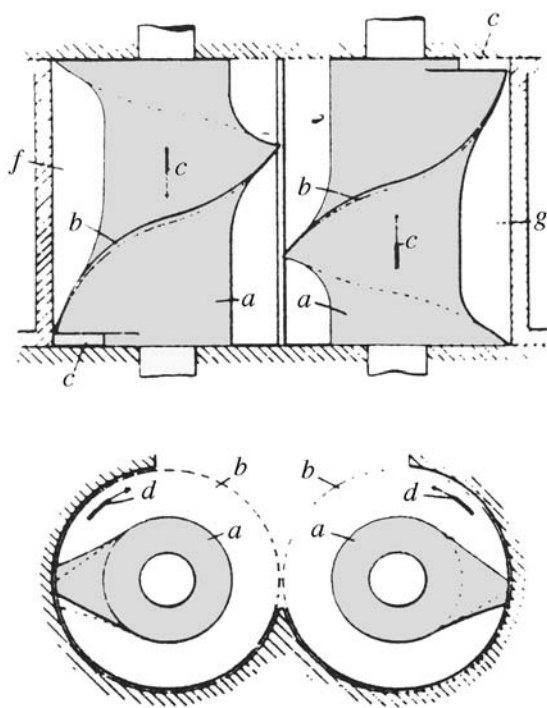


Figure 2

Pointon's rotors - US patent (a.2)

one end of the mixing chamber to the other, and returning it back using a second rotor, as indicated in the US patent, is the same as that used in the original intermix rotor of 1934. This same idea of a long, sweeping wing to drive material along the length of the mixing chamber could be said to have been incorporated in recent rotor designs by several companies, including some developed by the Farrel company for their Banbury mixer (see Wing Function Technology rotors later). Perhaps J.E. Pointon should be regarded as the Father of the Rubber Mixer, rather than F.H. Banbury.

For anyone interested in the history of internal mixers, the article by J.L. White, written in 1992 (356), is still one of the best-researched reviews of the development of rubber mixing machinery from the days of Hancock's Pickle to the end of the 1980s.

3 Batch Mixing Machinery: Developments in Recent Years

3.1 Mills

There have been no significant improvements in mixing mills over recent times. The use of hydraulic drives,

hydraulic nip control, drilled roll cooling and stock blenders was covered fully in the previous Rapra review report, and needs little further comment.

Use of hydraulic drives has allowed one manufacturer to introduce small mills with the ability to drive the rolls either forward or backwards, allowing extremely high shear to be achieved in the nip between the rolls (a.5, 216). Use of this mill would appear to be limited to laboratory applications, and the mixing of very soft materials such as silicone rubbers.

3.2 Internal Mixers

The basic design of all commonly-used batch mixers consists of two rotors contrarotating in a close-fitting chamber, with an arrangement to feed the raw materials into a machine, pressurising them into the mixing chamber using a ram, and with a door in the bottom of the machine to discharge the mixed batch. The kneaders are similar machines (Section 3.2.2.7), but they rely on a tipping movement of the mixing chamber to empty the mixed contents. Excluded from this simple description are the developments in novel mixing machinery mentioned towards the end of this section (Section 3.2.5).

3.2.1 Definitions of Terms Used in Descriptions of Internal Mixers

Tangential rotor internal mixers - Mixers which are arranged such that the predominant mixing action is to shear the mixing compound against the sides of the mixer.

Intermeshing rotor internal mixers - Mixers which are arranged such that the predominant mixing action is to shear the mixing compound between the rotors of the mixer, and the distance between the rotors is less than the rotor diameter.

Tip clearance - The gap between the outside diameter projected by a rotor, or part of a rotor, and the mixing chamber wall.

Tip width - The width of the mixing tip of, particularly, tangential rotors over which the materials must flow. This is normally expressed as a dimension perpendicular to the wing angle.

Wing - The lobe on a rotor responsible for the mixing action.

Wing angle - The angle of the wing relative to the rotor axis.

Friction ratio - The ratio between the differences in rotational speed of two rotors in a tangential internal mixer, or between the rolls of a two-roll mill.

Hopper - The part of the mixer through which raw materials are fed. This may be closed by a 'hopper door'.

Ram - The device which pushes the mix under pressure into an internal mixer.

Discharge door - The part of the mixer which is opened to let the mixed material exit from the mixer.

Fill factor - The amount of the total free volume available in an internal mixer occupied by the mixed compound at the end of the mixing cycle.

Approach angle - The angle, measured in the rotational direction, subtended by the tangent to the circumference of the mixer body and the angle of the front face of the rotor wing or scroll.

3.2.2 Tangential Rotor Internal Mixers

Notwithstanding strong evidence that tangential rotors are incapable of giving the highest quality of rubber compound (170), a large percentage of all rubber mixed in the world is still mixed on this basic style of rotor. The basis of all tangential rotors, and some intermeshing rotors is described in F.H. Banbury's patent of October 3rd, 1916 (a.3, **Figure 3**) where two rotors with attached, profiled, split paddles (or wings) contrarotate in a close fitting chamber. The chamber is closed by a ram at the top, to allow material to be fed into the machine, and at the bottom by a door which can be opened to release the mixed batch. Not all tangential mixers incorporate the door for discharging the mixed rubber. Some mixers discharge the batch by removing the top of the chamber and rotating the chamber about an axis of one of the rotors (see Section 3.2.2.7 - Kneaders).

3.2.2.1 Two-Wing Rotors

The conventional two-wing rotor (**Figure 4**) has been, and continues to be, the most widely used style of tangential rotor. The reason for this is not that rotor developments by major manufacturers have been ineffective, but that the style of rotor is easy

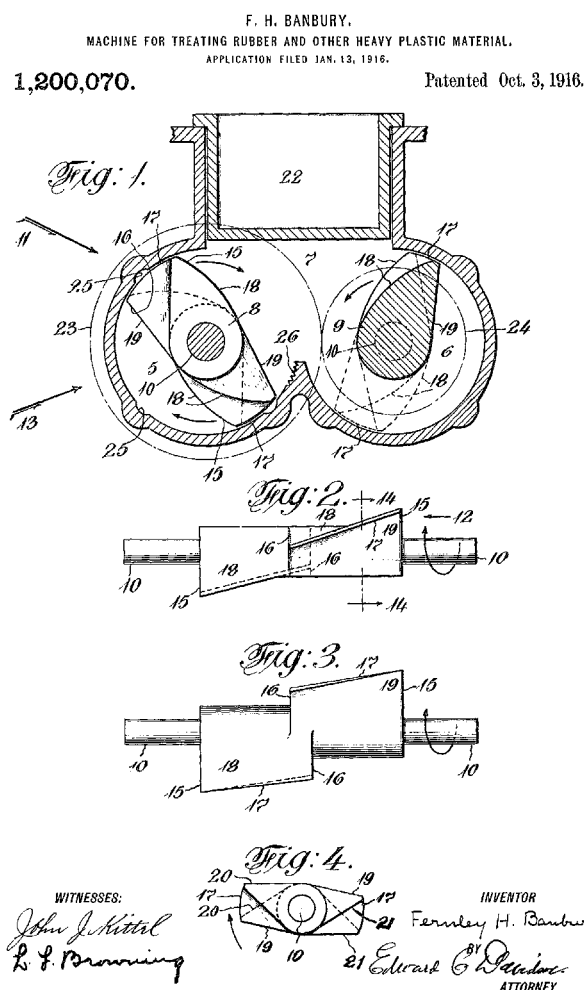


Figure 3

Banbury rotors - US patent (a.3)

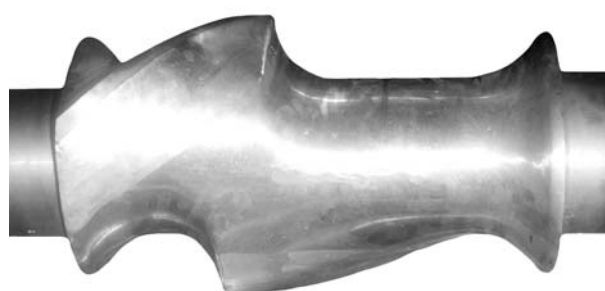


Figure 4

Two-wing tangential rotor

to copy. The result is that machines with this basic style of rotor are made by many small manufacturers, particularly in the developing countries. The style is common to both the lower powered machines such as side emptying kneaders as well as the more powerful, enclosed machines.

Developments over the years have included rotors becoming fatter and thinner, the tip gap (clearance between side and rotor) has decreased and then increased again, and changes have been made to wing angles and material approach angle. These things all have an effect, but the developments are not well documented except in terms of tip width (Carter Brothers/Carter International) and blade length (Kobe Steel). Many research studies have been carried out on the influence of the various rotor characteristics ((174) and others), but notwithstanding this the manufacturers each have their own preferred rotor profiles. There appears to be anecdotal evidence that the wider tip of the Carter two-wing rotor (called the Turboswirl rotor by Carter International) gives improved dispersion, and shorter mixing times approaching those achieved by four-wing rotors,

3.2.2.2 Four-Wing Rotors

The four-wing rotor (**Figure 5**) was initially developed for larger mixers where it was thought that there was insufficient mixing action from two wings in the larger volume. It was soon found that more rapid mixing could be achieved using four-wing rotors, especially in the tyre industry where multistage mixing was becoming more widespread. With two-pass and multipass mixing, quality of mix per pass was less important, as dispersion and distribution were generated over two or more mixing stages. Fill factor is increased compared to the two-wing rotor by some 7%, depending on compound, but distributive mixing is generally not so good; discharge temperatures are generally higher and mix viscosity is generally increased. The rotors can also suffer from a 'log jam' effect on certain compounds at the junction between the long and short wings, where a ring of compound can form around the diameter of the rotor.



Figure 5
Four-wing rotor

3.2.2.3 Tangential Rotor Developments at Kobe Steel

A development of the four-wing rotor by Kobe Steel in Japan, the Kobe H rotor (**Figure 6**), gave reduced cycle times and a claimed increase in fill factor for the same compound recipe of between 1 and 2% compared to 'standard' four-wing rotors. This was achieved by increasing the length of the long wings and was said to promote better flow around the mixing chamber compared to the shorter wing on the 'standard' four-wing rotor. The rotor found some popularity in the tyre industry and led to the development of the 'H-Mk.2' rotor which introduced more spiral twist to the long wings. This again promoted better flow around the chamber due to the increased wing angle, and was said to be even more beneficial when the rotors are run at equal speed with a particular orientation to each other (see Even Speed - Section 3.2.2.8).

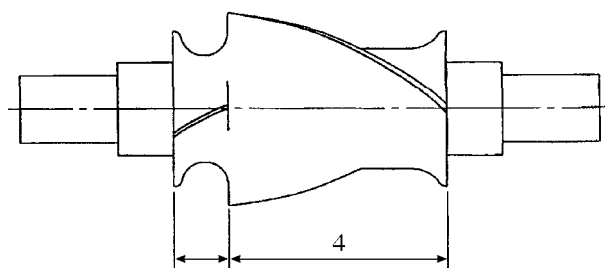


Figure 6
Kobe four-wing 'H' rotor
(Courtesy of Kobe Steel Limited)

The six-wing rotor (**Figure 7**) is a more recent development by Kobe Steel Ltd., which is claimed to give more versatile mixing because of varying tip clearance along each wing. The rotors are described, and information on mixing behaviour given, in a paper presented to the American Chemical Society in April 2000 (195). To prevent excessive heat build-up in the mix, each long wing has three different tip clearances along it, arranged in a different sequence on each long wing. Thus each of the tip clearances of narrow, medium and wide is presented across the length of the mixing chamber at each rotor revolution. It is likely that the three short wings of the rotor are also individually arranged with different tip clearance. Fill factor is increased compared to the four-wing rotor by up to 6.6%, depending on compound type and hardness. The rotors are claimed to achieve the higher fill factor with better distributive mixing and better viscosity

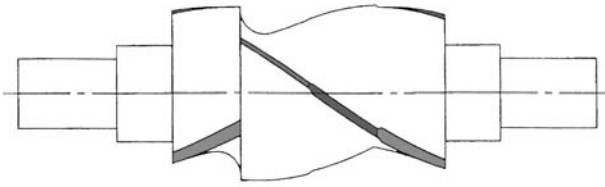


Figure 7

Kobe six-wing tangential rotor
(Courtesy of Kobe Steel Limited)

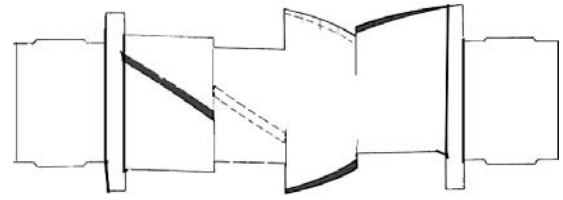


Figure 8

High Distributive Mixing rotor
(Courtesy of Techint Pomini)

control than the four-wing rotor. The reason for this improvement is that the varying tip clearance allows material to flow around and across some of each rotor tip more easily, reducing the tendency for compound to be carried around on one rotor.

3.2.2.4 Tangential Rotor Developments at Techint Pomini

The first development away from standard tangential rotors in the Pomini range was the High Distributive Mixing (HDM) rotor (**Figure 8**). Of some ‘multi-wing’ design, this rotor was developed to give better distributive mixing and mix homogeneity compared to that achieved by the company’s original style two-wing rotor which was produced when this company had a licence from the Farrel company of the USA. Testing of production machines indicates that the rotor is suitable for upgrading standard two-wing machines, allowing slightly higher batch sizes and productivity increases of up to 8%, but with better temperature control and permitting retention of existing drives and gearboxes.

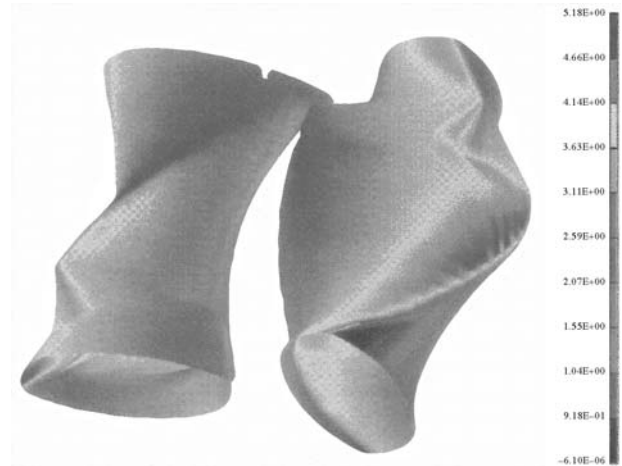


Figure 9

New Technology Tangential rotor
(Courtesy of Techint Pomini)

A more recent development, the New Technology Tangential (NTT) rotor (**Figure 9**) developed using fluid dynamics studies, incorporates a variable wing angle along the long wings of a four-wing rotor. This has the

Table 1. Comparison of performance of NTT rotors with standard four-wing rotors on a tyre compound

	Masterbatch		Final mix	
	NTT	NTT vs four-wing	NTT	NTT vs four-wing
Batch weight (kg)	220	215	210	205
Fill factor increase		0.02		0.02
Cycle time reduction		up to 10%		up to 10%
Productivity increase		up to 10%		up to 10%
Specific energy		similar		similar
Reduction in coefficient of variation, rheometric properties		n/a		between 30 and 50%
Reduction in standard deviation, mechanical properties		n/a		between 20 and 30%

effect of improving fill factor and productivity whilst reducing the coefficient of variation in the rheological and mechanical characteristics of the mixed compound. The rotor is said to be ideal for upgrading existing four-wing tangential mixers, and for new-build machines. Typical results on a tyre compound, comparing NTT rotors to standard four-wing rotors are indicated in **Table 1**.

3.2.2.5 Tangential Rotor Developments at Farrel

As the direct descendant of the Birmingham Iron Foundry, the company which manufactured the original Banbury mixer under the guidance of Fernley H. Banbury, this company was encumbered by a great deal of historical baggage, and continued to maintain that the original rotor designs were 'the best' until the introduction of even-speed mixing some 20 years ago. A modified rotor was developed by Nortey and patented by Farrel to attempt to improve mix circulation around the mixing chamber when both rotors ran at the same speed (a.6). This was (and is) marketed as the ST (Synchronous Technology) rotor, and is predominantly supplied in a four-wing arrangement. The rotor differs from the standard four-wing rotor by having a long wing and a short wing at each end of the rotor (**Figure 10**), rather than having both long wings at one end and both short wings at the other. When set in the correct orientation to each other in the mixing chamber, this is said to ensure improved material circulation around the chamber and around each rotor.



Figure 10

Synchronous Technology rotor (from Farrel)

A further, recent, development on this design has been called the Wing Function Technology (WFT) rotor (84, 118, 119). In this design the angle of both long and short wings at one end of the rotor is altered to give a more positive drive of material across the chamber. The aim is to give better blending of the compound. The wings at the other end of the rotor are set at a conventional

angle and act as the main shearing wing, thus each rotor has one set of wings providing better dispersive mixing, and one set of wings providing better distributive mixing. It is quite likely that the realisation of the very efficient material transfer capabilities of the conventional intermeshing rotor designs contributed to this rotor design, as the development took place after Farrel had begun manufacturing the intermeshing rotor mixing machines originally developed by Francis Shaw.

3.2.2.6 Tangential Rotor Developments at ThyssenKrupp Elastomertechnik GmbH

A forced flow cooling arrangement called the HESC full four-wing rotor has been developed specifically for 270-litre mixers. This rotor has significantly improved cooling compared to a normal rotor, and tests using thermal imaging equipment show that the system is capable of cooling a rotor from 90 °C to give a uniform temperature of 28-30 °C in approximately five minutes using 18 °C water. With a conventionally cooled rotor (spray-cooled internally) the temperature is not uniform and is still at approximately 45 to 50 °C. This rotor has been shown to give improved mixing times, reduced compound variability and higher mixing torque compared to a standard rotor (a.7, **Figure 11**).

A further development reported is the HD-SC rotor designed to take advantage of even-speed mixing (competitive with the ST rotor mentioned above in Section 3.2.2.5) when a customer is enthusiastic about this. Very little information is available on this rotor, but it would be expected that the rotor is of four-wing design, and that orientation of one rotor to the other would be important, as has been found for other rotors utilising even-speed technology.

For good distributive mixing the ZZ2 rotor, developed some time ago as an alternative rotor design to conventional two- and four-wing rotors, is capable of utilising higher rotor speeds at a lower specific energy input. The rotor is based on this company's original Lasch and Frei design of 1939 (a.8), but allows more freedom for the compound at the rotor ends, thus limiting the temperature rise in the mixing compound.

Finally, a pan-European research project involving universities, a tyre company and ThyssenKrupp Elastomertechnik, is involved in designing a new type of tangential rotor geometry capable of high specific energy input and short mixing times. This rotor is intended to be used for mixing of masterbatch materials. Results from this project are expected to be published early in 2005.

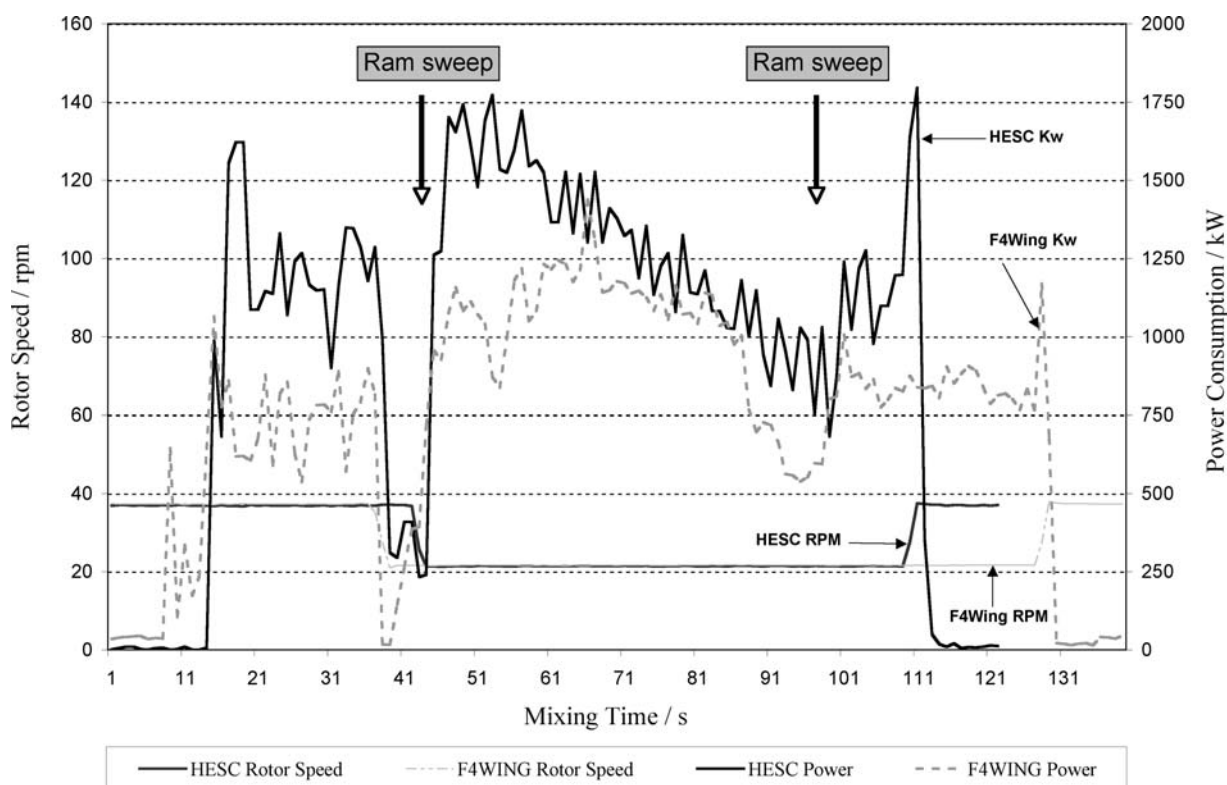


Figure 11

Comparison of HESC versus four-wing rotors examining power consumption and rotor speed
(Courtesy of ThyssenKrupp Elastomertechnik)

3.2.2.7 Kneaders

Possibly the best-known name in the manufacture of this type of mixer is Moryama, as a certain motor company once demanded that compounds should be finished in machines of this type if they were to be used in the manufacture of their cars. There are many other manufacturers of mixing machines operating on the same principle, particularly in the Far East and on the Indian subcontinent. Rotor shape is not dissimilar to the original Banbury patent, with wing lengths arranged to be of more or less equal length as opposed to the 2:1, 3:1 or 4:1 wing length ratio now found on tangential mixers. The wings are also arranged at a greater helix angle than seen in normal tangential mixers. Tip width is greater and tip gap smaller than would normally be found. The machines would therefore be considered to be designed for distributive, rather than dispersive mixing, notwithstanding the small tip gap and wide tip width.

A further difference from a conventional mixer with a ram is that the whole top of the mixer is closed by a retractable, possibly profiled, piece which has to be lifted mechanically, pneumatically or hydraulically

clear of the mixing chamber to allow the chamber to rotate around one rotor as it is emptied. The result of this large closure area is that the mixer operates at much lower chamber pressures than conventional mixers, and as a result the machine can use lower powered drives.

3.2.2.8 Even-Speed versus Friction-Ratio Mixing

Briefly mentioned above was the development in the 1980s of even-speed mixing. Conventionally, tangential internal mixers have the rotors running at slightly different speeds, resulting in a friction ratio between them similar to that originally used on two-roll mills. The driving force for development of the use of even-speeds came from the tyre industry where the extra rotational speed of the slower rotor was found to give shorter mixing times, and often increased batch size. A drawback of even-speed, particularly with conventional four-wing rotors, was that rubber tended to band onto one rotor and blending and distributive mixing across the mix was, as a result, poor. Rotors such as the ST rotor of the Farrel company were developed to try to overcome this problem, but evidence from the field where unmixed lumps of polymer were found

in masterbatch materials, and unmixed sulfur and chemicals in final mixes, indicated that problems still existed. Alteration of the relative rotational angles of the rotors improved the situation, but multipass mixing with cross blending between batches as used by the tyre industry was necessary to take advantage of the higher productivity allowed by this technology.

Against these developments, conventional friction-ratio technology resulted in lower productivity, but better mix distribution, especially when two-wing rotors were used.

Use of even-speed therefore tends to be somewhat polarised, with some (but not all) tyre companies favouring even-speed mixing, and some (but again not all) general rubber goods companies favouring conventional friction-ratio tangential mixers.

3.2.3 Intermeshing Rotor Internal Mixers

The Intermix (**Figure 12**), developed during the early 1930s, appears to have been the first commercially successful intermeshing rotor mixer. It was designed and constructed at Francis Shaw and Company of Manchester to the basic design of an unknown engineer of the ITS Rubber Company.

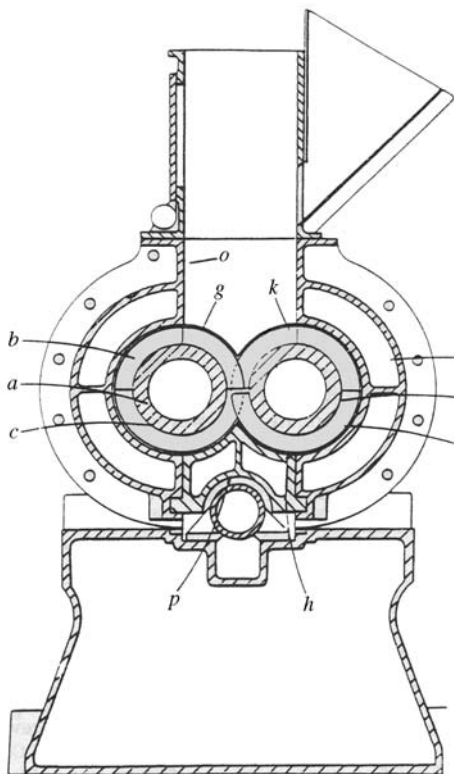


Figure 12

Intermix - Cooke - US patent (a.9)

The concept for this type of mixer uses two scrolls running from end to end of what are basically mill rolls. Each rotor is made to intermesh with the other rotor by allowing one continuous scroll on each rotor to pass through a gap in a second discontinuous scroll on the other rotor. Each rotor transfers material along its length and in the opposite direction to the other rotor. Transfer from rotor to rotor occurs due to the interlocking nature of the rotors, and mixing takes place at the start of the process in the nip between the two rotors. Because of this mixing action, which could almost be described as mathematical, chemical and filler distribution in the mix from an intermeshing mixer is generally better than can be achieved by tangential machines running at even speed. When the mix begins to flow across the top of the scroll, the high extensional shear allows development of very good dispersion.

3.2.3.1 Developments on the Original Francis Shaw Intermeshing Rotor

From the time of conception of the Intermix until the early 1980s, very little change had taken place in the external design of interlocking rotors (**Figure 13**). Redesign of scroll profiles, rotor body shape and the removal of the pressurised end of the long scroll (i.e., the end of the scroll towards which the rubber is driven by the Archimedean screw action) resulted in a new rotor (a.10). This had an increased fill factor of approximately 0.63 relative to a figure of 0.55 which was more typical of the original rotor.

Developments since the NR2 rotor have resulted in the NR5 rotors (305) which have improved cooling, achieved by incorporating what are effectively drillings into the rotor arranged so that virtually the full surface of the rotor is cooled just below the mixing surface. A modified rotor profile has been developed to allow an



Figure 13

Intermeshing rotor

increase in fill factor to figures close to 0.7. This increase in fill factor would appear to have been achieved by reducing the width of the scroll and altering the approach angle of its forward face. It has been suggested that this rotor is more sensitive to fill factor than was either the standard rotor or the NR2 rotor, both of which were very flexible in their capacity to mix low to medium fill factors.

3.2.3.2 Intermeshing Rotor Developments at ThyssenKrupp Elastomertechnik GmbH

From originally making a very presentable copy of the Francis Shaw Intermix, Werner & Pfleiderer (the forerunner of ThyssenKrupp Elastomertechnik) applied their tangential mixer knowledge to introduce the PES-3 intermeshing rotor. This appeared to have a reduced approach angle to the scroll of the rotor, and also to have altered scroll angle and profiles compared to the original intermeshing rotor patent. This allowed an increased 'window' between the rotors and more internal space between the rotors and sides, allowing for increased fill factors.

A development on the PES-3 rotor was the PES-5 with significantly improved temperature control ability, and allowing even greater fill factors. This rotor predated the Francis Shaw NR5 rotor, and employed a similar arrangement of cooling passageways to allow cooling over the full surface of the rotor.

3.2.3.3 Intermeshing Rotor Developments at Kobe Steel Limited

Along with developments in tangential rotors, discussed above (Section 3.2.2.3), this company has also developed an intermeshing rotor which can achieve mix fill factors similar to those of tangential rotors (a.11). This has largely been achieved by removing metal from both pressurised and unpressurised ends of the long scroll, thus allowing easier material transfer from one side of the mixing chamber to the other. This rotor is also available in mixers supplied in Europe by Meccaniche Moderne of Italy (104).

3.2.3.4 Intermeshing Rotor Development by Techint Pomini

Whilst the basic profile of the intermeshing rotor manufactured by Techint Pomini is very similar to the original Cooke patent, the fill factor has been

increased to a figure of around 0.65 for a typical, middle of the road, compound compared to around 0.55 for the original Cooke rotors. This has been achieved by a combination of changes in scroll width, scroll angle and ratios of minimum to maximum rotor diameter. The major contribution from this company is to arrange the rotors in adjustable bearing blocks such that the clearance between rotors can be adjusted prior to or during mixing (hence the name 'the variable intermeshing clearance (VIC) mixer'). The effect of this is to increase the fill factor of the machine from a typical fill of 0.65 to one of 0.69 or greater, and often to allow higher specific power (specific energy per second) input into the mixing batch. The higher specific energy input allows more rapid filler dispersion, shorter mixing times and higher productivity (**Figure 14**). The higher specific energy for NR and ECO compounds indicates the more aggressive mixing behaviour. The increasing specific energy with fill factor for the EPDM compound indicates that even higher fill factors would be possible with this compound. Feed of the machine with cold bales of rubber is also said to be enhanced.

3.2.3.5 Intermeshing Rotor Development by Carter International

Reduction of the approach angle of the scroll in an intermeshing rotor, as has been used by others (Section 3.2.3.1), was thought by this company to reduce the distributive mixing ability of the rotor. It was thought that more material tries to pass over the top of the scroll and is sheared in the approach angle, but transfer of material along the scroll is reduced. The rotor developed at Carter addressed this problem by maintaining a steep approach angle on the front of a wide scroll, ensuring transfer of material along to its trailing end. Early developments altered the trailing end of the scroll to a tangential rotor shape (**Figure 15**). Hence the distributive ability of an intermeshing machine was used to feed material into a compressive shear zone as used in conventional tangential mixers.

A further consideration in the shape of the continuous scroll was that as material transferred along its length, it was likely to increase in temperature and reduce in viscosity. Therefore to maintain a constant flow rate across this scroll, its width was increased as the distance from the end of the rotor increased (**Figure 16**). The actual tangential shaped part of this scroll can be set at a reverse angle, both to increase shear and to assist in protection of the mixer dust stops.

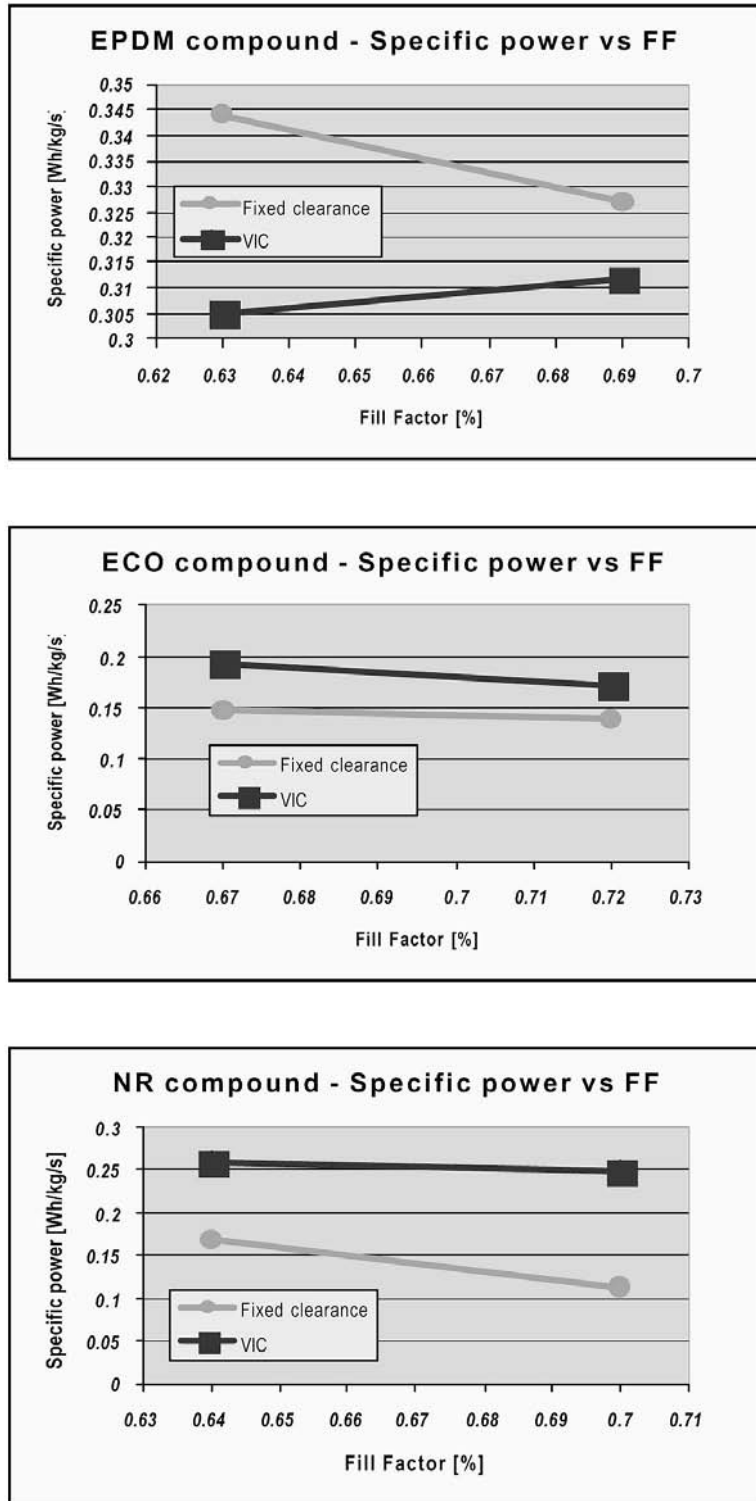


Figure 14

Graph showing the relationship of specific energy to fill factor (FF) in VIC and fixed clearance rotors for three different rubbers: natural (NR), EPDM and epichlorohydrin (ECO)
(Courtesy of Techint Pomini)



Figure 15

Intermeshing rotor - Carter International

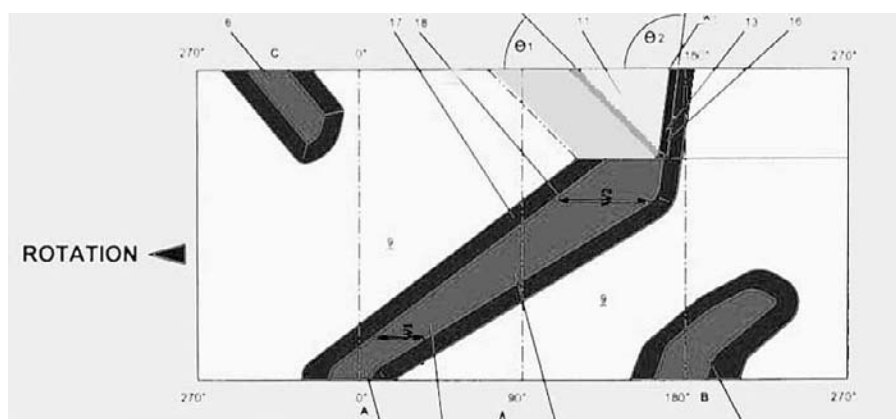


Figure 16

Carter intermeshing rotor footprint

This rotor therefore combines both the extensional shear of the standard intermeshing rotor (across the top of the blade) with the compressional shear of the tangential rotor (at the end of the blade), and has the transfer ability to give the good distributive mixing of a conventional intermeshing rotor. Fill factors are not so high as achieved in some developments where parts of scrolls have been removed, and have been found to be in the 0.65 to 0.67 region.

Recent information from this company indicates that current intermeshing rotors supplied by them do not incorporate all of the above developments, but do have improved cooling circulation in the rotor body.

3.2.4 Hybrid Intermeshing Rotor Developments: the Co-flow-4 Rotor

An interesting development at the Skinner Engine Company in the mid-1990s was the development by Nortey of an intermeshing rotor with a tangential rotor profile (141). Very good results were claimed for this rotor and a large machine was installed in a company in Canada. Comparative data against both conventional tangential mixers and intermeshing mixers, was obtained (139, 140). Further comparative information was obtained using comparable laboratory mixers (85). Unpublished information about the production machine indicates that the Co-flow-4 was capable of

single stage mixing of a soft EPDM compound that had previously required two-stage mixing in a conventional intermeshing rotor machine of similar volume, reducing total mixing time from some eight minutes to three, and reductions in mixing times with significant improvements in batch-to-batch consistency on various harder EPDM compounds. For SBR/BR treadstock masterbatch compounds the viscosity was lower, and better controlled from the Co-flow mixer with, again, significantly better batch-to-batch consistency after conversion (on a traditional tangential mixer) than compound from a slightly larger conventional tangential mixer. The future of this mixer design is presently unknown following the collapse of the Skinner Engine Company and the purchase of its assets and intellectual property by the Farrel Company.

3.2.5 Other Batch Mixer Developments

3.2.5.1 The Pressmixer (229)

Described in the last Review Report, this does not appear to have taken the rubber industry by storm, probably due to the complexity of operation and limited applicability in highly viscoelastic materials. The unit has undergone further development (234, 233), but would appear more suitable to preparation of low viscosity materials and materials with very little elastic element.

3.2.5.2 Watson-Brown Limited High Stress Mixers (HSM)

Although this development is primarily aimed at recycling of scrap rubbers (149, 160), some mention has been made in various articles including a paper given at a meeting of the rubber division of the American Chemical Society in Georgia in 2002 (102), on the possibility of mixing with this device. The machine consists of a rotor and a stator arranged so that the rubber goes through a series of high shear stress and low shear stress regions, allowing good temperature control whilst imparting higher shear than is possible in conventional batch mixers. The possibility of a continuous version of the machine is also mentioned.

3.2.6 The Tandem Mixer (Figure 17)

Described fully in the last review report, this principle, in which the primary mixer discharges into a second (ramless) mixer, does not appear to have been widely adopted by the rubber industry. It is known that one

of the early installations was altered to a conventional mixer and mill layout, with the second mixer converted to a conventional batch mixer by addition of a ram assembly.

Some work continues on this principle, with progress reported in the European Rubber Journal in 2002 (101). Advantages in the removal of ethanol during the silanisation reaction whilst mixing silanes and silicas was reported in a paper given to the American Chemical Society in 2003 (31). Recent information (a.12) indicates that this technology is of growing interest in both general rubber goods and tyre manufacture, especially in Germany, with significant reductions in total mixing times being found.

A necessary feature of the system, as reported in the last Review Report, is that the secondary (tandem) mixer has to be considerably larger than the primary mixer. This improves the surface area in contact with the mix to improve cooling, and helps to maintain the batch within the chamber. As a result, fill factors in the primary machine (assuming intermeshing rotor design) will be in the range of 0.6 to 0.65, whilst in the tandem machine the fill factor for the same batch will be in the range of 0.32 to 0.37. Fill factor of the tandem machine will not exceed 0.4, except in the case of very soft mixes where significant amounts of extra materials are added in the second mixer.

3.3 How They Mix: A Comparison of Mixing Behaviour of Intermeshing and Tangential Rotor Mixers

As may be expected, the mixing behaviour of tangential and intermeshing rotor mixers is very different. An attempt is made below to describe the mixing actions of the different concepts of machine in layman's terms, there being many learned texts published by various educational institutions which may be read by those wishing to explore this interesting subject further.

3.3.1 Tangential Rotor Mixing Machines

Figures 18 and 19 show the basic principle on which tangential mixers work.

It may be seen from **Figure 18** that the wings of the tangential rotors drive the compound away from the ends of the mixer and towards the middle. The angle of wing seen by the compound will affect the amount it is pushed towards the middle; the amount which is

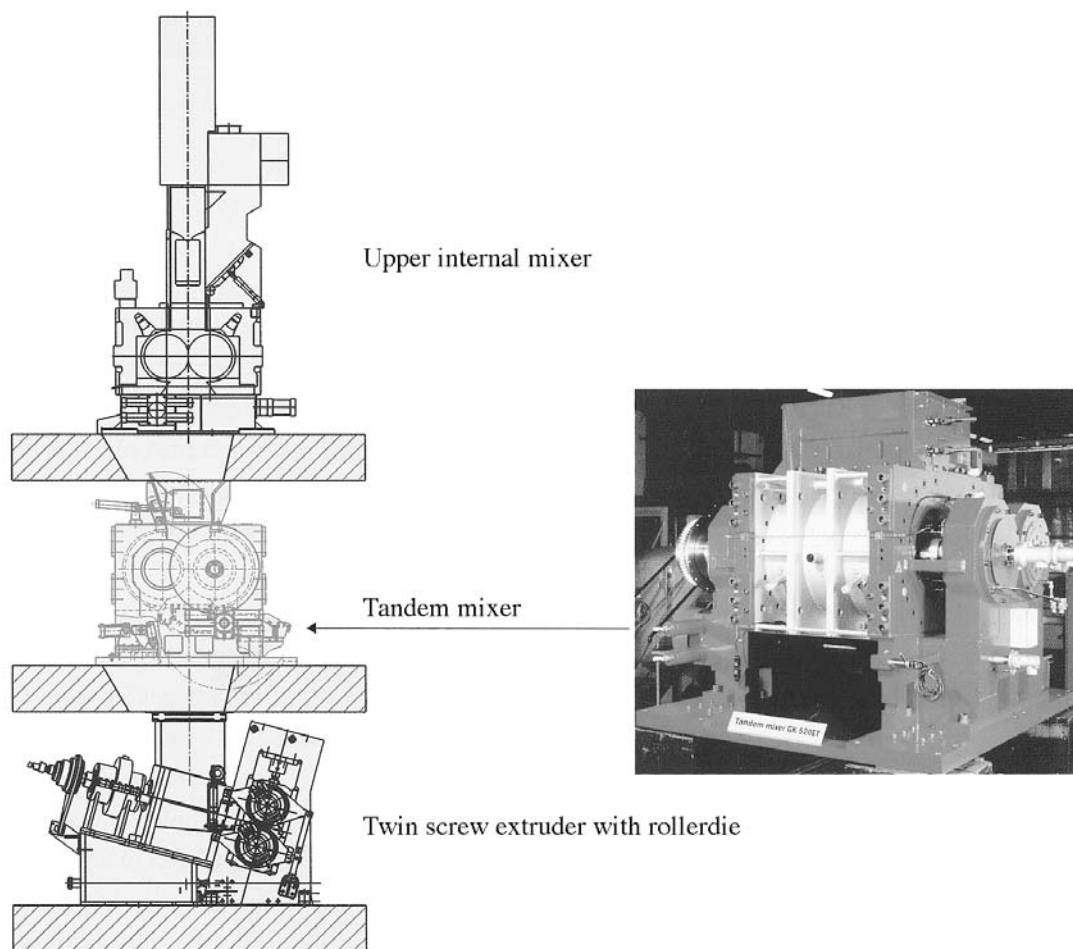


Figure 17
Tandem mixer arrangement
(Courtesy of ThyssenKrupp Elastomertechnik)

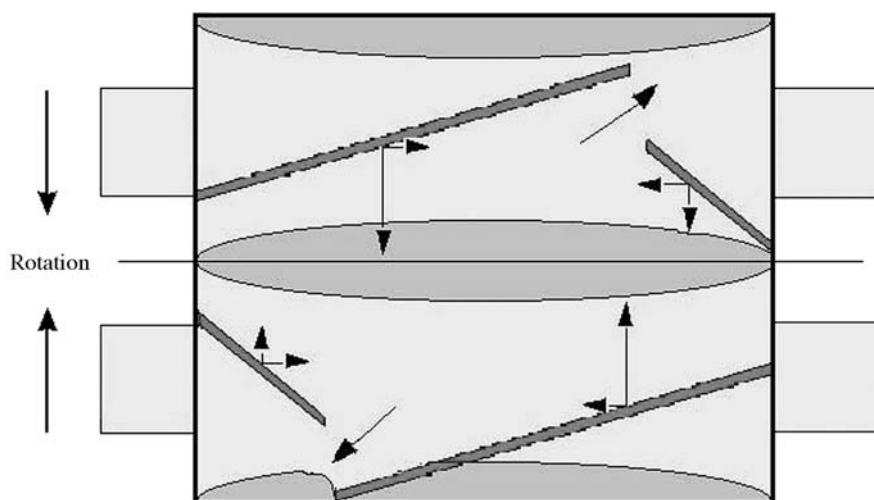


Figure 18
Tangential mixer mixing action (1)

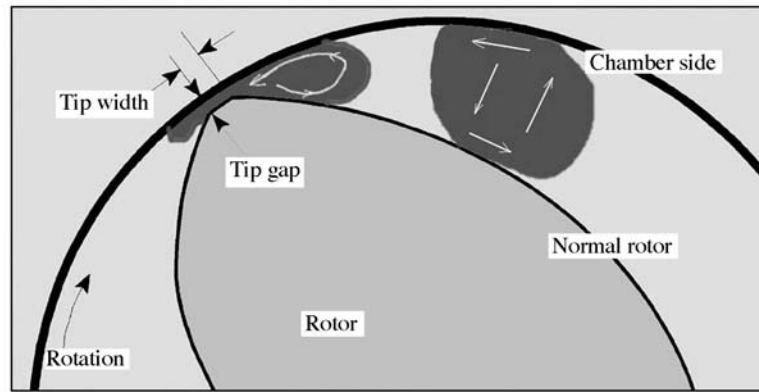


Figure 19

Tangential mixer mixing action (2)

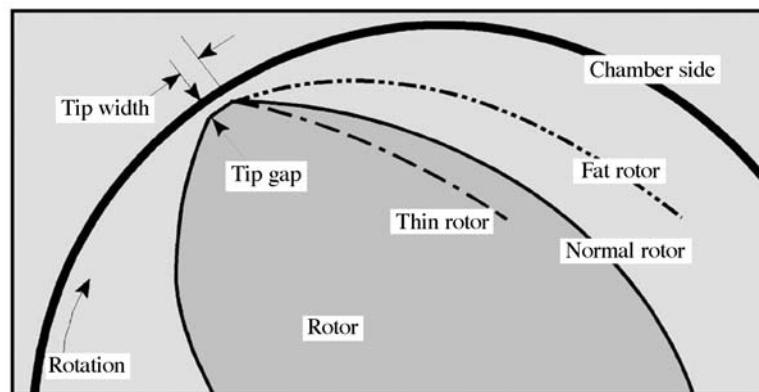


Figure 20

Tangential mixer - volumetric effects of fat and thin rotors

allowed to flow across the rotor tip will depend on both wing angle, tip width and tip gap. The relative lengths of long and short wing will affect the degree of transverse movement of compound within the chamber, the amount of compound carried around on one rotor, and transfer of material from one rotor to the other. Studies of worn rotors indicate that the amount of compound escaping round the end of the long wing is quite high, especially on four-wing rotors, as this is the first area of the body of the rotor to suffer significant wear.

Most tangential machines do not have a consistent chamber length to diameter ratio. Therefore different sized machines have different wing angles and this results in differences in performance between mixer sizes. Differences in performance will also arise from the changes in surface-to-volume ratio with machine size, giving different temperature control performance.

Dispersion within a compound will be affected by rotor shape, tip gap and tip width. Rotor shape effects may be illustrated by reference to **Figure 20**. Approach angle to the rotor tip strongly affects mixing quality. A small approach angle would seem to offer improvements in dispersion, but there is also increased heat build-up and a reduction in the proportion of compound under active shear. A large approach angle by comparison can tend to act as a paddle, moving compound around in the chamber but allowing insufficient compound to undergo shear across the rotor tip. The result in this case could be cooler mixing, better distribution, but poorer dispersion.

Rotor tip characteristics vary with both machine size and wear, larger machines having a greater tip gap to allow better flow of the greater volume of compound across the tip. Tip widths vary from machine to machine, and from manufacturer to manufacturer. True tip width

seen by the compound (the rotational length rather than the width normal to the blade angle) depends on wing angle, and greater tip widths tend to give better dispersion, but may restrict flow across the tip. This characteristic partially explains the recent approach to the use of variable and more acute wing angles exploited by manufacturers to give better material flow across and around a mixer.

In tangential mixing it is commonly thought that dispersion of ingredients occurs largely before distribution. Consideration of material flow supports this concept and may be explained by some of the materials, after initial incorporation of fillers and other ingredients into the polymer by the grinding and wedging action in front of the rotor, passing over the wing tips and undergoing the high shear required to achieve dispersion. When the materials have become more plastic with increasing temperature, flow along the angled wing of the rotor becomes easier, improving the distribution of the mix. Material passing over the tip at this stage in the cycle is less viscous, hence experiencing less shear and dispersive action compared to early in the cycle.

This theory of mixing is supported by consideration of power responses when mixing. The torque curve typically hits a peak shortly after the materials are fed into the machine, illustrating what is thought to be the peak point in dispersive action, and then shows reduction as the cycle progresses and viscosity falls.

3.3.2 Intermeshing Rotor Mixing Machines

Intermeshing rotors, based on the original Cooke patent, have a very different mixing action to a tangential rotor. **Figure 21** indicates how each rotor pushes material

towards the end of the machine with a force vector of the material along the rotor towards 50% of the rotational force vector. This results in a very good distributive mixing action early in the mixing cycle with material flow both across to the other rotor and up into the hopper. This flow above the rotors whilst the material is viscous prevents the ram reaching its bottom position quickly and is probably the reason for the belief held by many that the intermeshing machines do not feed as well as a tangential machine. In fact on those intermeshing rotor machines where the ram is seen to descend very slowly, the area above the rotors acts as part of the mixing volume and the higher ram position during much of the mixing cycle is not a deterrent to good mixing.

With the very wide scrolls used on most intermeshing rotors, most material in the early part of the mixing cycle does not pass over the scroll at all, and hence the belief that the intermeshing rotor machine mixes between the rotors in a similar manner to the two-roll mill. In the early part of the cycle mixing does take place between the rotors, but as chamber wear is seen to be almost as high as on the tangential machines, then some mixing must take place against the jackets. A study of the power trace of a mixing cycle indicates that material starts to flow across the scroll as soon as its viscosity will allow, and mixing torque increases. This flow across the scroll of the rotor results in both high shear and high extensional flow, and accounts for the very good dispersing ability and viscosity reduction during mixing, for which many intermeshing rotor mixers are known.

Intermeshing rotor machines have tended to be larger, and more expensive, for a particular mixing batch size because of the larger relative diameter of an intermeshing rotor to the mixing volume available (**Figure 22**). This

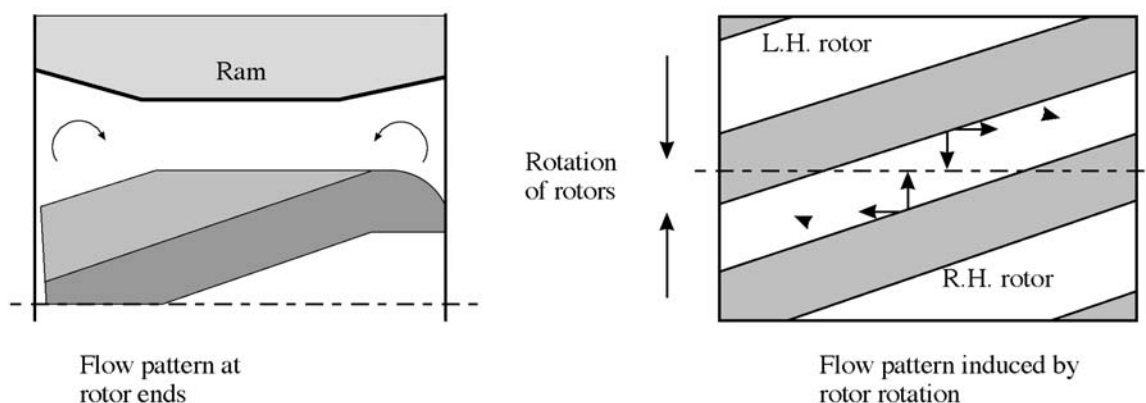


Figure 21

Intermeshing mixer mixing action

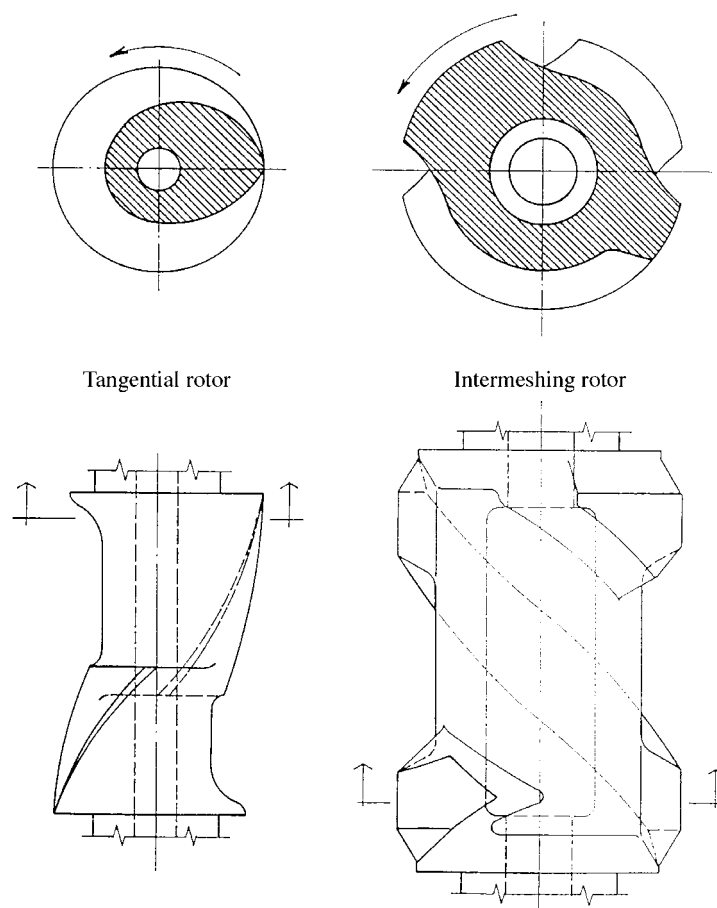


Figure 22

Comparison of tangential and intermeshing rotor size to give equivalent batch size
(Courtesy of Techint Pomini)

was particularly the case with the original design of rotor which had a typical operating fill factor of only 0.55, but as fill factors have increased towards the equivalent tangential machine, this commercial disadvantage is gradually being eroded. Larger rotor chamber diameters result in a much greater surface area to mixing volume ratio, and hence the better cooling characteristics for which these types of machine are noted. The effect of wear on compounding quality is not so much of a problem on most intermeshing machines, as even quite high degrees of wear of both rotor diameter and chamber bore do not alter dramatically the shear to which compound is exposed during mixing.

As indicated, the distribution of ingredients occurs largely before dispersion. Consideration of material flow supports this concept, with the flow over the mixing scroll and consequential high shear only taking place when the materials have become sufficiently plastic with increasing temperature. The consequential increase in mixing torque can, when compounds are

very tough, give problems on the mixer drive system if insufficient power is available.

3.3.3 Hybrid Rotor Mixing Machines

Behaviour of the mixing material in the hybrid intermeshing rotor machine is, as may be expected, a combination of the flow in the two basic types of machine. The fact that the rotors intermesh ensures very good flow from one half of the chamber to the other, with no possibility of materials 'banding' on a single rotor. Hence distributive mixing is likely to be improved compared to a mixer where the rotors do not intermesh. The tangential rotor profile results in dispersion taking place early in the mixing cycle, as is found with conventional tangential rotors. Temperature control is improved compared to a tangential machine as there is an increase in mixing rotor and chamber diameter, for mixers of equivalent batch size.

Table 2. Observations on mixing behaviour in tangential and intermeshing rotor mixers

Observation	Tangential rotor	Intermeshing rotor
Average fill factor	Up to 78%	Up to 75%
Speed of ram descent after feed	Relatively fast	Depends on rotor shape, but generally slow(er)
Time for ram to bottom	30-50% into cycle	50-100% into cycle, depending on rotor shape
Power peak occurs	Earlier in cycle	Later in cycle
Mix development	Disperse/Distribute	Distribute/Disperse
Material motion around chamber	Towards centre, with greater distributional flow with more recent rotor designs	Each rotor carries material towards opposite chamber end, resulting in excellent distributional flow
Oil incorporation	Slower	Faster
Mix temperature control	Poorer - lower surface/volume ratio in mixing chamber	Better - higher surface/volume ratio in mixing chamber
Form of dump	Large lump	Rough sheet

3.3.4 Summary of Observed Differences, and Comparative Mixing Data

Tabulation of differences in behaviour has become more difficult since the introduction of the many different styles of intermeshing and tangential rotors over the last few years. **Table 2** should therefore be considered as a guide only.

Note that the difference in shape of the discharged lump occurs because of the way that the batch breaks at the door edges as the door opens. With an intermeshing mixer on which the door is more closely profiled to the shape of the rotors, the batch is wound out from between the rotors in the form of the gap between them, hence the rough sheet form of the dumped batch. With a tangential machine, a significant proportion of the batch is between the door and the rotors, hence a large lump is dumped followed by material which is carried round and often stretched out by the rotor.

Published comparative data for batches mixed in different types of mixer is comparatively thin on the ground as all mixer manufacturers have vested interests in maintaining sales of all their machines, even if they manufacture both types. The small amount of published information coming from various university research institutions is often developed on laboratory-sized equipment and, particularly for tangential mixers, is not totally indicative of what can be achieved on larger machines. Usually a much better quality of mix is achieved on a laboratory tangential machine than on a production machine, because of the increased surface-to-volume ratio giving much improved cooling ability.

Nevertheless, most published information points to mixing quality and viscosity control being better from an intermeshing rotor mixer (147, 170). This certainly accords with personal experience where many instances have been found where reductions in numbers of mixing stages, more processable compounds, and better filler dispersion have been found when using intermeshing rotor mixers. An exception to this general experience has been published where, in the particular case of ramless mixing during the silanisation process in a tandem mixer arrangement, a recently developed tangential rotor with good material transfer ability was found to give the best results (31). Comparative tests of two intermeshing rotor machines (181) indicates that the increases in fill factor achieved by movement of the rotors in one design may be achieved by other intermeshing rotor designs, but to achieve this there will be significant differences in the intermeshing rotor profiles used which may have different effects on mix quality with some compounds.

3.4 Around the Batch Mixer

Rubber mixing quality depends not only on the mixer itself, but also on control of the whole mixing process, from the moment the raw materials arrive in the factory to the moment the compound leaves the mill room for further processing.

Such important items around a batch mixer as the drive, hopper arrangement, temperature measurement system and discharge system were briefly mentioned

previously, but deserve a little more investigation as all of these affect the ability of the mixer to achieve high productivity and high quality mixing in one way or another. Mixer feed systems, accuracy of weighing of the mix ingredients and mixer control systems are all part of the process and could be considered to be as important as the choice of type of mixer in achieving quality.

3.4.1 Mixer Drive Systems

Invariably a new mixer supplied to the tyre industry, and most mixers supplied to the rest of the rubber industry today would have a variable speed drive system. The days of single speed and two-speed mixers are numbered due to the significant increase in versatility given by a variable speed drive.

There are three options for a variable speed (VS) drive: variable voltage direct current (DC) electrical drives, variable frequency alternating current (AC) electrical drives, and hydraulic drives.

Of these, the first VS drives were invariably of the DC type. As drive sizes increase, the cost of motors escalates rapidly, but this type of drive still has advantages at low speeds over other types of electrical drives, as full torque (or full load current) is available down to a stall condition. This has particular advantages in feeding second pass materials at a low rotor speed.

Variable frequency AC drives suffer from torque limitations at low speeds, and it is not uncommon to have to feed second pass materials at a higher rotor speed than is required for mixing, simply to prevent

the drive from stalling. The advantage of this type of drive is the lower motor cost and easier motor maintenance.

Hydraulic drives (3, 30, 132, 204) have been available for some time and were discussed in the last review report, but some progress has been made and this type of drive is gradually achieving greater acceptance for batch mixers as well as two-roll mills. The layout of hydraulic drives on a tangential mixer is illustrated in **Figure 23**, and it has to be admitted that this type of drive is more suited to a tangential mixer where exact timing between rotors is not required. For a drive of this type to be used on an intermeshing rotor machine, an auxiliary gearbox is required to maintain rotor alignment.

There are advantages in the use of hydraulic drives on tangential rotor mixers, not the least being the space saving compared to a motor and gearbox arrangement; other advantages include savings on power usage (no high current spikes at start-up and lower installed power), safety (extremely rapid stopping of the drive), and the ability to incorporate into the hydraulic system other hydraulically-driven items such as the ram and drop door.

An interesting feature requiring much more development is the potential to radically alter the mixing action of a tangential mixer. Conceivably, with a hydraulic drive on each rotor, one rotor can actually be reversed for part of the time during the mixing cycle. This may well play havoc with the mixer dust stops, but effects on material flow (**Figure 24**) could prove interesting and valuable. The potential for rotor development to exploit this characteristic of hydraulic drives may well be something for the future!

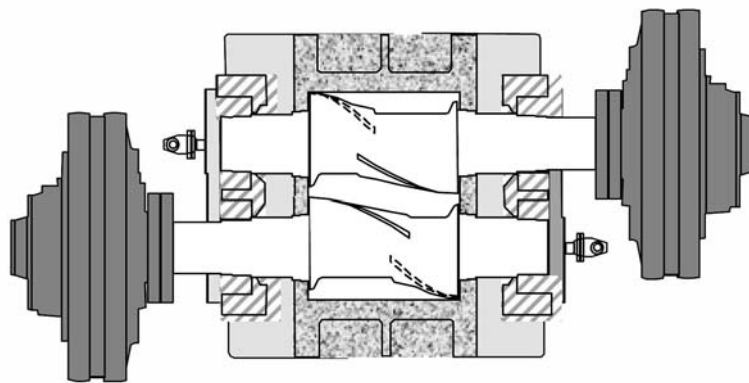


Figure 23

Layout of tangential mixer operated using two hydraulic drives
(Courtesy of Hagglunds Drives)

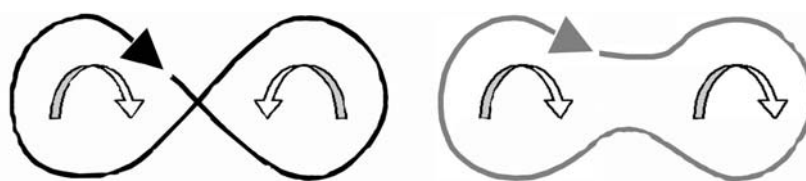


Figure 24

Compound flow with different rotor rotation direction settings
(Courtesy of Hagglunds Drives)

3.4.2 Mixer Hopper and Ram Operation

This has conventionally required pneumatic cylinders and an expensive compressed air supply. Hydraulic operation has become much more popular recently, with a high percentage of new machines now being supplied with this. The major advantage of hydraulic operation is consistency of the mixing operation, with independence from a varying factory air supply. Cleaner mixer operation is assisted as both speed of operation and extent of ram lifts can easily be controlled. Increasing the mixing chamber pressure by use of a hydraulic ram is not an option, as problems with dust stops are likely to follow if this route were to be taken.

3.4.3 Mixing Temperature Measurement

This is perhaps one of the most difficult operations in mixing, and there have been no particular advances here for many years. Two types of thermocouple have, and are still being, used. The first, and most widely used, utilises a strong thermocouple probe fitted with a thermocouple junction, and extending into the mixing chamber at some point. The second type is an infrared temperature measurement system, fitted to the mixer body to 'see' into the mixing chamber.

3.4.3.1 Thermocouple Location

In the tangential machine a thermocouple mounted in the end frame is more robust, but is often far less responsive than one mounted in the door top, although recent rotor designs which improve material flow to the ends of the mixing chamber should have improved the response of endframe thermocouples. Infrared probes are most commonly fitted in an endframe.

3.4.3.2 Thermocouple Response and Accuracy

It is impossible to measure accurately the compounding temperature in a mixer. In truth the temperature

measured by a mixer thermocouple bears some relationship to the true mixing temperature, but this relationship is constant only for one compound, one thermocouple and at one temperature.

Reference to **Figure 25** illustrates the problem. A mixer thermocouple consists of a thermocouple junction, often type J (iron/constantan), braised into a steel surround, and the whole is usually chromium-plated to reduce wear. The temperature measured and indicated is only that at the thermocouple junction. Relative to the temperature of the compound surrounding the thermocouple, this is affected by:

- The position of the junction in its steel body, which can be close or more distant from the probe tip.
- The thickness of the chromium plating layer.
- The heat drain away from the thermocouple junction into the steel body.
- The heat drain from the steel probe into the surrounding body of the mixer, and this in turn is governed by the temperature of the part into which the thermocouple is fastened.
- The actual temperature of the rubber surrounding and passing the thermocouple.
- The heat generated by the friction of the rubber sliding past the thermocouple.
- Whether the thermocouple is constantly surrounded by rubber, or whether it 'sees' some of the free volume in the mixer.

With all these competing influences, it is surprising that the thermocouple is of any use whatsoever, but in fact readings are remarkably consistent.

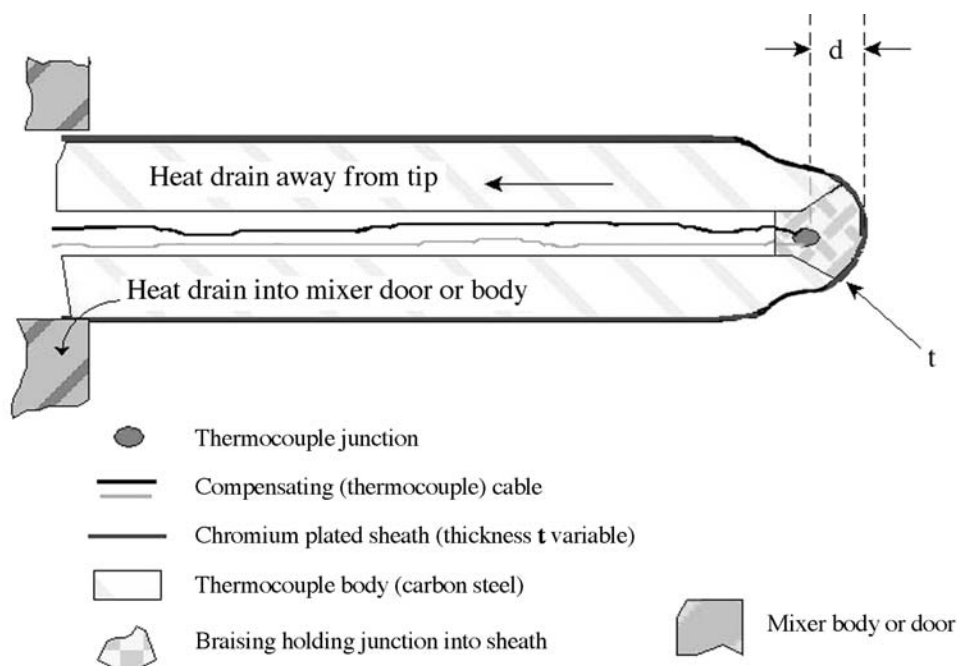


Figure 25

Typical mixer thermocouple indicating problems of temperature measurement

Consistency, however, only runs to one compound and is not present from one compound to the next. To explain this further, a thermocouple 'error' of x °C on one compound will always be $x \pm 1.5$ °C for that compound and thermocouple. For another compound the 'error' on the same thermocouple will not be x °C, but will consistently be $y \pm 1.3$ °C. Hence for control purposes an indicated mixing temperature can be relied upon, providing the discrepancy from true batch temperature has been calibrated for all compounds, and again on installation of a new thermocouple probe.

At various times, the use and accuracy of infrared temperature measurement has been extolled. This is very far from the truth, and accuracy and consistency has not been seen to be any better than the conventional thermocouple. Because of the requirements for a crystal 'window', location of an infrared thermometer has to be in one of the less severe mixing zones, resulting in a system life which is usually extended compared to conventional thermocouples. An infrared probe only measures a surface temperature; the readings are therefore susceptible to the variations which can occur due to frictional heating of the mixing rubber surface, or alternatively to the effects of the cooled metal on the rubber surface from which it may have just parted.

3.4.4 Mixer Temperature Control Systems

The benefits of controlling the mixer temperature rather than simply circulating cooling water around the machine are, at last, widely accepted. Temperatures as high as 50 °C and even 70 °C are now widely used, depending on the compound being mixed. Essential characteristics of a temperature control system for a batch mixer are:

- Each zone must have a sufficiently high water flow rate such that temperature increase through the mixer is less than 2 °C.
- The temperature should be adjustable from 20 °C (wherever possible) up to 80 °C.
- The system must be able to hold its temperature within ± 2 °C over a long run of compound.

The number of temperature control zones is usually recommended by the mixer manufacturer, with three being quite common, one each for rotors, mixing chamber sides and drop door. Where the door top is profiled to the mixer shape, as is often seen in intermeshing rotor mixers, two zones are commonly adequate, one for the mixing chamber sides and ram, if this is temperature controlled, and one for the rotors and drop door.

3.4.5 Mixer Discharge Arrangements

Other than the kneader type of machines which discharge the batch using a tipping mechanism, all mixers utilise an opening door at the bottom of the mixer. Sliding door systems are mostly obsolete, and are only of value where compounds are extremely sticky. Drop door systems are most common, but are subject to occasionally not closing properly. This results in high maintenance costs and loss of production. Drop doors which are positively lifted into location have been found more trouble-free than ones held by a hinge and latch assembly.

3.4.6 Materials Handling Systems and Feed Systems for Batch Mixers

Assuming materials of satisfactory quality have been delivered, then maintaining that quality is the first requisite for satisfactory mixing. Storage of raw materials is very important, particularly in preventing

cross-contamination or ingress of moisture. It is surprising just how many chemical stores fall below an acceptable level, and give rise to problems with compounds or compounding at a later stage.

Handling of the chemicals is becoming increasingly automatic where this can be justified, both for reasons of throughput and for employee health and safety. A typical automatic weighing and mixer feed system for a small mixing plant is illustrated (**Figure 26**) Larger plants, such as those used in the tyre industry, would use bulk silos for major fillers (**Figure 27**). Transfer of fillers from bulk silo to daybin and from weigh station to mixer commonly utilises pneumatic transfer, and the use of checkweigh hoppers behind the mixer to ensure total transfer of the batch is virtually mandatory.

Weighing of the small materials is increasingly being carried out automatically, and a typical small powder weightment system is illustrated (**Figures 28 and 29**). This particular system uses a moving cart system (so-called Smart Cart) on which a scale is

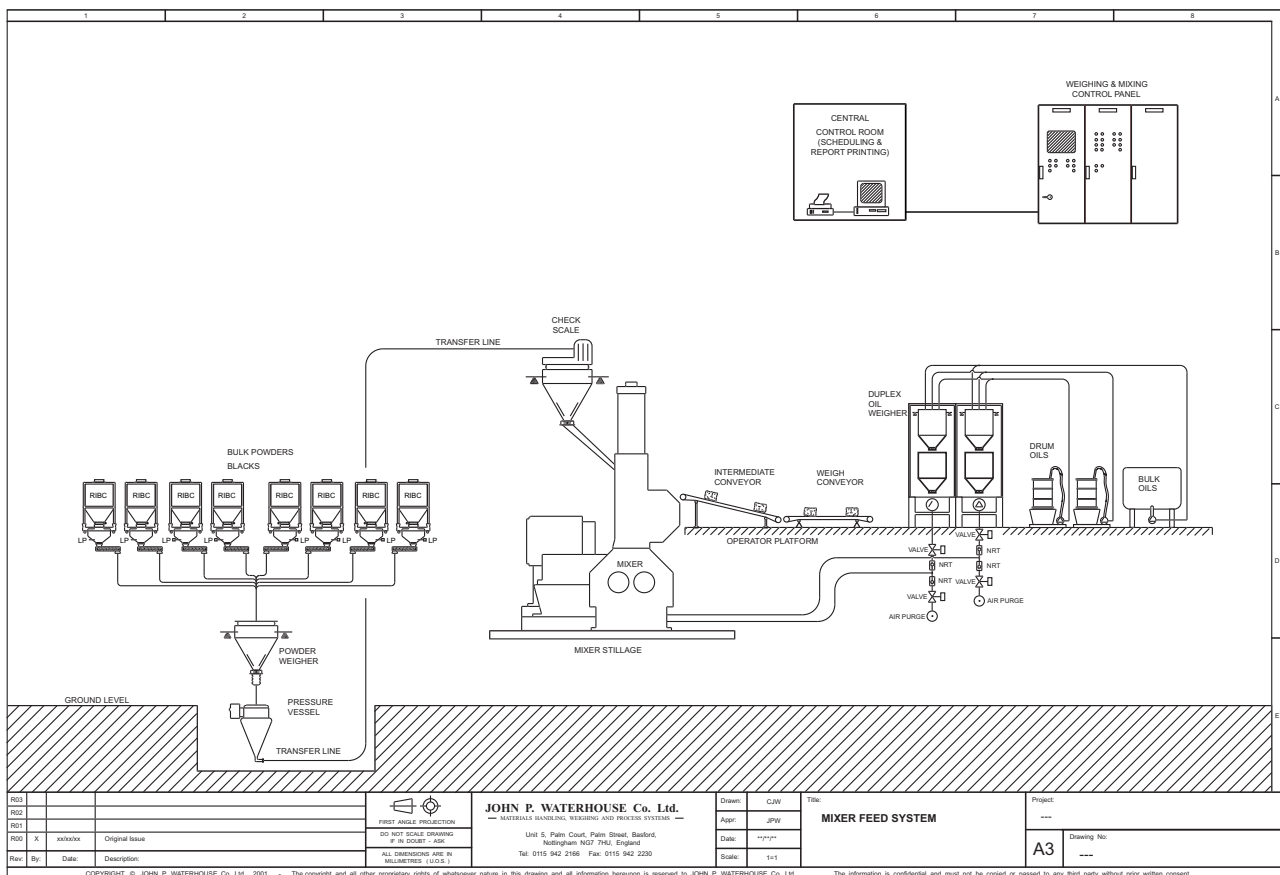


Figure 26
 Automatic weigh system schematic (1)
 (Courtesy of John P. Waterhouse Co. Ltd.)

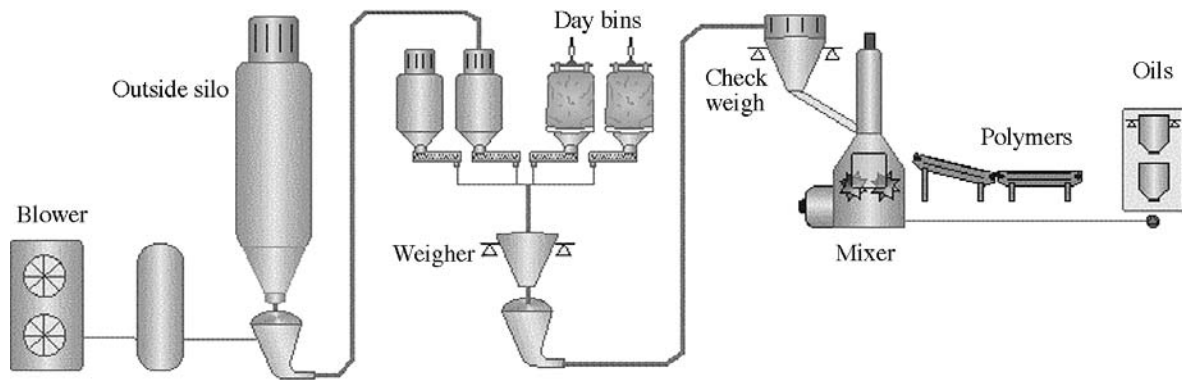


Figure 27

Automatic weigh system schematic (2)
(Courtesy of John P. Waterhouse Co. Ltd.)

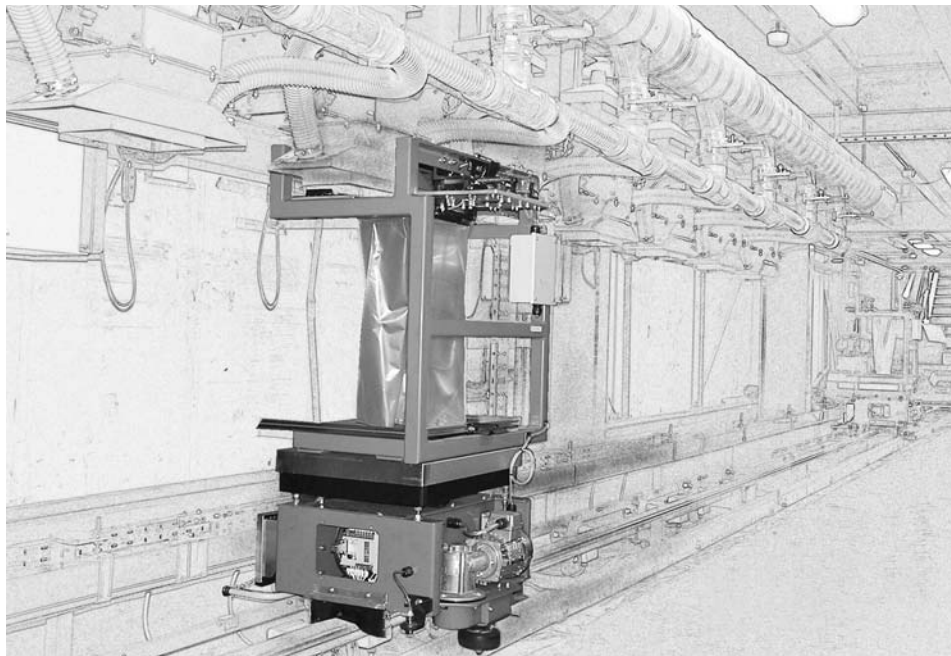


Figure 28

Smart Cart system for small powder weighing
(Courtesy of John P. Waterhouse Co. Ltd.)

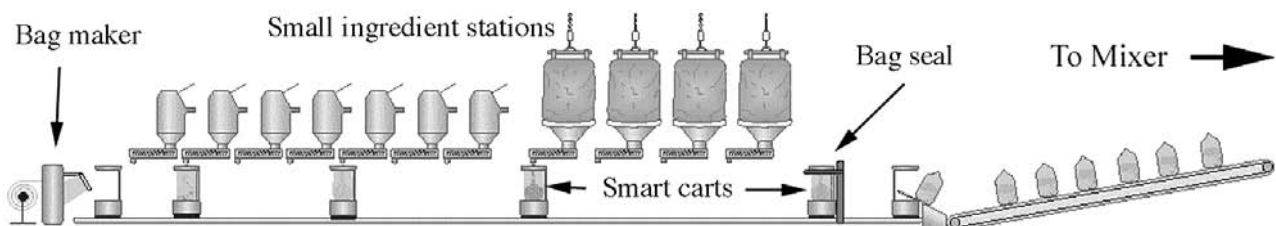


Figure 29

Smart Cart system for small powder weighing schematic
(Courtesy of John P. Waterhouse Co. Ltd.)

mounted. Communication with the computer is by a track bus system, but radio links could well be used for this. Ingredients are weighed into a bag which is automatically fixed onto the scale and which, after filling, is heat sealed and conveyed to the mixer. An alternative and cheaper system would have a computer controlled manual weigh station on rails which can be moved manually to the particular small powder demanded by a display screen attached to the scales, but greater health and safety considerations would be necessary for operation of the manual system. Unlocking of bins for manual weighing could be controlled individually from the computer, or utilising a bar-code system on the scale trolley.

3.4.6.1 Plant Requirements and Weighing Accuracy

The design of the weighing and feeding plant should take into consideration the following questions:

- What accuracy is required in the weight of each material?
- What maximum weight is required on any particular scale?
- What minimum weight is required on that scale, and is it compatible with the range of the scale?
- To what cycle time must the system operate?
- How many ingredients are to be incorporated into the system?
- Can the plant be extended easily?
- How versatile is the system, to accommodate any unforeseen changes in demand?
- Can black and white fillers be weighed in the same scale? (Note - not if coloured compounds are mixed.)
- Does the mixing cycle require fillers to be fed in a single lot, or in several lots?
- Are all the oils compatible for injecting through a single injection system?
- If large amounts of oil are used, is one injection system sufficient?
- Where is the mixing cycle control to be incorporated (the plant control system or the mixer control system)?

Accuracy of weigh scales has improved, and dynamic accuracies of some 0.25% and static accuracies of some 0.1% are now considered as normal. However, the minimum weight which can be made into a scale should be no less than 5% of its range (i.e., 5 kg in a 100 kg scale). Having tight tolerances on weightings can slow a system down, and a compromise will be necessary between accuracy and speed of operation. There has been a movement towards faster and smaller screw feeders, for those materials which can be fed using a screw, and this gives faster and more accurate weighing. Where materials are fed into scales using vibratory feeders, it is common to use cut-off gates to prevent overrun.

Where manually fed scales are required, such as the polymer scale prior to the mixer, anti-fiddle systems can be incorporated to try to overcome the natural tendency of operators to make their life easier by 'fiddling' weightings. This fiddling has generally been achieved by either gentle leaning on the scale until a weighting has been accepted, or to utilise small blocks of polymer (or wood!) to obtain the accurate weighting demanded by the system. Once a weighting has been accepted by a system, the makeweight pieces are removed to use again for adjustment of exact weight on the next batch. Anti-fiddle systems work by rechecking total weights randomly, but these invariably slow systems down to some degree.

For materials that are bad to handle, flexible linings in weigh hoppers are often utilised, so that an air blast can be used to dislodge any material sticking in the hopper. Silos often use baffles to prevent too much weight causing pressurised material to bridge.

Oils are preferably weighed, rather than metered, as accuracy is considerably enhanced, but oil compatibility problems often demand more than one oil system.

3.4.7 Mixing Plant Control and Data Acquisition

These two items are commonly split, with the mixing plant control achieved using programmable logic controllers (PLCs). These are well tried and tested and are robust enough for operation in the harsh environment of a mill room. Setting up mixing cycles, weightings etc., is normally done on a programmable computer which communicates with the PLC but is kept in a clean environment away from the mixing room. Communication generally uses ethernet networks rather than serial links, as the system is said to be more robust.

Data acquisition, is carried out in reverse, with the actual data being measured by the PLC, but collected and tabulated on the computer. Commercial programmes are used for data manipulation to give the various charts, warnings and error messages which may occur.

4 Mixing Techniques in Batch Mixers

There is probably no industry more capable of using varying and variable raw materials than the rubber industry. The industry has grown up using a natural polymer which varies from plantation to plantation, mineral fillers which vary depending on the quarry and rock band in that quarry, and chemicals prepared from the detritus remaining when more valuable materials have been extracted in the oil refinery. In addition various chemical reactions are carried out to give a product, both in the mixer and in the manufacture of the finished article. For this reason the range of mixing methods used and adjustments made would take more space to discuss than is available here.

A summary of techniques used is included below, but for a more extensive discussion on achieving quality mixing, the reader is referred to articles by this author (185, 198).

4.1 Single Stage Mixing

This is popular for productivity reasons, but is only feasible for certain compounds, and where mixing time is not limited by temperature rise. Single stage mixing is very difficult to achieve with highly filled or highly viscous mixes. Conventional mixing techniques are usually used, where the polymer is added first to the mixer, possibly with small ingredients, but excluding the bulk of the fillers. After a period of mixing, the filler is added followed by any plasticisers or oils. Final addition would be the curatives and accelerators, although these are often added on the dump mill following the mixer. Upside down mixing, where the filler and oils are added to the mixer, followed immediately by the polymer, has been used in single pass mixing for EPDM compounds, but is more often used in two-pass mixing of weatherseal compounds.

4.2 Two-, or Multi-Stage, Mixing

This will always give a better dispersion of the finer particle size blacks and is used for compounding tougher

compounds such as those used in the tyre industry. Choice of how many stages of mixing are used is often controlled by compound viscosity considerations, as well as filler dispersion.

4.3 Upside Down Mixing

This is said to improve black dispersion in EPDM compounds. But most of this information comes from the research laboratories of the polymer manufacturers and is developed using small-scale machinery. Upside down mixing is usually disliked by the machinery manufacturers who suspect that dust stop damage and leakage is more likely than when conventional techniques are used, but production mixer control systems usually ensure that a one-shot conventional feed is used where black and oils are added on top of the polymer.

4.4 Variable Rotor Speed

During mixing this has become commonplace for achieving the best possible quality in a single mixing pass. Control of batch temperature and batch discharge conditions are two areas where this technique is very powerful.

4.5 Use of Ram Movement

Since a sight rod was first installed on the ram of an internal mixer, ram movement and ram position have been used to monitor both batch size and progress of mixing. Without the sight rod, even with automatic control of the mixer, the mixing technologist seems to be operating with one hand tied behind his/her back. Such is the power of the rod to indicate what is happening in the mixer. Attempts to replicate sight rods on control system displays are usually doomed to failure as the relative motion is too slow, and too limited in response due to scaling factors (a 2 metre rod is easier to observe than a 20 cm simulated rod).

4.6 Machine Temperature

As mentioned previously, this is very compound-dependent, but in terms of temperatures of different zones in the mixer it is more common to have the mixing chamber sides at a higher temperature than the rotors and drop door. Occasionally these temperatures

may be reversed, possibly if a compound is particularly sticky due to resin additions. In this case the higher temperatures will ensure that any free resin in the area of the rotors or door melts and allows the batch to drop freely when it is dumped.

4.7 Discharge of the Batch with the Ram Up or Down?

This is a common matter of debate in various companies. The one certain fact is that the ram should not be moved whilst the drop door is open, or any loose material from the mixer hopper will fall directly into the discharge/take-off equipment. If discharge takes place with the ram down, it is good practice with a tangential mixer to set the ram in neutral shortly before opening the door. This reduces the chances of squeezing material into the door sealing faces as the door opens. With intermeshing rotor mixers, the pressure of the ram acts onto the rotors rather than through the rotors onto the drop door, and the requirement for exhausting ram pressure is less imperative. If the batch is to be dumped with the ram up, then it is good practice to lift the ram some 10 to 15 seconds before discharge to allow any loose materials from the ram to be mopped up by the mixing batch prior to discharge.

4.8 Thermoplastic Elastomer Mixing

Whilst the mixing of thermoplastic elastomers in batch mixers is not very widespread, this type of machine is perfectly suitable for manufacture of these materials. The mixers themselves require no modification whatsoever, although take off arrangements will have to be modified. Many of these materials have quite high oil content, and for rapid incorporation of oils the intermeshing rotor has been found to be superior. On the other hand, if the dynamically crosslinked materials are being mixed in a batch mixer, it is much easier to follow the crosslinking reaction in a tangential machine. As viscosity increases with crosslinking, the torque increase can be observed as a rise in the drive motor current, and the reaction can be stopped at a particular value. This can give good control over the level of crosslinking.

When using scrap, cured rubbers as the rubber element in thermoplastic elastomers, and polypropylene as the thermoplastic element, it has been claimed that a batch mixer gives better mixing than a continuous mixer (146).

5 Downstream Equipment

The equipment following a mixer depends very much on the products being made on that mixing line, with major differences found between large and small compounding plants, and between those lines mixing curable rubbers and those mixing thermoplastic materials.

5.1 Curable Rubbers

Advances made since the last Review Report in the equipment immediately following the batch mixer have been minimal, compared to the introduction of the biconical twin-screw dump extruder. The use of the twin-screw dump extruder has increased, particularly in the tyre industry, and to a lesser degree in the general rubber goods sector, and more manufacturers now make versions of this device. A typical unit is illustrated in **Figure 30** and consists of two contrarotating biconical screws feeding a set of sheeting rolls. The advantage of this machine is the very low shear imposed on the mixed rubber, consequently it does not add significant temperature to the batch as found when using single-screw dump extruders. Drive to this extruder often uses two hydraulic motors due to space constraints - the only form of extruder yet to be driven by a hydraulic motor. Use of two motors, one to each screw and each with a separate drive control allows variation of screw speeds, one to the other, which is said to improve self-cleaning of the twin-screw machine (a.13).

A development to this machine introduced by one company (a.13) has seen the fitting of a gear pump to the twin-screw dump extruder (**Figure 31**), allowing pressure development with minimal temperature increase. This allows compounds to be strained and is of particular interest in general rubber goods compounding. It would also allow accurate sheet extrusion, with replacement of those roller die extruders which were designed for this product.

Other than this device, the use of the single-screw extruder, fitted with either a roller die, roller sheeter, split-tube die, or rubber pelletiser, is still widespread for masterbatch materials, and the use of two-roll mills is common for finished compound.

Most general rubber goods compounding plants still have a single, or multiple, mill arrangement, depending upon plant output. A single mill tends to cause a bottleneck, particularly if used for adding curatives and if used as a take-off mill into a festoon cooler.

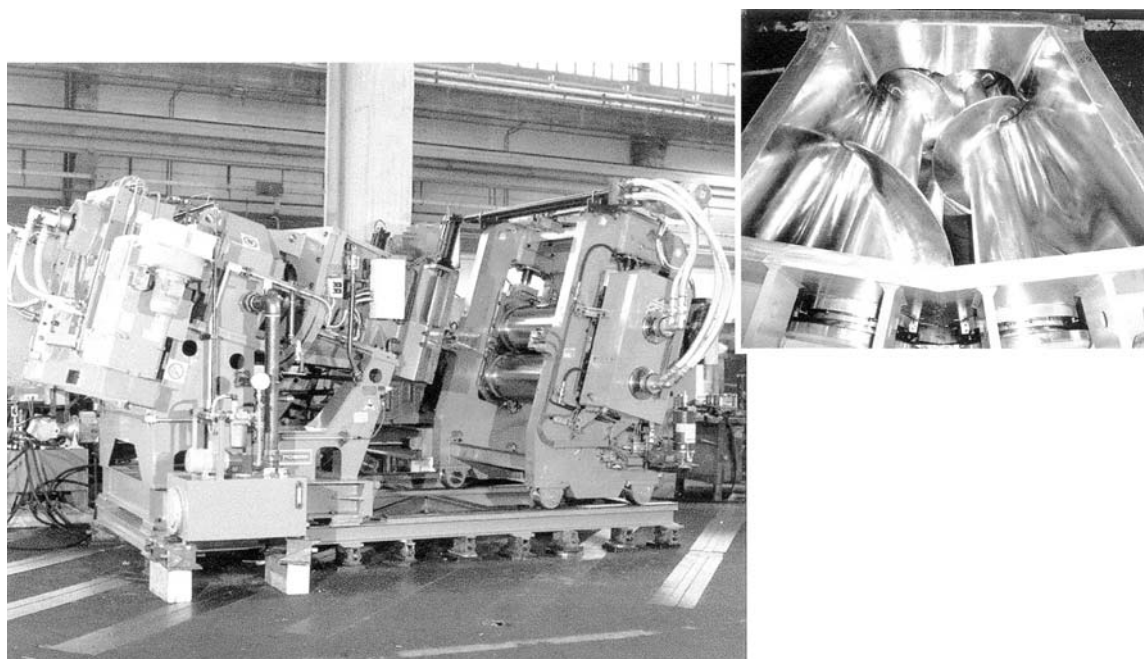


Figure 30

Twin-screw dump extruder
(Courtesy of Techint Pomini)

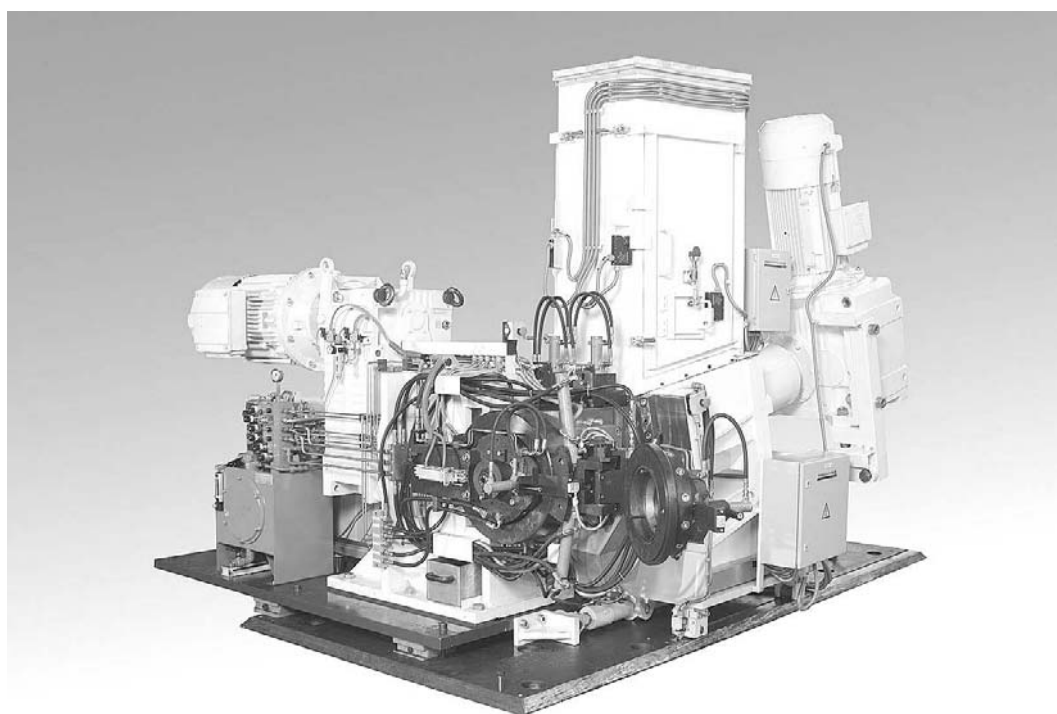


Figure 31

Twin-screw dump extruder with gear pump and strainer head
(Courtesy of ThyssenKrupp Elastomertechnik)

Cooling of rubber sheet would generally utilise a festoon cooler if plant size warranted it. Only the smallest compounding plants would use a manual dip and rack cooling system.

5.2 Thermoplastic Elastomers

Although only a limited amount of thermoplastic elastomer is mixed on batch mixing plant, handling of this type of compound requires a dump extruder fitted, ideally, with some variety of pelletising head. The best type of pelletising head which will cope with all types of thermoplastic elastomer, from the softest to the hardest, is the underwater pelletising head. In this device the compound is extruded through small holes, generally in an annulus about the extruder and die centre line, and is cut by a rotating knife directly into water which flows across the die face and is used to cool and convey pellets away from the head. Alternative pelletising systems which can be used include dry face cutting, where pellets are conveyed and cooled in air, or a water ring pelletiser where pellets are cut in air, but when cut fall into a centrifugally circulating channel of water to cool and convey them away.

An alternative system could use a strand bath and pelletiser, or a heated mill and stair step dicer, but these are likely to be found only in the smallest plants.

6 Monitoring Mixing Quality

The Holy Grail of rubber mixing is to have a test which can be executed in the minimum possible time, certainly within the period that it takes to mix one batch, which can be used to predict the downstream processing properties of the rubber. It should also be capable of indicating that a finished article manufactured from this compound is likely to pass any properties demanded of it and the component's final inspection. With all the effort which has gone into this area, there is nothing, yet, which is universally accepted as fulfilling this duty. Off-line testing is still the norm, but there are some improvements in this area, and in the prospects of on-line testing.

6.1 Off-Line Testing

For many years the primary tests used in assessing mixing quality have been Mooney viscosity, for

masterbatch, and the oscillating disc rheometer (ODR) for the finished compound. Neither of these tests gives any information about the filler dispersion but both are rapid tests which, using limits based on historical association, can be used to pass or fail compound for further processing. Very often, unless specified differently, a compound has been used in production before a full evaluation of its properties is available from the laboratory.

The technologist's armoury of rapid tests to assess mixing quality has been improved by two further items of test equipment, and both these items are seeing much more use. For assessing filler dispersion, the disperGRADER, originally made by Optigrade in Sweden and now marketed by TechPro.Inc. (www.techpro.com), is finding widespread application across the rubber industry. From early beginnings based on the Phillips dispersion test, this is now a valuable, and fast, tool for use in assessing dispersion in both black and mineral filled materials.

A further unit developed for assessment of dispersion, particularly for weatherstrip extrusion compounds where surface finish is very important, is a combined small extruder and surface roughness analysis system. This is a joint development between a mixer manufacturer and an optical instrumentation company (a.14). Developed further with the fitting of a rheometer die, rather than a strip die, the extruder can be instrumented to give rheological information on the compound. An automated method that gives information on shear viscosity at two different flow rates has been developed.

A second test instrument, which is perhaps a little harder to interpret, is the Rubber Process Analyser (RPA) made by Alpha Technologies. This instrument is based on the ODR but is capable of exploring much higher shear regimes. It appears that the instrument is now being used for process control, certainly in the new continuous mixing plants being installed in the tyre industry (95) where its probable application is to confirm the extent of the silanisation process in silica mixing. As this instrument becomes better understood its application in process control, rather than in the research and development laboratories, is likely to spread.

6.2 On-Line Testing

Work continues on the RELMA (REmote Laser MicroAnalysis) system (172) in which spectral analysis is carried out on samples ablated continuously from a passing sheet of rubber compound by a laser. Relative

element concentrations and distributions can be determined, but it would appear that the system has to be tuned to look at a particular element at a time with comparison made with a 'standard' known material. Developments are no doubt ongoing to try to assess continuously the large number of elements found in a typical rubber compound.

Changes in conductivity during mixing of a compound have been examined as an on-line device for measuring black dispersion (197), and it would appear from work carried out in a Brabender mixer that there is a correlation between compound conductivity and mixing torque. The value appears to be in measuring black incorporation time, but whether this could be developed into a suitable on-line test for use industrially remains to be seen.

The most likely system to be successful for on-line testing would seem to be utilisation of mixing parameters obtained from the mixer and feed system. Using mathematical models developed from off-line evaluation of mixed compound, and relating these to particular features of the mixing process would seem to allow development of computer predicted compound quality (37). Whilst still in relative infancy, this could develop into the on-line testing system of the future.

7 Developments in Continuous Mixing Machinery

Continuous mixing equipment has long been used in the plastics industry for the compounding, filling and alloying (blending as it has always been known in the rubber industry) of thermoplastics. Development of the early thermoplastic elastomers (for example Santoprene) was carried out on continuous mixing machinery, and most thermoplastic elastomers manufactured today are still made on this type of equipment. Several machines have been suggested for use in the compounding of curable rubbers, and recent publications (95) indicate that there are now plants in existence utilising continuous mixing for these materials.

7.1 Single-Screw Extruders

Whilst these are used for low quality compounding, particularly addition of filler to polyolefins, in the plastics industry, their use in compounding rubbers is negligible. Attempts have been made to 'mix' a

compound by feeding two masterbatch strips, one of filled rubbers and one of curatives, but these have not proven very successful due to the inability to maintain strict proportions between the two ingredients.

Use of a blended pellet feed, where pellets of the two materials are accurately proportioned, will result in a usable compound, provided that both masterbatches are similar in viscosity, but extruder output is very much reduced compared to using a strip feed.

These machines are not viable for true compounding operations, although a modification of a single-screw extruder had limited success some years ago compounding low viscosity ethylene-propylene compounds. This was the EVK (Extruding, Venting, Kneading) machine made by Werner & Pfliederer. The present status of this machine is not known, as it fell into the Coperion stable, rather than the Thyssen Krupp Elastomertechnik stable when the original Werner & Pfliederer company was split. Coperion, of course, are more concerned with thermoplastic materials than rubbers presently.

Use of single-screw extruders for the addition of small amounts of additive to thermoplastic elastomers, where the amount of blending is limited, and can be enhanced by the use of 'mixing sections' along the screw, is a distinct possibility. The effects of flood and starved feed on blending ability in two different designs of single-screw have been studied (126).

7.2 Single Rotor Continuous Mixing Systems

A concept developed by Freakley at Loughborough University, with prototype units made and developed at Carter Brothers in Rochdale, has been described (86). The arrangement consists of a statistical blending system to ensure successful distribution of mix, and an extrusion screw pressurising the preblend into a single rotor mixing unit. A method of converting the output from the single rotor mixer into a suitable form for downstream use (for example a shaping die, or roller head assembly) has yet to be incorporated.

A second single rotor machine which had some success some years ago in the compounding of elastomeric cable coverings, was the Buss-Ko Kneader. The single rotor in this machine has both a rotating and an oscillating movement, and mixes between the rotor and projections on the barrel wall. Several compounding plants were installed using this machine, giving outputs in the region of approximately 1 tonne per hour.

7.3 Twin Rotor, Contrarotating, Non Intermeshing Continuous Mixers

7.3.1 The Farrel Continuous Mixer (FCM) (Figure 32)

This was probably the first, partially successful, continuous mixer developed for the rubber industry. The mixing principle was akin to a Banbury mixer, with screws feeding a preblend into the tangential mixing section. A controlled back pressure was set on the mix by adjustment of a discharge gate to set the level of mixing. In practice, rotor speeds proved too high, and temperature development too fast, for wide acceptance of this machine as a mixer for curable rubbers. The machine has, however, been extremely successful in the refining and compounding of thermoplastic polymers, and in this respect has seen some use in the compounding of simple thermoplastic elastomers. Only limited oil additions are possible due to the very short compounding section on the rotors and short material dwell time in this machine.

Various developments on the FCM principle have been made by various companies, including versions with long mixing rotors in which the intensity of mixing has been reduced, and versions where the discharge gate has been replaced by a variable orifice where adjustment is made by alteration of clearance against a taper on the rotor end. None of these appears to have achieved any success in the rubber industry, even in the compounding of thermoplastic elastomers.

7.3.2 The MVX (Mixing, Venting, eXtruding) Machine (Figure 33)

Probably developed a little bit before its time, the MVX, developed by Elwood and others at Farrel Bridge in the late 1970s and early 1980s, was a truly successful continuous compounder for curable rubbers. This machine was initially designed to be used in the plastics industry to manufacture products such as filled polypropylene sheet, the idea being to remove the requirement of having plastics compounded with filler as a separate, off-site, operation. It was therefore designed with accuracy of extrusion a high priority. Effectively the machine could be thought of as an extruder with a mixing unit in the feed hopper, with feed of raw materials to the mixing unit under the control of the extruder screw, to give consistent extrusion. With some of the machines in use on various sites today, this machine proved capable of directly extruding accurate nitrile rubber hose sections for use in hydraulic hoses and, in test runs, accurate apex strip for tyres from a harder compound than could be mixed by conventional means.

Operating to give dimensionally accurate extrudate, the MVX had limitations. At relatively low throughput rates the dimensions could be held accurately, but as soon as output was increased dimensional accuracy became inadequate for section extrusion. This was probably caused by the system of feed control which uses an oscillating ram in the feed hopper.

When used only as a compounding unit to provide strip for later cold feed extrusion or injection moulding, the throughput of the MVX became more acceptable,

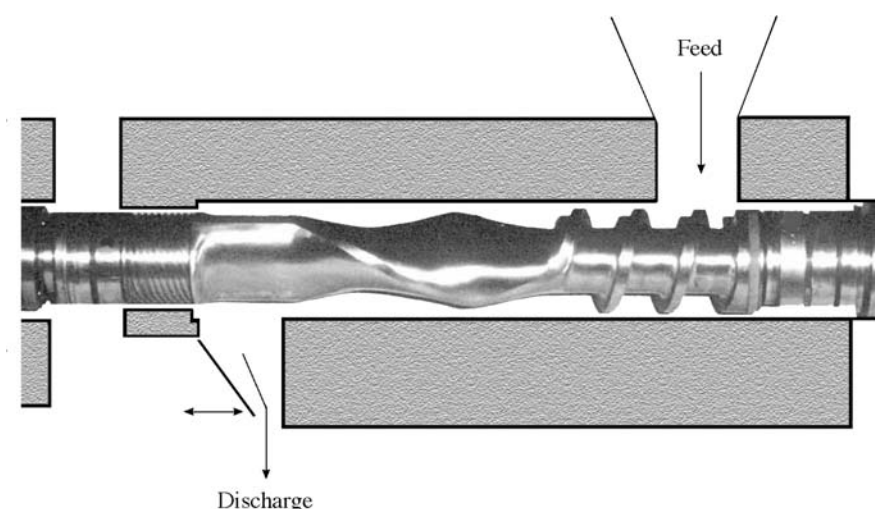


Figure 32
Farrel Continuous Mixer

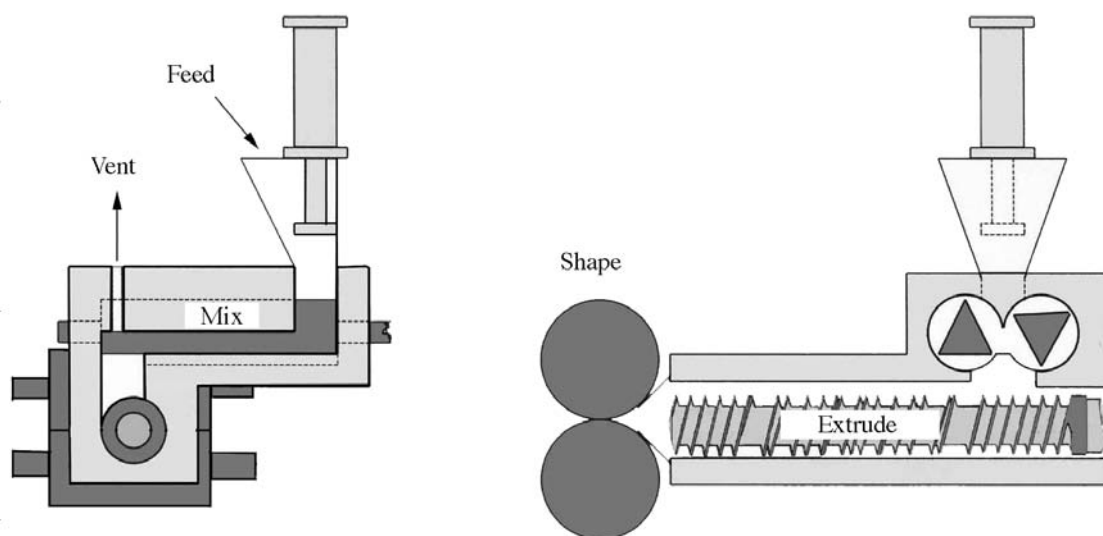


Figure 33

Mixing and Venting Extruder

and compounding rates in the order of 2 tonnes per hour or more of finished compound were not unusual. Masterbatch was produced at even higher rates, once the compounding temperature limitation of some 115-120 °C was removed (5.5 tonnes per hour quoted (46)). All types of vulcanisable elastomer were compounded, from silicone rubbers at one end of the scale, through fluoroelastomers, and including all common rubber types.

Probably the major limitation on this machine was that it was only arranged with a single feed port. It was not suitable for adding curatives later in the mixing process. It was also difficult to control, until software programmes were developed to assist in mixer operation, but a fully automatic plant including materials preparation and compound stacking was operational fifteen years ago. The only manual intervention required between intake of raw materials and take-away of pallets of finished compound was to transfer extruded strip onto a take-off conveyor.

It appears that further development of the MVX concept may be under consideration. (46).

7.4 Planetary Extruders

A machine has been described (67) which is said to be suitable for compounding elastomers, and consists of a series of planetary units in which an arrangement of toothed rollers rotate around a central rotating

shaft. Between planetary sections the central shaft is arranged as an extruder, into which addition of different ingredients can be arranged. Active ingredients can therefore be added prior to the last planetary unit, with a consequent reduction in heat history compared to being fed at the beginning of the process.

7.5 Twin Rotor Contrarotating Intermeshing Extruders

These types of machines have been popular for the compounding of PVC, but do not appear to have made any particular inroads in the compounding of elastomeric materials. It is possible that this type of equipment could be quite successful on simple thermoplastic rubbers, but less so on either curable compounds or the dynamically vulcanised elastomers.

7.6 Twin Rotor Corotating Intermeshing Extruders (Figure 34)

This is presently the type of machine on which most development work in the compounding of curable rubbers, and in the compounding of thermoplastic elastomers, is being concentrated. Like the Betamax video recorder compared to VHS machines, other machines may be better but the corotating intermeshing extruder, presently, raises the greatest market interest. This has come about since the introduction of the high torque machines which can operate at the lower

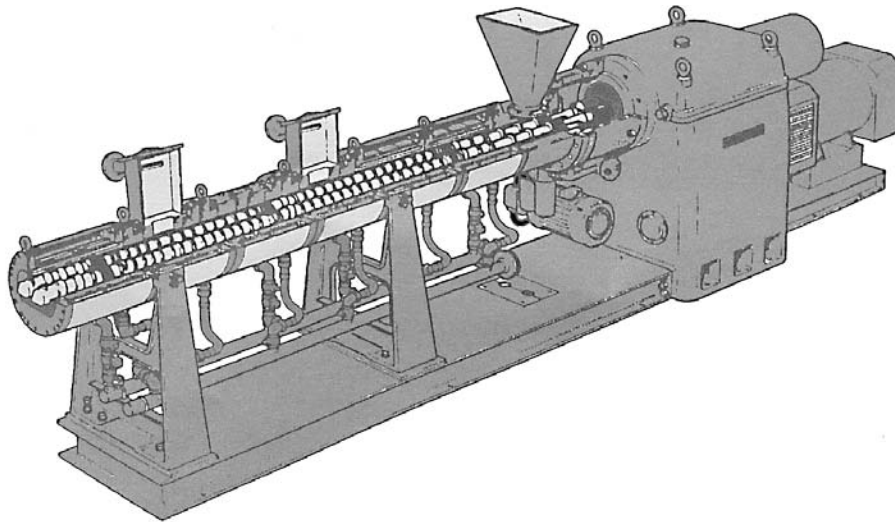


Figure 34

Corotating twin-screw compounding extruder
(Courtesy of Berstorff UK)

speeds necessary for compounding of viscoelastic materials. It is recorded that machines of this type are now in operation in the tyre industry (95), and there has been much development work done, not least at the Deutsches Institut für Kautschuktechnologie in Hanover (39, 65, 66, 70), and others.

The machines may best be described as consisting of an assembly of intermeshing elements onto two-drive shafts, different elements offering different degrees of shear, blending and forwarding action. A selection of different types of elements is illustrated in **Figure 35**. Due to the complexity of the screws, the machines cannot be regarded as totally self-cleaning, although elastomeric materials tend to clear the screws better than thermoplastic materials.

Advantages of this type of machine centre around the ability to add different materials along the barrel, allowing several addition points for oils, process aids and fillers. These ingredients may be added after polymer mastication, with curatives added late in the mixing process. A conventional mill mixing process can therefore be replicated, but in a continuous fashion. Disadvantages include the lack of ability to apply cooling to the compounding screws.

Many companies supply this type of equipment, but only a limited number appear to be actively engaged in developing these machines for compounding of curable rubbers. Of those involved, as one would expect, the major suppliers of batch mixing machinery all appear to be carrying out work in this area. Other suppliers

Right-handed or neutral elements				Left-handed elements	Screw elements
					Mixing elements

Figure 35

Corotating twin-screw extruder intermeshing screw elements

currently active include some who have traditionally supplied extruders to the rubber industry as well as supplying twin-screw machines to the plastics industry. Those companies who have traditionally only had an interest in thermoplastics do not appear to have 'crossed the divide' into thermosetting materials.

7.7 Ring Extruders

Like an overgrown corotating twin-screw extruder, this machine has twelve corotating screws arranged between an outer barrel and a central stator (68). The surface area available for temperature control is therefore significantly greater than on the twin screw machine, and a range of curable compounds has been produced experimentally. A combination of gravimetric feeders is used to feed preblends and chemicals into the machine, and feedports along the barrel can be arranged to allow later addition of various small ingredients in a similar manner to the twin-screw machine. Compound is shaped by passing through an auxiliary single-screw extruder mounted after the ring extruder. Outputs of greater than 1.5 tonnes per hour of finished compound for production sized equipment are expected.

7.8 Other Machines

A continuous machine for cold mixing of vulcanisable rubber compounds, driven by an extruder screw, has been proposed by a development company, but information on this equipment is sketchy (167).

8 Operation of Continuous Mixing Machinery

8.1 Material Suitability

The major obstacle to the operation of continuous mixing is to obtain polymers, fillers and chemicals in suitable form, and maintain feed of the many dissimilar materials used in a range of vulcanisable rubber compounds. Continuous mixing of thermoplastic elastomers does not present the same problem, as a maximum of perhaps four feeds (rubber component, thermoplastic component, filler and oils/plasticisers) is likely in this case.

Although some rubbers, for instance some grades of EPDM and even some black filled rubbers (33, 113, 190), are becoming available in a powder form, for most rubber compounds to be processed continuously requires comminution of the rubber polymers. Although this is relatively easy using modern granulation systems, some partitioning agent is generally required on the polymer to prevent re-agglomeration. This could be carbon black, or any other filler used in a particular rubber compound, but this still begs the question of a universal partitioning material that could be used in any rubber compound. With the wide range of applications for rubbers, no such material is available.

A potential method of overcoming this problem, suggested by Berstorff, is to use a short single-screw extruder and gear pump to feed raw rubber into the continuous compounding process (**Figure 36**), but even

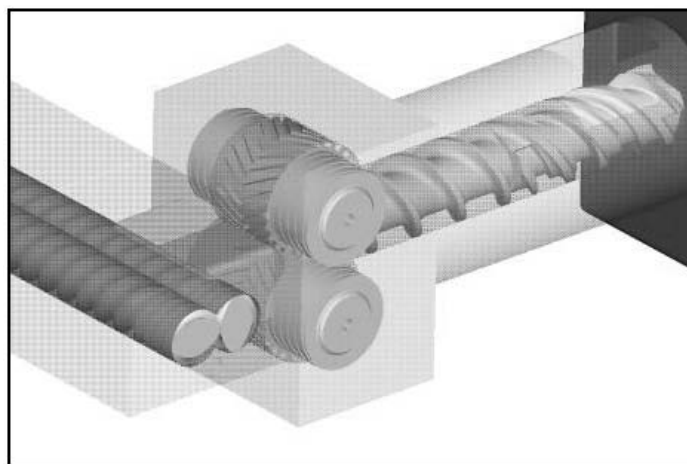


Figure 36

Gear pump/single-screw extruder feed combination for solid rubber compounds
(Courtesy of Berstorff UK)

here bales would require breaking to a size suitable for feeding to the single-screw extruder.

The use of a gear pump feed of solid rubber compound is an ideal way for adding the rubber component to thermoplastic vulcanisates (the so-called TPV materials), once calibration of the gear pump for throughput has been completed.

The second limitation in the development of the continuous compounding of vulcanisable rubbers has been the complexity of most rubber compound formulations. It is easy to consistently feed, in controlled proportions, a limited number of ingredients to a continuous process, even when these are in different forms, but the problem becomes much greater when the range of materials used in rubbers is considered. An approach commonly adopted is to use preblending of ingredients, such that the extensive mixing is completed before the compound passes into the intensive mixing of the continuous processor. Unfortunately, separation due to differing particle sizes and physical forms (pellets, granulate, flake and powders) is common in a preblend. Many different ideas have been put forward to overcome separation, such as the statistical feeder mentioned above (Section 5.2), but use of a range of gravimetric feeders delivering a range of dissimilar preblends is the more common approach. Some high viscosity ingredients (liquid antioxidants or heavy oils and greases) can still present problems.

8.2 Production Scale

A second problem which is encountered with regard to all continuous compounding machines comes in scaling-up machine throughput from the small machines on which development work is usually carried out. Scale-up is often regarded as a volumetric ratio between machines, even on production scale batch mixers but, as may easily be demonstrated when using laboratory sized batch mixers, cycles developed on these machines cannot be directly applied to production machines. With rubbers which include curatives, the critical factor is the maximum processing temperature. As the cooling ability of a machine is proportional to the area of cooled surface, then the true scale-up to maintain a particular maximum processing temperature can only be proportional to the increase in cooled surface area, all other factors being equal. This inevitably results in what appears to be poorer outputs on large machines. Alteration of cooling conditions and machine temperatures may help, but as is often found with temperature control in single-screw extruders, the effect is simply to tinker around the margins.

8.3 Material Take-Off

Material take-off is usually in the form of strip, for a vulcanisable rubber compound, or in pellets for thermoplastic elastomers. Where masterbatch compound is being prepared on a continuous machine, product would preferably be in pellet form, to allow easier feed. This method has been reported as in use by one of the major tyre companies (94, 95).

8.4 Quality Monitoring

Monitoring of product quality from a continuous mixing plant will follow similar lines to a batch mixing plant for curable rubbers.

For thermoplastic elastomers, the possibility of on-line quality assessment using a bypass rheometer fixed to the continuous compounding machine is a practical possibility.

8.5 Comparison with Batch Mixing

Comparison with batch mixed compound of similar formulation indicates that more consistent mixes, with better dispersion, can be obtained from continuous mixing (65), although dispersion from a larger machine is slightly inferior to that from a small laboratory machine (66). This is, of course, dependent on mixing screw configuration for co-rotating intermeshing screw designs, although personal experience would support these findings when using other types of continuous mixing machine.

Economic comparisons of plant costs for continuous mixing plant compared to batch mixing plant are notoriously difficult to determine. For comparative output, the cost of the continuous plant and its ancillaries (feeding, blending, etc.) is likely to be only a little less than a batch mixing plant with its weighing and feeding system, but this depends on the degree of sophistication of each plant. Operating costs of a continuous mixing plant are likely to be less than for a batch mixing plant as there will be fewer, and smaller, electricity power peaks, and manning levels are likely to be less.

8.6 Thermoplastic Elastomers

Thermoplastic elastomers are commonly mixed on continuous plant, especially intermeshing corotating

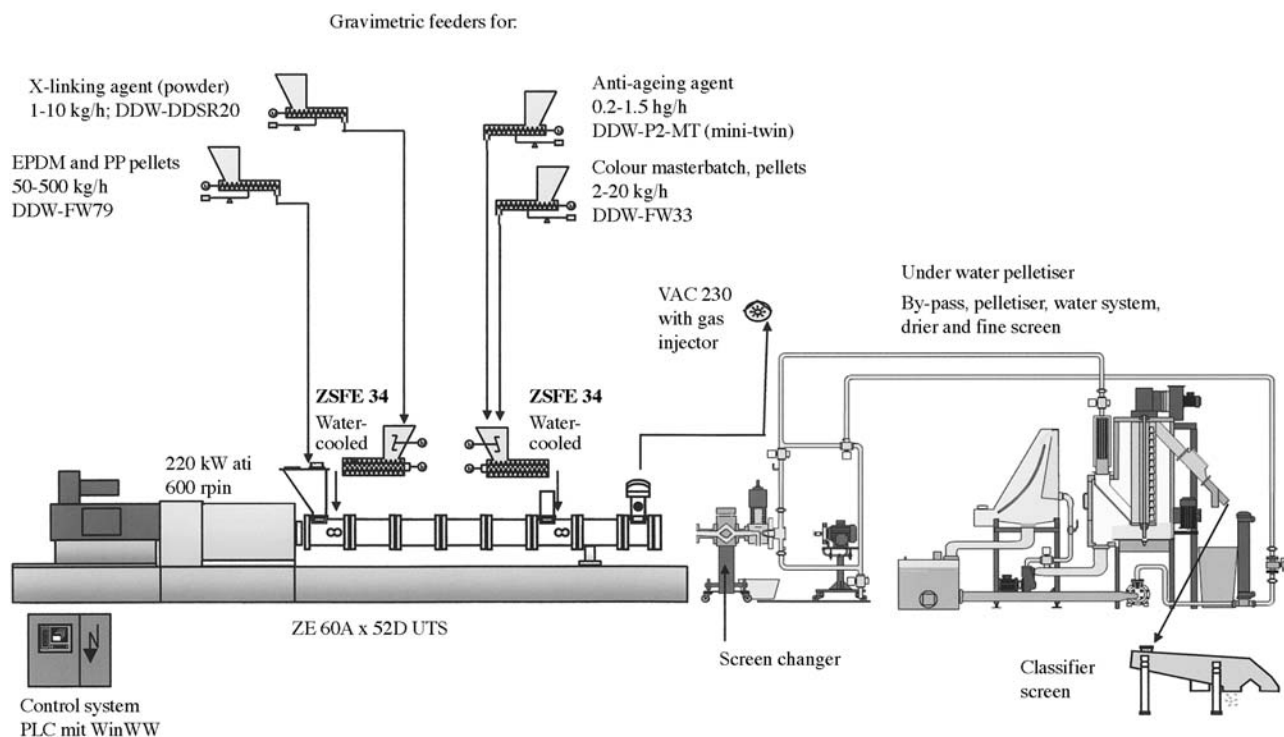


Figure 37

Twin-screw extruder mixing plant schematic (a typical TPV-compounding line)
(*Courtesy of Berstorff UK*)

twin screw extruders. These materials, like curable rubbers, require a multifeed arrangement, and will still require batch rubber materials to be fed to the machine. A typical plant arrangement is illustrated in **Figure 37**, although the particular plant arrangement illustrated assumes a preblend of polypropylene and EPDM as polymer feed, rather than using a separate feed for rubbers incorporating a gear pump.

9 Research and Development

There continues to be much work done in universities and educational institutions to understand the mixing process, much of which is totally ignored by the industry at large, except where they are directly involved. An example of this latter case is the EU-funded pan-European research project on tangential rotors for masterbatch compounding, mentioned earlier.

Deutsches Institut für Kautschuktechnologie in Hanover has been carrying out interesting work on the continuous mixing of both curable rubbers and thermoplastic vulcanisates, with published papers comparing different screw designs, for example (39).

Akron University continues to publish many papers on mixing and blending, more particularly using batch mixers and with a developing interest in intercalation and exfoliation of nanofillers in rubbery materials (41). Osaka City University is also carrying out work on mixing techniques as reported recently (24).

Many other institutions are also concerned with polymer-polymer and polymer-filler interactions (including silane coupling of fillers) and the morphology of filled compounds. A list of institutions taken from recent journals submitted to the Rapra library includes:

- Kaiserslautern University (34)
- Twente University (38)
- AmirKabir University (45)
- Leuven, Catholic University (82)
- Gyeongsang, National University (91)
- Mahidol University (135)
- Akron University (142)
- Université Pierre et Marie Curie in Paris under Jean LeBlanc (42)

Work on mixing mechanisms and mathematical models of mixing and control is being carried out at:

- Qingdao, University of Science & Technology (44)
- South China, University of Technology (77)
- Jiangsu, Institute of Petroleum Technology (158)
- Russian Academy of Sciences (61)
- AmirKabir University (96)
- Institut für Kunststoffverarbeitung (138)

Loughborough University continues to work on mixing and mixing mechanisms (155, 163), although recent published papers seem to concentrate on a single rotor continuous mixer (see Section 5.2).

This list of institutions carrying out research work on mixing, material interactions and mixer design and control is by no means exhaustive, but does give an indication of the worldwide interest in this topic.

There is little doubt that developments in the use of nanofillers, both of clay and black varieties, and including carbon nanotubes, will have a significant effect on the rubber industry, particularly on the range and uses of thermoplastic elastomers over the years to come. The stiffening effects of some of these materials at quite low filler levels appear quite remarkable, and are sure to have an influence on the range of applications of elastomeric materials.

10 The Future?

What will the future bring? Certainly whilst the use of curable rubbers may grow as more of the world becomes developed, it will not grow at the same rate as the usage of elastomeric materials generally. Thermoplastic elastomers, as their properties are improved, will replace curable elastomers in many areas currently the preserve of the cured materials.

The effects this will have on the compounding of rubbers will be that more and more continuous mixing plants are commissioned, and fewer batch mixing plants. Continuous mixing of vulcanisable materials is also likely to see some increase, particularly in the tyre sector as the smaller tyre cell production units replace the present large tyre factories.

What about the machinery? The proliferation of different rotors made available for batch mixers over the last few years leads one to believe that this part of the industry is in its infancy, rather than approaching old age. It is likely that further designs will appear, but some specialisation may creep in where particular rotor designs are matched to particular parts of the industry. In continuous mixing machinery, the corotating twin-screw machine appears, at last, to be achieving inroads into the rubber industry, and this is likely to continue. Other continuous compounding machines which have had a measure of success in the past are likely to be reintroduced in modified form, particularly those, like the MVX, which were shown capable of outputs in terms of tonnes per hour.

Rubber compounds are showing no signs of simplification; therefore the influence of 'black art' looks set to continue for many years to come, and for that, if for no other reason, the rubber technologists of the future will be able to give their heartfelt thanks.

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Abbreviations and Acronyms

AC	Alternating current
BR	Butadiene rubber
DC	Direct current
ECO	Epichlorohydrin rubber
EPDM	Ethylene-propylene-diene terpolymer
EVK	Extruding, Venting, Kneading
FCM	Farrel Continuous Mixer
HDM	High Distributive Mixing
HSM	High stress mixer
MVX	Mixing, Venting, eXtruding
NR	Natural rubber
NTT	New Technology Tangential
ODR	Oscillating die rheometer
PLC	Programmable logic controller
RELMA	REmote Laser Micro Analysis
RPA	Rubber Process Analyser
SBR	Styrene-butadiene rubber
ST	Synchronous Technology
TPV	Thermoplastic vulcanisate
VIC	Variable intermeshing clearance
VS	Variable speed
WFT	Wing Function Technology

Abstracts from the Polymer Library Database

Item 1

Plastics, Rubber and Composites

33, No.4, 2004, p.177-83

USE OF NFM IDDON COLD FEED EXTRUDER AND NOVEL LOW TEMPERATURE CURING EPDM TO REDUCE PROCESSING AND CURING ENERGY CONSUMPTION

Lewan M; Campion R; Iddon M

Materials Engineering Research Laboratory Ltd.; NFM Iddon Ltd.

The formulation of low temperature curing EPDM sulphur-cure compounds containing a compatible liquid polymer for inducing mouldability at low temperatures and ultra-active accelerators for effecting vulcanisation at temperatures as low as 90 to 120C is reported. The results are also reported of extrusion trials carried out on these low temperature curing compounds in an NFM Iddon high intensity mixing scroll extruder. The processing energy consumption and heating of the formulations are compared with those for a high grade EPDM automotive profile control compound as are the mechanical properties. The costs of the polymer/liquid and ultra-fast accelerators are also indicated.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.923506

Item 2

Polymer Engineering and Science

44, No.7, July 2004, p.1247-57

DISPERSION, TEMPERATURE AND TORQUE MODELS FOR AN INTERNAL MIXER

Campanelli J R; Gurer C; Rose T L; Varner J E

Goodyear Tire & Rubber Co.

The development of models based on kinetic, thermodynamic and rheological equations to calculate degree of dispersion, batch temperature and relative batch viscosity at intervals during a mix cycle in an internal mixer is described. Predicted values based on the models are discussed in comparison with experimental torque and temperature curves for mixing natural rubber with carbon black over a wide range of compositions at various rotor speeds. 19 refs.

USA

Accession no.921390

Item 3

Rubber World

230, No.4, July 2004, p.19/37

IMPACT OF MAXIMUM ROTOR CONTROL ON MIXING

Lattstrom L I

Hagglunds Drives

The effect of maximum rotor control(MRC) on mixing is discussed with reference to the knowledge accumulated by Hagglunds over thirty years. The concept of hydraulic direct drives is described and MRC is examined, in terms of speed control, friction control, offset control and rotation direction control. Productivity benefits are considered including low current spikes at start, less power installed, use of installed power, compound quality, drive setting examples, and reliability and maintenance. A comparison of the frequency-controlled AC drive with gearbox and the Hagglunds direct drive is presented and the advantages of the Hagglund concept are listed.

Accession no.921977

Item 4

Rubber World

230, No.4, July 2004, p.24-9

IMPROVED PRODUCTIVITY IN THE RUBBER INDUSTRY

Jorkasky R J

Kobelco Stewart Bolling Inc.

Improved productivity in the rubber industry is defined by mixing a better quality rubber in the same amount of time or less and/or mixing more of the same quality rubber in less time. Equipment (mechanical) parameters that affect productivity are discussed, including milling versus internal mixing, mixer size, rotor design, mixing parameters, rotor speed and material addition. The improvement of productivity via the combination of various parameters is considered. 1 ref.

USA

Accession no.921978

Item 5

KGK:Kautschuk Gummi Kunststoffe

57, No.7-8, July-Aug.2004, p.363-70

RUBBER/FILLER-COMPOSITES. CONTINUOUS AND DISCONTINUOUS MIXING UNDER ASPECTS OF THE MATERIAL QUALITY

Bogun M; Abraham F; Muresan L; Schuster R H;

Radusch H J

DIK eV; Halle,Martin-Luther-Universitat

A comparative study of bale rubber and rubber/filler composite mixing was conducted with the aim of comparing the rheological behaviour of the mixes and the physical properties of the corresponding vulcanisates. By varying the processing conditions, the state of the mixes was changed while maintaining the same composition. The comparison showed that free-flowing rubber/filler composites provided superior quality rubber mixes after just short mixing times (lower power consumption) in discontinuous mixing processes. The state of dispersion of the filler, the viscoelastic properties of the mixes and

the dynamic crack growth resistance of the corresponding vulcanisates were improved significantly. In addition, the continuous mixing process performed on a co-rotating twin-screw extruder was studied for comparison. The very similar levels of the viscoelastic, dynamic and ultimate properties of continuously-mixed compounds indicated the influence of the screw configuration and screw rotation speed. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.920263

Item 6

Industria della Gomma

47, No.9, Nov.2003, p.18-20

Italian

CONTINUOUS MIXING OF RUBBER WITH THE RING EXTRUDER

Fritsche B

Buehler AG

This article discusses the advantages of continuous mixing processes compared with batch mixing processes. It looks at the approach adopted by the Buehler group as a supplier of installations, processing technologies and services for the food industry, animal feed, foundries and the chemical industry in general. Bruehler's polymer activities are reviewed, including granulated rubber processing and in free-flowing powder. A structural model of a ring extruder is examined as well as possibilities offered by twin-screw extruders and ring extruders. A base formulation is given for continuous mixing tests. Also examined is a ring extruder combination with a conveyor belt and an extruder supplied with a head for simulating the complete production process in the laboratory.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
ITALY; WESTERN EUROPE

Accession no.915107

Item 7

Industria della Gomma

47, No.8, Oct.2003, p.

Italian

NEW NR/CARBON BLACK MASTERBATCH FROM CONTINUOUS MIXING IN A LIQUID PHASE

Wang M-J; Wang T; Shell J; Pasquale S; Mahmud K
Cabot Corp.

Cabot Elastomer Composites (CEC) are a masterbatch of natural and batch rubber produced by a continuous mixing process in a liquid phase and allow a superior quality carbon black dispersion to be obtained without depending on batch morphology. This article looks at mixing techniques as well as the CEC process, its characteristics and behaviour during mixing, carbon black and bound rubber and mixing and its problems. Also covered are the effect on Mooney viscosity, vulcanising compound batches

based on CEC, abrasion resistance tests and dynamic hysteresis at high temperature.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.915110

Item 8

China Synthetic Rubber Industry

27, No.3, 2004, p.133-6

Chinese

FINITE ELEMENT ANALYSIS OF BLENDING PROCESS IN S SHAPED ROTOR LONG CONTINUOUS MIXER

Yang Weimin; Mu Han; Ding Yumei; Liu Tongshuai
Beijing, University of Chemical Technology

The long continuous mixer(LCM), a new type of mixer, not only exhibits the good compounding properties of the internal mixer, but it also able to process continuously. A finite element analysis of the blending process of LCM with S-shaped rotors was carried out using ANSYS software. With 70 phr POE, 10 phr EPDM and 20 phr LDPE as the experimental material studied, the distribution law of pressure and velocity field was simulated. The effects of velocity, pressure and the index of power law flow on blending quality and output were also analysed from the simulated results. 6 refs.

CHINA

Accession no.915988

Item 9

Nippon Gomu Kyokaishi

77, No.2, Feb.2004, p.71-6

Japanese

FRACTAL APPROACH TO THE MIXING-MICROSTRUCTURE-PROPERTY RELATIONSHIP ON RUBBER COMPOUNDS

Hirata M

Bridgestone

The use of fractal analysis for characterising the mixing treatment applied to a rubber compound and for determining the filler dispersion developed during mixing was studied. Fractals were also used to examine the fracture surfaces generated during tensile testing of vulcanised samples. The maximum entropy method and the box counting method were used to analyse the mixing treatment and the filler dispersion, respectively. It was found that fractal dimensions of mixer power traces and fracture surfaces of vulcanised rubber decreased with increasing mixing time, while the fractal dimension of the state of mix also decreased. The relationship of the fractal dimensions thus determined with properties such as TS, electrical resistivity and fracture surfaces was then explored. The use of the fractal methods for establishing mixing-microstructure-property relationships was compared with more conventional methods such as electrical resistance and carbon black dispersion. It was

found that the characterisation by fractal analysis agreed with the conclusions from these conventional methods. It was also possible to interpret the relationships between these conventional methods using the fractal concept. 5 refs.

JAPAN

Accession no.916007

Item 10

British Plastics and Rubber

June 2004, p.20

COMPOUNDING LINES DEVELOPED TO MEET GROWTH IN TPES

Uphus R

Berstorff

The physical properties of a TPE-V depend primarily on the phase morphology that is achieved. This is done in a reactive compounding process. Because compounding in a twin-screw extruder is a continuous process, raw material feeding must also be continuous. In plastics processing, materials are usually available in the form of pellets. Rubber, on the other hand, is usually supplied in bale form. Up to now, the only way to feed the rubber continually was to pelletise it. The objective of the new Berstorff development was to establish a method of continuously feeding rubber in the form of bale or strip into a twin-screw extruder. Using a combination of a short single-screw extruder and a gear pump, it is possible to feed either bale rubber cut into strips or pre-compounded rubber in endless strips continuously into the twin-screw extruder. The system is particularly beneficial when used with a pre-batch from an internal mixer.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.914353

Item 11

China Rubber Industry

51, No.5, 2004, p.293-6

Chinese

INSTANTANEOUS POWER CONTROL OF AUTOMIXING IN INTERNAL MIXER

Yi Yu-hua; Huang Wei-bin; Li Jun; Zhao Zhi-qiang; Ma Tie-jun

South China,University of Technology; SCUT Bestry Auto Co.Ltd.

The most important feature of instantaneous power control in an internal mixer is the control of the viscosity of the mixing material. It was shown that the Mooney viscosity fluctuation of the mix could be decreased by using instantaneous power control. During the auto-control mixing, the parameters of the mixing process, such as the rotor speed, filling factor, ram pressure and mix temperature, affected the mix quality. The effect of some of these parameters could be decreased by using instantaneous power control. Instantaneous power control

could be realised using the MLJ-300 intelligent internal mixer control system, by means of which the Mooney viscosity fluctuation of the mix could be controlled within + or -3. 4 refs.

CHINA

Accession no.913767

Item 12

2003 PLACE Conference and the Global Hot Melt Symposium. Proceedings of a Conference held Orlando, Fl., 3rd-7th Aug. 2003.

Atlanta, Ga., TAPPI Press, 2003, Paper 6-3, 30 cm. 012

SERIAL MIXING AS IT APPLIES TO THE MANUFACTURER OF HOT MELT ADHESIVES

Pearce M

Reynolds Industries Inc.

(TAPPI)

Machinery for mixing medium and high viscosity hot melt adhesives is discussed, with emphasis on different blades and blade arrangements.

USA

Accession no.912006

Item 13

Rubber World

229, No.6, March 2004, p.33/40

IMPROVING SILICA COMPOUND PROCESSING: OPTIMIZATION OF THE MIXING EQUIPMENT

Dierkes W; Noordemeer J W M; Kelting K-U; Limper A Twente,University; Paderborn,Universitat; Thyssen Krupp Elastomertechnik

The effects of different mixers and mixer adjustments on the efficiency of the silanisation process were investigated using a passenger car tyre tread masterbatch based on a blend of solution SBR and BR with silica and silanes as coupling agents. Mixers employed were three intermeshing mixers varying in size and two tangential mixers with different rotor geometries. Factors investigated were mixer type, mixer adjustment, pressureless mixing, silanisation on a mill, air injection and mixing temperature. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

Accession no.912226

Item 14

Rubber World

229, No.6, March 2004, p.43-5

DEVELOPMENT OF COMPOUNDING PROCESSES FOR FKM USING TWIN-SCREW COMPOUNDERS

Godavarti S; Koenig S; Worm A

Aspen Research; Worm A.,Consulting LLC

The feasibility of developing a continuous extrusion process for the manufacture of fluoroelastomer blends

was investigated using a parallel, co-rotating, twin-screw extruder. A unit operations methodology, which allowed for stage process development, was employed to scale up the process. Unit operations studied were feed, melt, mix, vent and pump. The extruded blend was evaluated by means of wavelength dispersive X-ray fluorescence, scanning electron microscopy and rheometry.

USA

Accession no.912227

Item 15

Rubber World

229, No.6, March 2004, p.46-50

COOLING IMPACT ON RUBBER MIXING

Ghafouri S N

Farrel

The importance of cooling in the mixing of rubbers is discussed and two examples of successful temperature control in the Intermix, which highlight the importance of cooling efficiency in mixing, are presented. An attempt is made to provide useful calculations relating to the components of the energy balance for a rubber mixing cycle and a correlation is established between the level of silica silanisation reaction and Mooney viscosity measurements. Data from tests on a silica filled passenger tyre tread processed using conventional multi-stage mixing and reactive mixing are presented and discussed. 5 refs.

USA

Accession no.912228

Item 16

IRC 2003. Proceedings of a conference held Nuremberg, 30th June-3rd July 2003.

Frankfurt, Deutsche Kautschuk Gesellschaft eV, 2003, p.245-9, 30cm. 012

OPTIMISATION OF THE MIXING PROCESS AND EQUIPMENT FOR SILICA COMPOUNDS

Diekes W

Enschede, University of Twente; Paderborn, Universitat (Deutsche Kautschuk Gesellschaft eV)

The replacement of carbon black by silica in order to reduce hysteresis of rubber compounds is an item of high interest in the rubber industry. The best-known application for silica is the 'green tyre', characterised by a reduced rolling resistance and, as a consequence, a reduced fuel consumption of the vehicle. The core of this technology is the reaction of the silanol-groups on the surface of the silica with a coupling agent. This reaction reduces the hydrophilic character of the filler surface and increases the compatibility with the polymer. It enables the filler to react with the polymer by creating chemical crosslinks between filler particles and polymer chains. This results in an improvement of the processing behaviour and an active reinforcement by the filler. However, silica technology has its shortcomings: the time-temperature profile required for the silanisation reaction and the upper

temperature limit for scorch-safety increase mixing time. These compounds require 3-4 mixing steps for a complete silanisation, drastically reducing mixer capacity. This problem is approached from the perspective of the mixer. Crucial factors during mixing of this type of compounds are efficient temperature control and evaporation of the ethanol generated during silanisation. Different existing mixer concepts and combinations are compared to elaborate the optimal mixer design for silica compounds. Further mixer adjustments, like improved ventilation and optimal temperation of different areas of the mixer, are tested. Mixing conditions such as fill factor and input of mechanical energy are optimised. Different coupling agents are tested under these optimised mixing conditions. The results of these investigations on laboratory scale and the scale up are presented and the optimised. design of a 'silica mixing system' introduced.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

Accession no.912562

Item 17

IRC 2003. Proceedings of a conference held Nuremberg, 30th June-3rd July 2003.

Frankfurt, Deutsche Kautschuk Gesellschaft eV, 2003, p.275-8, 30cm. 012

MACHINE CONCEPT SCREENING FOR CONTINUOUS MIXING OF RUBBER COMPOUNDS

Priebe J N

Trelleborg Industri AB; Paderborn, Universitat (Deutsche Kautschuk Gesellschaft eV)

The availability of 'free flowing polymers' stimulates a long-lasting tendency in the rubber industry to develop and introduce continuous mixing processes as already applied in the thermoplastics industry. Parts of the industry expect to increase the homogeneity of the compounds' quality and to reduce costs by elimination of various process steps. Investigations in this field have been carried out within the European research project SATPRO (System analysis for the production of technical rubber goods and tires), funded by the European Commission in the 5th frame program. One of the two main subjects of this project is the development of a direct extrusion line for the production of rubber extrudates in a one-step process, combining continuous compounding and profile extrusion. In a first step, an independent machine concept screening is conducted in order to evaluate the suitability of the available extruder concepts for continuous compounding of rubber compounds. This screening is carried out as a round robin test looking at three different extruder concepts established in the market, as there are a planetary roller extruder, a multi-screw extruder and two co-rotating twin-screw extruders.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.912568

Item 18

IRC 2003. Proceedings of a conference held Nuremberg, 30th June-3rd July 2003.

Frankfurt, Deutsche Kautschuk Gesellschaft eV, 2003, p.279-82, 30cm. 012

German

QUALITY ASSURANCE CONCEPT FOR THE RUBBER MIXING ROOM

Keuter H

ThyssenKrupp Elastomertechnik GmbH
(Deutsche Kautschuk Gesellschaft eV)

Rubber compounds consist of a multitude of very different raw materials which have to be mixed with each other homogeneously by means of appropriate mixing aggregates such as the ram mixer. At the receipt of goods in the mixing room no examination is made of the raw materials regarding quality parameters, as the raw material suppliers are normally specified according to ISO 9001 or other similar quality standards. This means that suppliers check the quality parameters before the dispatch themselves, and they indicate the measured values in certificates accordingly. The quality of the compound is determined after the mixing process and before their release for processing. The results of tests are summarised. The correlation between raw material influences, mixing process and the final product characteristics essentially depends on the recipe, the process and the product itself. In case of standard test methods the forecast accuracy of diverging final product characteristics is very little. A considerably better correlation exists between the data of the mixing process and the final product characteristics. Based on the results collected, an optimised concept for the quality assurance for the mixing room is proposed, based on the analysis of all weight data and process data from the mixing room brought together in a control system.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.912569

Item 19

APRI Journal

March 2004, p.12-5

OPTIMIZATION OF THE MIXING PROCESS AND EQUIPMENT FOR SILICA COMPOUNDS

Dierkes W; Kelting K U

Twente,University; Paderborn,Universitat

Studies were conducted with the aim of developing an elastomer mixing system that was specially adjusted for silica compounds. The parameters that had an effect during mixing and silanisation were investigated, including pressureless mixing, different mixer types and air injection. Based on the results, the mixer design was optimised and tests were performed on the laboratory scale and on the production scale. The key to an improvement of the silanisation efficiency was an enhanced evaporation of the ethanol generated during the silanisation reaction. The most effective measures were a pressureless silanisation

step and air injection into the silanisation reactor. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

Accession no.912909

Item 20

Thermoplastic Elastomers Topical Conference:

Stretching your opportunities with thermoplastic elastomers. Proceedings of a conference held Akron, Oh., 22nd-24th Sept.2003.

Brookfield, Ct., SPE, 2003, Paper 14, pp.9, CD-ROM, 012

INTEGRATION OF TWIN SCREW EXTRUSION SYSTEMS FOR TPE COMPOUNDING

Kapp S J

Leistritz

(SPE)

The use of twin-screw extruders in compounding systems for thermoplastic elastomers is discussed. Topics covered include properties of twin-screw extruders, mass transfer regions, direct extrusion, commonly-used auxiliary equipment, material handling and conveying systems, gravimetric feed systems, screen changers, gear pumps and screw pumps, pelletising systems, and programmable logic controller and personal computer-based controls. 11 refs.

USA

Accession no.913039

Item 21

Materie Plastiche ed Elastomeri

69, No.1-2, Jan.-Feb.2004, p.60-6

Italian

THERMOPLASTICS PROCESS ALSO WORKS FOR ELASTOMERS

Nazari G

A continuous mixing process is described which is markedly changing elastomer processing technologies, allowing semi-finished products to be used immediately, thus reducing requirements for storage space within the moulding shop. The process is shown to be making progress in the processing industry as a result of the availability of raw materials with suitable structure, a better knowledge of the phenomena governing the relationship between materials and the development of innovative processing lines.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.910386

Item 22

Rubber India

56, No.1, Jan.2004, p.7-10

ROLE OF POLYMER BOUND PREDISPERSED CHEMICALS

Sin Siew Weng

Sin Rubtech Consultancy Sdn.Bhd.

The history and nature of polymer bound predispersed chemicals (PBPCs) are described. The art and science of mixing is briefly reviewed so that the role of PBPCs in improving mixing quality, productivity and consequently final product quality, with economic as well as environmental benefits, can be more easily understood.

INDIA

Accession no.909633

Item 23

Journal of Applied Polymer Science

92, No.2, 15th April p.871-7

ON THE USE OF EXTRUDERS AS CHEMICAL REACTORS

Natov M; Mitova V; Vassileva S

Sofia,University of Chemical Technology & Metallurgy

Extrusion processing of polyamide-6 (PA6) with acrylonitrile butadiene rubber (NBR) of different nitrile contents, and at elevated temperatures resulted in graft copolymerisation between the two components. Improvement of the impact strength of the PA6 was at a maximum with approximately 10 percent addition of NBR and blends were soluble in formic acid. Products were characterised using infrared and nuclear magnetic resonance spectroscopy, differential thermal analysis and mechanical properties. 16 refs.

BULGARIA; EASTERN EUROPE

Accession no.908594

Item 24

Plastics, Rubber and Composites

32, No.7, 2003, p.291-5

EFFECT OF MIXING SEQUENCE ON THE PROPERTIES OF CARBON BLACK AND SILICA FILLED RUBBER

Kataoka T; Zetterlund P B; Yamada B

Osaka,City University

The Y-sequence mixing of rubber compounds using silane coupling agents has been investigated. Y-sequence mixing has the potential of making it possible to produce different compounds effectively by combining one silica masterbatch with various carbon black masterbatches. Compound properties including Mooney value, modulus, tensile strength, elongation at break, hardness and visco-elasticity have been measured and compared with the results with those obtained using multistep sequence mixing and the all-in-one approach. The results have showed that the compound properties from the Y-sequence mixing were similar to those obtained by the multistep sequence, and superior to the all-in-one mixing sequence. It is concluded that the Y-sequence mixing has potential as a more economical alternative to currently employed mixing processes. 34 refs.

JAPAN

Accession no.908883

Item 25

Industria della Gomma

47, No.7, Sept.2003, p.17-22

Italian

SINGLE-ROTOR CONTINUOUS BLENDING SYSTEM

Freakley P K; Pedrosa H

Loughborough,University; Carter Bros.Ltd.

Continuous blending has currently returned for the greater number of suppliers of raw materials in particle form and for the development of new machines and manufacturing technologies. These include the blender and the continuous blender which was introduced at the Assogomma Technical Conference on continuous mixing. This article looks at powder mixers used in business for rubber compound blending, as well as blender-feeders and the principle of the single-rotor continuous mixer (SRM). It also examines blend composition based on SBR used for tests on the SRM, along with the SRM prototype, blending tests with SBR- and EPDM-based blends and results.

ASSOGOMMA

EUROPE-GENERAL

Accession no.907091

Item 26

Revista de Plasticos Modernos

86, No.566, Aug.2003, p.142-53

Spanish

CARBON BLACK MAIN BLENDS AND NATURAL RUBBER PRODUCED BY MEANS OF LIQUID-PHASE CONTINUOUS MIXING

Wang M J; Wang T; Shell J; Mahmud K

Cabot Corp.

The basic initial mixing phases are reviewed for the production of rubber articles, including load dispersion and polymer ingredients. This article is focussed on the production of the Cabot Elastomer Composite (CEC) that is a main blend of natural rubber and carbon black. It looks at the mixing of CEC as well as CEC features related to the blended product like Mooney viscosity, polymer gel formation and formation of bonded rubber. Mixing equipment is also described along with mixing stages, carbon black dispersion in CEC, as well as vulcanisation features of CEC compounds, physical properties of vulcanised items and resistance to fracture and flaking. 11 refs.

USA

Accession no.907096

Item 27

Engineering Elastomers 2003. Proceedings of a conference held in Geneva, Switzerland, 13th-14th Nov.2003.

Shawbury, Rapra Technology Ltd., 2003, Session 6, Paper 15, p123-128, 29cm, 012

MIPS (MULTI-INGREDIENT-PREWEIGHS)

**- UNIQUE IMPROVEMENTS OF PROCESS
VARIATION AND DISPERSION BY
PREBLENDING CHEMICALS**

Waibel H

Rhein Chemie Rheinau GmbH

(Rapra Technology Ltd.)

The health, safety and quality benefits of supplying rubber compounders with a bag of pre-blended chemicals are outlined. The compounder is not exposed to chemicals as the pre-weighed rubber chemicals are sealed in a low melting point polyethylene bag that is incorporated in the mix. The uniformity and contents of the blended chemicals are checked using near-infra red spectroscopy techniques which results in a far more consistent mix than usually achieved by compounders. Production and quality procedures are outlined.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.905484

Item 28

Engineering Elastomers 2003. Proceedings of a conference held in Geneva, Switzerland, 13th-14th Nov.2003.

Shawbury, Rapra Technology Ltd., 2003, Session 2,
Paper 6, p41-54, 29cm, 012

**OF THE NFM IDDON COLD FEED EXTRUDER
AND NOVEL LOW TEMPERATURE CURING
EPDM TO REDUCE PROCESSING AND CURING
ENERGY CONSUMPTION**

Lewan M,Campion R,Iddon M

Materials Engineering Laboratory Ltd.; NFM Iddon
(Rapra Technology Ltd.)

Extrusion processing trials on a patented range of low temperature cure EPDM sulphur cured compounds developed by the Materials Engineering Laboratory are described. These compounds were formulated with a compatible liquid polymer, which aided mouldability at low temperatures, and ultra active accelerators to enable vulcanisation at temperatures as low as 100C to 120C. Extrusion trials were conducted on a 50mm High Intensity Mixing scroll extruder manufactured by NFM Iddon. Full formulation and processing details are provided, and mechanical and curometry test results given for three low temperature cure compounds extruded together with a automotive grade control compound for comparison. It was concluded that the low temperature cure rubbers evaluated could be successfully extruded with resultant reduction in manufacturing energy consumption and acceptable properties achieved.

NFM IDDON

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN
EUROPE

Accession no.905476

Item 29

Journal of Applied Polymer Science

90, No.14, 27th Dec.2003, p.4038-46

**RELATIONSHIP AMONG PHASE
MORPHOLOGY, OIL RESISTANCE, AND
THERMAL AGING PROPERTIES IN CPE/NR
BLENDS: EFFECT OF BLENDING CONDITIONS**

Sirisinha C; Saeoui P; Guaysomboon J

Bangkok,Mahidol University; Bangkok,National Metal
& Materials Technology Center

Chlorinated polyethylene/natural rubber (CPE/NR) blends with a blend ratio of 50/50% by weight were prepared under various blending conditions. The resistance to oil and thermal ageing of the blends was investigated and correlated with the phase morphology. The NR dispersed phase size in blends decreased with increasing rotor speed up to 45 rpm, and subsequently levelled off at higher rotor speeds. With increasing mixing time at a given rotor speed, the NR dispersed phase size reached a minimum and then increased with increasing mixing time, owing to a domain break-up and phase coalescence, respectively. There is a strong relationship between the NR phase size and resistances to oil as well as thermal ageing: the oil resistance and the thermal ageing properties increased with decreasing dispersed phase size, the higher. 41 refs.

THAILAND

Accession no.904604

Item 30

164th ACS Rubber Division Meeting - Fall 2003.

Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.

Akron, Oh., ACS Rubber Division, 2003. Paper 121,
pp.16, 28cm, 012

**IMPACT OF USING MAXIMUM ROTOR
CONTROL ON RUBBER MIXING**

Lattstrom L I

Hagglunds Drives Inc.

(ACS,Rubber Div.)

The features of tangential mixers with maximum rotor control drive capability from Hagglunds Drives Inc. are described and the benefits of drives with the Hagglunds concept are discussed. Some examples of the ways in which the Hagglunds drive concept, including the maximum rotor control, can be used in the mixing of rubbers to achieve optimal productivity are also given and a comparison is made of a frequency controlled AC drive system with the Hagglunds drive hydromechanical drive system.

USA

Accession no.903405

Item 31

164th ACS Rubber Division Meeting - Fall 2003.

Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.

Akron, Oh., ACS Rubber Division, 2003. Paper 111,

pp.32, 28cm, 012

IMPROVEMENTS IN PROCESSING OF SILICA COMPOUNDS: OPTIMIZATION OF THE MIXING EQUIPMENT

Dierkes W; Noordermeer J W M; Kelting K-U; Limper A
Twente, University; Paderborn, Universitat;
ThyssenKrupp Elastomertechnik GmbH
(ACS, Rubber Div.)

An investigation was carried out aimed at increasing the efficiency of the silanisation reaction through optimisation of mixing equipment and mixing conditions. Tests were performed on a passenger car tyre tread masterbatch composed of a blend of solution-SBR and BR containing silica and a silane, as coupling agent. The effects of various factors (pressure-less mixing, different mixer and rotor types, silanisation on a mill, air injection and mixer temperature) on silanisation efficiency were evaluated and factors contributing to increased silanisation efficiency identified. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
NETHERLANDS; USA; WESTERN EUROPE

Accession no.903395

Item 32

164th ACS Rubber Division Meeting - Fall 2003.
Proceedings of a conference held Cleveland, Oh., 14th-17th Oct.2003.

Akron, Oh., ACS Rubber Division, 2003. Paper 109,
pp.20, 28cm, 012

A REVIEW OF THE DIFFERENT MIXING METHODS AND PROCESS ADDITIVE INFLUENCES IN BLACK AND SILICA FILLED COMPOUNDS

Clarke C; Hensel M
Schill & Seilacher Struktol AG
(ACS, Rubber Div.)

Three different techniques for mixing a silica and carbon black filled tyre tread compound were evaluated and the effect of surfactant-based process additives (modified zinc soaps and a zinc soap/resin combination designated Struktol HT 266) on productivity and compound quality investigated. Mixing methods studied involved the use of a separate filler addition stage for each component type and different orders of filler addition. Mixing efficiency and dispersion/filler interactions were examined and the effects of process additives on Mooney viscosity and extrusion assessed. The cure characteristics, physical properties and dynamic properties of the vulcanisates were also examined. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
USA; WESTERN EUROPE

Accession no.903393

Item 33

164th ACS Rubber Division Meeting - Fall 2003.
Proceedings of a conference held Cleveland, Oh., 14th-

17th Oct.2003.

Akron, Oh., ACS Rubber Division, 2003, Paper 24,
pp.19, 28cm, 012

LIQUID PHASE MIXING: THE FUTURE OF NATURAL RUBBER COMPOUNDING FOR PRODUCTIVITY AND PERFORMANCE

Wang T; Wang M J; Shell J; Wong Y L; Vejins V
Cabot Corp.
(ACS, Rubber Div.)

The distinguishing features of Cabot's continuous coagulation/liquid phase mixing process, which produces NR/carbon black masterbatches having excellent carbon black dispersion and reinforcing quality, are described. These features are high mixing efficiency, no effect of filler morphology and loading on the quality of filler dispersion and retention of high rubber molec.wt. The processability, consistency, stability and chemistry of masterbatches processed using this technology and the properties of various compounds obtained using this technology are reported. 19 refs.

USA

Accession no.903317

Item 34

Journal of Applied Polymer Science

91, No.2, 15th Jan.2004, p.813-9

MELT-COMPOUNDED NATURAL RUBBER NANOCOMPOSITES WITH PRISTINE AND ORGANOPHILIC LAYERED SILICATES OF NATURAL AND SYNTHETIC ORIGIN

Varghese S; Karger-Kocsis J
Kaiserslautern, University

The preparation of composites of natural rubber with a range of natural and synthetic silicates (with or without organophilic treatment) by melt compounding and sulphur curing, and their curing, thermomechanical (DMTA) and mechanical (tensile strength, elongation at break, resilience, hardness, and tear strength) properties, are described. The dispersion of silicates was investigated by x-ray diffraction and TEM and the results are discussed in terms of intercalation and exfoliation. 25 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.902901

Item 35

Nippon Gomu Kyokaishi

76, No.6, June 2003, p.204-9

Japanese

THE UNIT PROCESSES OF MIXING AND EFFECTS ON THE MECHANICAL PROPERTIES

Ahagon A
TYokohama Rubber Co.Ltd.

An investigation was carried out into the effects of filler dispersion, polymer chain scission and bound rubber formation on the mixing and quality of a highly loaded

SBR. It was found that all the above factors proceeded cooperatively and influenced both crosslink density and tensile properties. 18 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.901746

Item 36

Nippon Gomu Kyokaishi

76, No.6, June 2003, p.192-7

Japanese

FILLERS INCORPORATION IN RUBBER MIXING

Takatsugi H

Sinmei Rubber Ind.Co.Ltd.

An investigation was carried out into the incorporation and dispersion of fillers into rubbers. Factors contributing to the dispersion of fillers into rubber were examined and the disadvantages of tangential-type mixers and intermeshing-type mixers for incorporating fillers into rubbers indicated. 8 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.901744

Item 37

Kunststoffe Plast Europe

93, No.9, 2003, p.48-50

ONLINE QUALITY CONTROL

Haberstroh E; Linhart C; Fuchs F; Ryzko P

Institut fuer Kunststoffverarbeitung

The development of an on-line quality assurance system, with the aims of improving the process of evaluation of rubber compound properties and reducing cost and the time required, is discussed. It is shown that by using the functional relationships, determined by mathematical analysis, between the compounding process and the property of the compound or end-product, information from the compounding process can be used to a significant extent in the quality control. As a result, the compounding process, being a quality-determining stage, acquires far greater importance in assessing the compounding properties. This also leads to an increase in the transparency of the compounding process because more accurate conclusions can be drawn as to the cause of any change in the compounding properties. (See German version in *Kunststoffe*, ibid p.157-9, for further graphs/tables)

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.900592

Item 38

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.

Prague, Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 24, pp.11, CD-ROM, 012

EFFECT OF ZINC OXIDE ON THE REACTION OF TESPT SILANE COUPLING AGENT WITH SILICA AND RUBBER

Reuvekamp L A E M; Debnath S C; ten Brinke J W; van Swaaij P J; Noordermeer J W M

Twente, University

(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

The reactions of bis(triethoxysilylpropyl) tetrasulphide (TESPT) coupling agent in rubber blends of solution styrene-butadiene rubber and butadiene rubber containing zinc oxide were investigated. The compounds were prepared by internal mixing, and curing studied using a dynamic mechanical rheology tester. Reaction kinetics were determined using high performance liquid chromatography, and X-ray photoelectron spectroscopy was used to study the reaction of TESPT with the silica surface. It was concluded that the dump temperature after mixing was of paramount importance when TESPT was used as a coupling agent. The presence of zinc oxide resulted in premature scorch, attributed to its catalytic effect on the reaction between TESPT and the rubber. When zinc oxide was added later in the mixing process, the scorch effect was much less and it was possible to mix to higher dump temperatures without pre-scorch problems. Later addition of the zinc oxide resulted in a lower Young's modulus, and better hydrophobisation of the silica surface. The latter was attributed to the TESPT not having to compete with zinc oxide for the silanol groups on the silica surface. 26 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.900215

Item 39

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.

Prague, Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 15, pp.10, CD-ROM, 012

ADVANCEMENTS IN THE CONTINUOUS RUBBER COMPOUNDING PROCESS BY TWIN-SCREW EXTRUSION

Amash A; Bogun M; Gorl U; Schuster R-H

Deutsches Institut fuer Kautschuktechnologie eV

(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

Natural rubber-based powder, containing carbon black, was processed by co-rotating twin-screw extruder, using several designs of screw and mixing elements. The extrudate was characterised by measurements of filler dispersion

and Mooney viscosity. The vulcanised rubber was characterised by stress-strain studies, and measurements of tensile strength, elongation at break, modulus and hardness. It was concluded that the continuous processing of rubber using a twin-screw extruder requires an optimum screw configuration, including a low-shear mixing region for the incorporation of chemicals. A significant increase in throughput was achieved by increasing the screw speed. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.900209

Item 40

IRC 2002. Proceedings of a Conference held Prague, 1st-4th July 2002.
Prague, Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry, 2002, Paper 12, pp.7, CD-ROM, 012

**ZINC-FREE RUBBER PROCESSING
ADDITIVES MATCHING THE PROPERTIES OF
TRADITIONAL ZINC SOAPS**

Galle-Gutbrecht R; Hensel M; Menting K-H;
Mergenhausen T; Umland H
Schill & Seilacher Struktol AG
(Rubber Divisions of the Czech and Slovak Societies of Industrial Chemistry)

The behaviour of a zinc-free rubber processing additive was compared with that of traditional zinc soap and a standard zinc-free additive. Additions of 1.5 and 3 phr were made to carbon black filled blends of natural and styrene-butadiene rubbers (SBR). Comparable reductions in Mooney viscosity were achieved. At mixing, compared with the traditional additive, the zinc-free additive reduced the dump temperature whilst only slightly increasing the energy consumption. It gave the highest extrusion rate, and had an activating effect on curing. Only slight differences in physical properties, including hardness, tensile strength, tensile modulus, elongation at break and tear resistance were observed. The additive was also effective in blends of solution styrene-butadiene rubber (SSBR) with SBR.

Accession no.900206

Item 41

Journal of Applied Polymer Science

90, No.6, 7th Nov.2003, p.1581-8

**MELT-INTERCALATION NANOCOMPOSITES
WITH CHLORINATED POLYMERS**

Younghoon Kim; White J L
Akron, University, Inst. Of Polym. Engineering

Polyolefins and chlorine-containing polymers were investigated to produce polymer nanocomposites. Natural and organic-treated montmorillonite clays were melt compounded with the polymers. Organic-treated montmorillonite clay dispersed well in polychloroprene, chlorinated-polyethylene, polyvinyl chloride, chlorinated-

polyvinyl chloride, and polyvinylidenechloride polymers, and formed nanocomposites. They were not well dispersed in polyolefins that contain no chlorine. X-ray diffraction and transmission electron microscopy techniques indicated the separation of montmorillonite layers and indicated the formation of polymer nanocomposites in chlorine-containing polymers. Mechanical testing showed enhanced tensile strength and Young's modulus of chlorinated-polymers/clay compounds, but not polyolefins/clay compounds. 26 refs.

USA

Accession no.899634

Item 42

Revue Generale des Caoutchoucs et Plastiques

No.809, Dec.2002, p.44-52

French

**WHAT IS THE OPTIMUM BLENDING FOR
RUBBERS?**

Leblanc J-L
Paris, Universite Pierre et Marie Curie

By calling upon empirical knowledge and an accumulation of savoir-faire, the blending of rubber remains a complex operation. In this article, however, the author tries hard to demonstrate mechanisms that lead to a better understanding. The technique for blending rubber is explained in detail. This includes the various blending stages based on silica and the points used for sampling. Occurrence of rheological properties is traced during blending operations. A diagram is given for the morphology of carbon black rubber blending. The author also discusses kinetic aspects of blending, dispersion of particles and the development of rubber-charge interactions. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.898764

Item 43

APRI Journal

Sept.2003, p.15-6

**QUALITY MANAGEMENT SYSTEM -
COMPREHENSIVE APPROACH FOR QUALITY
AND PRODUCTION OPTIMIZATION FOR
MIXING LINE**

Brassas S; Sarbatova M; Priebe J N
Mixcont AB; Trelleborg Industri AB

A brief report is presented on the MixCont Quality Management System, a comprehensive approach for quality control and optimisation of rubber mixing. Information is provided on the data needed for optimisation of rubber compound production and the MixCont control module for rubber compound optimisation.

EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.897975

Item 44

China Rubber Industry

50, No.8, 2003, p.481-5

Chinese

PREDICTING MAIN TECHNICAL PARAMETERS OF INTERNAL MIXER BY BP NEURAL NETWORK MODEL

Yang Fu-qin; Wang Chuan-sheng; Hou Yong-zhi

Qingdao, University of Science & Technology

The technical parameters of an internal mixer, such as maximum power consumption, specific energy consumption, mixing time, capacity and dumping temperature, were predicted by BP neural network model using rotor speed, filling factor, ram pressure and cooling water temperature as the input parameters. It was found by comparison of the measured results with the predicted results that the prediction by BP neural network model could meet the requirement for precision in quantitative calculation and provide a new means for analysing the complex mixing process in an internal mixer. 5 refs.

CHINA

Accession no.896313

Item 45

Rubber Chemistry and Technology

76, No.1, March-April 2003, p.239-52

FORMATION OF RUBBER PARTICLE AGGLOMERATES DURING MORPHOLOGY DEVELOPMENT IN DYNAMICALLY CROSSLINKED EPDM/PP THERMOPLASTIC ELASTOMERS. I. EFFECTS OF PROCESSING AND POLYMER STRUCTURAL PARAMETERS

Goharpey F; Katbab A A; Nazockdast H

AmirKabir, University

Results are presented of a study carried out with the aim of gaining a better understanding of the mechanism by which the morphology was developed during the melt mixing of EPDM rubber and PP in the presence of a crosslinking system. Attempts were also made to study the effects of the mixing condition and polymer structural parameters on the degree of rubber particle networking. The results obtained indicated that the structure of the rubber aggregates and the associated networks, together with the extent of interaction between the two phases, played an important role in controlling the final morphology, processing behaviour and, therefore, mechanical properties of the dynamically cured blend system. 27 refs.

IRAN

Accession no.895435

Item 46

Rubber World

228, No.4, July 2003, p.31-5

CONTINUOUS TANGENTIAL MIXING OF ELASTOMERS

Wickenheisser P

Farrel

The structure and principles of operation of various continuous mixers for processing of rubber are described. The mixers considered are the Farrel Continuous Mixer, the Mixing Venting Extruder and the Spiramax mixer/extruder. Mixing elements, which use tangential mixing technology derived from continuous mixers for use in co-rotating twin-screw extruders are also considered. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.894111

Item 47

Rubber World

228, No.4, July 2003, p.28-30

TILT MIXER ROTOR EVOLUTIONS

Glasser P F

Midlands Millroom Supply Inc.

Some of the applications where the tilt mixer offers a viable alternative to more conventional drop/slide door mixers are identified and design differences between tilt mixers and internal mixers are indicated. Details are also provided on the latest and most advanced tilt mixer from Moriyama. The performance of this new mixer, called the G-III mixer, is compared with that of other mixers.

MORIYAMA CORP.

USA

Accession no.894110

Item 48

KGK:Kautschuk Gummi Kunststoffe

56, No.7-8, July-Aug.2003, p.376-80

German

PROCESS- AND MATERIAL ASSURED COMPOUND PRODUCTION

May W

CT Datentechnik GmbH

Processing control in mixing and quality assurance achievable with present day computer systems and software are discussed. Particular attention is paid to the ability to trace each component used from the beginning to the end of the process.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.894053

Item 49

Polyolefins 2003. Proceedings of a conference held Houston, Tx., 24th-26th Feb. 2003..

Brookfield, CT, SPE, 2003, p.45-52, 27 cm, 012

NEW MIXING STRATEGIES FOR THE REACTIVE COMPOUNDING OF THERMOPLASTIC OLEFINS AND THERMOPLASTIC VULCANIZATES FORMULATIONS

Mack M H; Uphus R

Berstorff Corp.
(SPE, South Texas Section; SPE, Thermoplastic
Materials & Foams Div.; SPE, Polymer Modifiers &
Additives Div.)

This paper discusses the mixing process of polyolefin with rubber components, with special reference to the new screw elements, which have been developed, and which are tailored to the specific needs of dispersing elastomeric materials in a PP matrix. Studies on the particle formation in shear and elongational flows have revealed that a viscosity ratio of approximately 1 between the thermoplastic material and the uncrosslinked elastomer, is advantageous for a simple shear dispersion, and that dispersion can be more easily accomplished with an elongational flow. The mixing studies on the effect of viscosity ratio on domain sizes formed the basis of the development of new shear and elongation elements for co-rotating twin-screw extruders at Berstorff. The reactive compounding of EPDM in PP is used to demonstrate the versatility of co-rotating twin screw extruders, and details are given of the special mixing elements which have been developed based on theories of elongational mixing and which have been tested for TPV formulations. 2 refs.

USA

Accession no.892535

Item 50

KGK:Kautschuk Gummi Kunststoffe

56, No.6, June 2003, p.338/44

INCREASING THE SILANISATION EFFICIENCY OF SILICA COMPOUNDS: UPSCALING

Dierkes W; Noordermeer J W M; Rinker M; Kelting K U; Van de Pol C

Twente, University

An attempt was made to enhance the efficiency of the reaction between the silane-based coupling agent and the silica filler by adjusting the mixing equipment. Different rotor types, temperature-time profiles and more efficient removal of the ethanol generated during the silanisation reaction were the factors investigated. Positive results found on the laboratory scale were verified on the production scale. Measures found to improve the efficiency of the silanisation reaction included working pressure-less in an open mixer with an optimised fill factor, a rotor design combining the good intake behaviour of the tangential mixer and the good temperature control of the intermeshing mixer, air injection into the mixer chamber for better evaporation of the ethanol, and heating of condensation-sensitive parts of the mixer (ram). 17 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; WESTERN EUROPE

Accession no.891733

Item 51

Tire Technology International

June 2003, p.22-5

MIX IT WITH THE BEST

Bogun M; Schuster R H; Goerl U; Radusch H-J
Deutsches Institut fuer Kautschuktechnologie eV;
Degussa AG; Martin-Luther-Universitat Halle

The results are reported of an investigation into the influence of various screw elements and configurations for maximising output in the continuous mixing of rubbers. The mixing capabilities of two different screws are also reported together with a comparison of a laboratory-twin-screw extruder with a large-scale twin-screw extruder. Tests were carried out on two powdered rubbers (NR and SBR) and the data obtained used to develop and optimise a continuous mixing process for powdered rubber.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.891527

Item 52

China Rubber Industry

50, No.5, 2003, p.261-5

Chinese

SCORCH SAFETY OF CR DURING MIXING PROCESS

Zhang An-qiang; Wang Lian-shi; Zhou Yi-yu

South China, University of Technology

The scorch time and dynamic curing index during mixing over a wide range of temperatures (110-160°C) and rotor speeds (40 to 100 r/min) on a Brabender torque rheometer and the Mooney scorch safety were measured using a polychloroprene (CR) mix prepared on an open mill. It was found that the scorch safety of CR mix during the real mixing process could not be well reflected by Mooney scorch safety. A relationship curve and a relationship model for the scorch safety of CR during mixing to the mixing temperature and the rotor speed were fitted on the basis of the experimental data. The effect of the mixing temperature and the rotor speed on the scorch safety of CR mix was explained in terms of the mechanical-chemical reaction in rubber and the model was accordingly verified. The results of the square-error and regression analyses showed that the model could be used to characterise the dependence of the scorch safety for CR during mixing on the mixing temperature and the rotor speed accurately. The scorch safety of CR during mixing depended on the rotor speed more strongly than on the mixing temperature and there was an interaction between them. 9 refs.

CHINA

Accession no.891185

Item 53

163rd ACS Rubber Division Meeting - Spring 2003.
Proceedings of a conference held San Francisco, Ca.,
28th-30th April 2003.

Akron, Oh., ACS Rubber Division, 2003, Paper 81,
pp.15, 28cm, O12

STUDY ON THE WASTE TIRE POWDER/ THERMOPLASTIC BLENDS

Jin Kuk Kim; Sung Hyo Lee; Sung Hyuk Hwang
Gyeongsang, National University
(ACS, Rubber Div.)

The recycling of waste tyres by producing thermoplastic vulcanisate from waste vulcanised rubber powder by blending with polypropylene and polyethylene using a twin-screw extruder was investigated. Extrusion conditions such as screw configuration, temperature profile and screw speed were optimised, and the effect of ultrasonic treatment studied. It was found that addition of the compatibiliser, maleic anhydride grafted styrene-ethylene-butylene-styrene, gave significantly improved mechanical properties. 16 refs.

KOREA

Accession no.890023

Item 54

163rd ACS Rubber Division Meeting - Spring 2003.
Proceedings of a conference held San Francisco, Ca.,
28th-30th April 2003.
Akron, Oh., ACS Rubber Division, 2003, Paper 65,
pp.22, 28cm, O12

**FILLER PHASE DISTRIBUTION IN
ISOBUTYLENE-BASED ELASTOMER
COMPOUNDS**

Waddell W H; Tsou A H
ExxonMobil Chemical Co.
(ACS, Rubber Div.)

Carbon black and silica phase distributions in brominated isobutylene-co-para-methylstyrene rubber (BIMS) blends with various high diene hydrocarbon rubbers (cis-1,4-polybutadiene, natural rubber and styrene-butadiene rubber) were quantified by image processing of their tapping mode AFM micrograph blend morphologies. Preferential filler partitioning into the BIMS phase was found for both fillers and the results are discussed in terms of the mixing processes used and filler characteristics. 23 refs.

USA

Accession no.890008

Item 55

Rubber World

227, No.6, March 2003, p.24/42

RECENT TRENDS IN MIXING TECHNOLOGY

Blum A W
Chemintertech Associates

This detailed article examines recent developments in rubber mixing technology. Section headings include: early developments, the factors affecting the mixing of polymeric materials, the mixing process (incorporation, dispersion, roll mills, internal mixers, extruders), novel mixing concepts and systems, instruments for quality control and process optimisation, trends and opportunities, and conclusions. 24 refs.

POLYSAR; SHELL; GOODRICH B.F.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA;
WESTERN EUROPE

Accession no.886575

Item 56

Polymer

44, No.8, 2003, p.2337-49

**CONTINUOUS ULTRASONIC PROCESS
FOR IN SITU COMPATIBILISATION OF
POLYPROPYLENE/NATURAL RUBBER BLENDS**

Oh J S; Isayev A I; Rogunova M A
Akron, University; Polymer Diagnostics Inc.; PolyOne Corp.

The effect on rheology, morphology and mechanical properties of treating polypropylene (PP) and natural rubber (NR) blends, previously prepared on a twin screw mixing extruder, to ultrasonic excitation whilst passing through a slit die on a separate cold feed extruder was examined. No significant rheological differences were observed, but mechanical properties were improved when compared to untreated materials. Morphological studies using atomic force microscopy indicated interfacial roughening and improved interfacial adhesion between the two polymer phases. It was proposed that ultrasonic treatment caused a copolymer to be formed in situ at the interface between PP and NR, thus improving material properties. 27 refs.

USA

Accession no.885777

Item 57

China Rubber Industry

50, No.2, 2003, p.77-80

Chinese

**STUDY ON DISPERSIBILITY OF NANO-ZNO IN
BR COMPOUND**

Zhou L-L; Chen G-L; Fu Z; Li Y-Q; Mei G-P
Qingdao, University of Science & Technology;
Shandong Xingya New Material Co.Ltd.

The effects of mixing temperature, mixer and processing technology on the dispersivity of zinc oxide nanoparticles in BR were investigated. It was found that dispersivity was improved at elevated temperature in an internal mixer and that blending the zinc oxide nanoparticles with stearic acid before mixing improved both aggregation and dispersivity. 3 refs.

CHINA

Accession no.883024

Item 58

Macromolecular Materials and Engineering

287, No.11, 12th Dec.2002, p.815-23

**COMPOUNDING UNIT PLANETARY ROLLER
EXTRUDER**

Limper A; Seibel S; Fattmann G

Paderborn, Universitat

Planetary roller extruders are shown to be the most successful multi-screw extruders for feeding calender/lamination units, for pelletising, for compounding powdered paint and for the reuse of recycled materials. The range of materials which can be compounded extends from plasticised PVC, via PP and ABS, through to powdered rubber. These extruders are shown to be an improvement on other compounding machines in their thermally careful compounding, the balanced ratio of shear and heat transfer and the narrow residence time distribution. Experimental investigations to analyse the process behaviour of the extruders are reported. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.882180

Item 59

European Rubber Journal

185, No.2, Feb.2003, p.22-5

EPDM MIXING. COMPOUND QUALITY IN THE MIXING ROOM

Limper A; Keuter H; Rinker M; Lindop J
ThyssenKrupp Elastomertechnik GmbH

The effect of raw material variations on final mix quality was studied and differences between intermeshing mixers and tangential types, particularly in the mixing of EPDM-based compounds, were examined. The fines content of the carbon black was shown to have a significant effect on the mixing process. It was concluded that it was possible to save mixing time by the use of modern dense-phase conveying systems, creating the lowest fines content possible in the carbon black conveying process from the silo to the mixer waiting hopper. The pellet hardness could also influence the mixing process, but this was a very complex raw material quality parameter. The degree of long-chain branching of the EPDM also influenced the mixing process. The effects of mixing parameters such as fill factor, rotor speed, thermal boundary conditions, ram pressure and the mixing procedure itself, were also briefly examined. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; UK; WESTERN EUROPE

Accession no.881137

Item 60

KGK:Kautschuk Gummi Kunststoffe

55, No.12, Dec.2002, p.646-52

DEVELOPMENT OF PROCESS MODELS FOR THE ON-LINE-CONTROL OF COMPOUND PROPERTIES FOR AN INTERNAL MIXER USING ARTIFICIAL NEURAL NETWORKS

Haberstroh E; Linhart C; Ryzko P
IKV

The advantages and limitations of artificial neural networks for predicting the properties of rubber compounds are

discussed and comparisons made with regression models. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.877291

Item 61

Kauchuk i Rezina (USSR)

No.5, 2001, p.23-6

Russian

INFLUENCE OF THE WIDTH OF THE PADDLE RIDGE OF BATCH MIXER ROTORS ON THE EFFICIENCY OF RUBBER COMPOUND PRODUCTION AND THEIR QUALITY

Shikhirev N I; Rasskazov A N; Trofimov A P; Skok V I

The paddle ridge width of a batch mixer was varied between 0.2-20 mm and the effects on the rubber mixing process were studied photographically. The distribution of carbon black in the mix was uniform with a width below 11 mm, while a width below 15 mm was required for efficient dispersion. 9 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.877228

Item 62

ANTEC 2002. Proceedings of the 60th SPE Annual Technical Conference held San Francisco, Ca., 5th-9th May 2002.

Brookfield, Ct., SPE, 2002, Paper 369, Session T26-Alloys on Blends, Extrusion II. Interactive Presentations, pp.5, CD-ROM, 012

MIXING BEHAVIOR OF MODEL MISCIBLE POLYMER SYSTEMS HAVING EXTREMELY LOW VISCOSITY RATIO

Shea P T; Pietruski R D; Shih C-K; Denelsbeck D A
DuPont de Nemours E.I., & Co. Inc.
(SPE)

A batch internal mixer was used to study the mixing of styrene-butadiene-styrene and styrene-isoprene-styrene block copolymers with oils having a range of molecular weights and viscosities. The block copolymers were added first, followed by the oil. The time to the phase inversion point, at which the continuous phase changed from oil to copolymer, was observed as a sudden increase in machine torque. The time to the phase inversion point decreased as the viscosity and molecular weight of the oil increased. The time could also be decreased by adding the oil in two or more doses, with the smaller dose being added first when the doses were of unequal size. The phase inversion time was also reduced by partially substituting a lower viscosity or molecular weight oil with one of higher viscosity. 6 refs.

USA

Accession no.876459

Item 63

Industria della Gomma

46, No.1, Jan./Feb.2002, p.54-5

Italian

SILICONE RUBBER PROCESS FROM COLMEC AND DOW CORNING

A process and machinery developed by Colmec and Dow Corning for the in-situ mixing and extrusion of silicone rubber compounds are described.

COLMEC SPA; DOW CORNING CORP.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

Accession no.873923

Item 64

162nd ACS Rubber Division Meeting - Fall 2002.

Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 111, pp.29, 28cm, 012

POWDER RUBBER SYSTEMS IN THE CONTINUOUS MIXING PROCESS UNDER ECONOMICAL ASPECTS

Goerl U

(ACS,Rubber Div.)

The compounding costs for a standard passenger car tyre plant equipped with internal mixers and with an output of about 66,000 tons/year of tyres are reported and compared with those determined analogously for a compounding plant equipped with continuous mixtruders. The calculations take into account mixing room equipment, production time, output, investment costs, number of employees and energy costs. A comparison is also made of the compounding costs of various tyre tread compounds and base compounds produced by current processes and possible future continuous mixing methods. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.871408

Item 65

162nd ACS Rubber Division Meeting - Fall 2002.

Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 107, pp.24, 28cm, 012

CONTINUOUS AND DISCONTINUOUS MIXING UNDER ASPECTS OF THE MATERIAL QUALITY

Bogun M; Abraham F; Muresan L; Schuster R H; Radusch H J

Deutsches Institut fuer Kautschuktechnologie eV (ACS,Rubber Div.)

The rheological properties and vulcanisate properties of mixtures of emulsion SBR filled with carbon black produced by internal mixing under different conditions are compared with similar mixtures of powdered SBR. The

rheological properties and vulcanisate properties of SBR compounds obtained by continuous mixing in a co-rotating twin-screw extruder are also compared and the effects of different screw designs and screw speeds on mixing are examined. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.871405

Item 66

162nd ACS Rubber Division Meeting - Fall 2002.

Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 93, pp.16, 28cm, 012

PROGRESS IN THE DEVELOPMENT OF THE CONTINUOUS RUBBER MIXING PROCESS BY TWIN-SCREW EXTRUSION

Amash A; Bogun M; Schuster R-H

Deutsches Institut fuer Kautschuktechnologie eV (ACS,Rubber Div.)

A study was carried out to optimise the continuous mixing of powdered rubber in a co-rotating twin-screw extruder equipped with various screw and mixing elements. The effects of the screw elements on the development of the degree of filler dispersion, Mooney viscosity, extrudate temperature and residence time along the screw were examined and a screw design concept was developed. Trials were carried out using both laboratory equipment and a large-scale twin-extruder. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.871393

Item 67

162nd ACS Rubber Division Meeting - Fall 2002.

Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 92, pp.9, 28cm, 012

INNOVATIVE PROCESSING OF ELASTOMER MASSES IN A PLANETARY ROLLER EXTRUDER

Batton M W

ENTEX Rust & Mitschke GmbH (ACS,Rubber Div.)

A description is given of a novel planetary roller extruder developed by ENTEX for the continuous mixing of rubbers and plastics. The efficiency of this extruder for compounding rubbers is demonstrated by a comparison with a discontinuous internal mixer.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.871392

Item 68

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 91,
pp.13, 28cm, 012

CONTINUOUS MIXING - NEW CONCEPTS

Fritsche B; Naef C

Buhler AG (ACS,Rubber Div.)

Details are provided on the RingExtruder, which is equipped with 12 intermeshing co-rotating screws arranged in a stationary circular configuration, for the continuous mixing of rubber. The advantages of this continuous mixer over twin-screw extruders are demonstrated and the results of extrusion trials on various rubbers and a profitability study are presented and discussed. 7 refs.

SWITZERLAND; USA; WESTERN EUROPE

Accession no.871391

Item 69

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 90,
pp.13, 28cm, 012

TWIN SCREW MIXER FOR RUBBER COMPOUNDING

Pomini L; Regalia R

Techint-Pomini (ACS,Rubber Div.)

The advantages and disadvantages of continuous mixing are briefly considered and a description is given of Pomini's counter-rotating non-intermeshing long continuous mixer. The latest developments in Pomini's twin screw co-rotating intermeshing single screw mixing technology are presented along with the results of three-dimensional computational fluid dynamics analysis and experiments carried out on NR, EPDM and SBR cable compounds, which demonstrate the capabilities of this technology to blend, disperse and distribute rubber compounds. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

Accession no.871390

Item 70

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 89,
pp.18, 28cm, 012

TWIN-SCREW RUBBER MIXING AND EXTRUSION CONCEPTS

Uphus R

Berstorff GmbH (ACS,Rubber Div.)

The use of a combination of a short single-screw rubber extruder feeding a gear pump for the continuous feeding of bale rubbers is discussed. Methods of dealing with heat

generation caused by screw speed and head pressure and heat generation in conventional twin screw-mixing zones using the concepts of two pairs of twin screws or newly developed mixing elements for co-rotating twin-screw extruders, are also discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.871389

Item 71

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 76,
pp.11, 28cm, 012

THE SINGLE-ROTOR CONTINUOUS MIXING SYSTEM (CARTER CONTINUOUS COMPOUNDER & CAROUSEL BLENDER)

Freakley P K; Fletcher J B

Loughborough,University; Carter Bros.Ltd.
(ACS,Rubber Div.)

Information is provided on the Carousel Blender/Feeder whose action is based on ordered subdivision to render it insensitive to segregation during blending and of the Single Rotor Continuous Mixer (SRM), a prototype designed for versatility, compactness and energy efficiency. Results of mixing trials on SBR and EPDM compounds compounded in the SRM are reported and comparisons are made of the mixing efficiencies for this system with conventional internal mixing. Data on the physical properties of the rubber compounds and purging characteristics of the SRM are also included. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

Accession no.871377

Item 72

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 75,
pp.14, 28cm, 012

CONTINUOUS TANGENTIAL MIXING OF ELASTOMERS

Wickenheisser P

Farrel Corp.
(ACS,Rubber Div.)

The structures and principles of operation of the Farrel Continuous Mixer, a starve-fed, counter-rotating, non-intermeshing, twin-rotor mixer, the Spiramax, a single rotor mixer/extruder with a stationary scroll for conveyance, and the MVX, a mixing venting extruder, are described and the design of the Farrel twin-screw extruder is briefly discussed. 11 refs.

USA

Accession no.871376

Item 73

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 72, pp.21, 28cm, 012

CONTINUOUS MIXING: A CHALLENGING OPPORTUNITY?

Nijman G

Vredestein Banden BV

(ACS,Rubber Div.)

The concept of internal mixing and mixing of rubbers with carbon black are briefly described and recent developments in the continuous mixing of rubber compounds are discussed. The advantages and disadvantages of continuous mixing with respect to batch mixing are explored and the future for continuous mixing is briefly considered. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; USA; WESTERN EUROPE

Accession no.871374

Item 74

Rubber World

226, No.2, May 2002, p.29-31

VARIABLE FRICTION DRIVES FOR MIXERS AND ROLL MILLS

Lattstrom L I;

Hagglunds Drives Inc.

The concept of variable friction drives is described and a comparison is made between frequency controlled AC and hydraulic drives. Some of the features and benefits of using hydraulic drives on a roll mill and mixer are outlined and a functional description is given of a radial-piston type motor with a rotating cylinder block/hollow shaft and a stationary motor case/housing (Hagglunds Marathon motor).

USA

Accession no.871362

Item 75

162nd ACS Rubber Division Meeting - Fall 2002.
Proceedings of a conference held Pittsburgh, Pa., 8th-11th Oct. 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 1, pp.18, 28cm, 012

TILT MIXER ROTOR EVOLUTION

Glasser P F

Midlands Millroom Supply Inc.

(ACS,Rubber Div.)

The development of the tilt mixer is outlined and tilt mixer applications are listed. The differences between the tilt mixer and internal mixer are identified and data from compounding trials carried out on rubber formulations processed using the latest and most advanced tilt mixer rotor design (G-III Technology) introduced by Moriyama.

USA

Accession no.871304

Item 76

China Rubber Industry

49, No.10, 2002, p.607-9

Chinese

ROTATING HEAT PIPE COOLING TECHNIQUE WITH SELF-EVAPORATING CIRCULATING LIQUID FOR ROTOR IN CONTINUOUS MIXER

Zhang L

Jiangsu,Institute of Petrochemical Technology

A study of the above technique revealed that it featured efficient thermal conductivity, a uniform temperature on the surface of the rotor and no leakage. Heat transfer was influenced by the liquid swelling factor, working temperature and rotor speed. 2 refs.

CHINA

Accession no.871050

Item 77

China Rubber Industry

49, No.10, 2002, p.581-4

Chinese

EFFECT OF MIXING CONDITIONS ON RHEOLOGICAL BEHAVIOR OF HAF BLACK FILLED POWDERED SBR

Zhang A-Q; Wang L-S; Zhou Y-Y

South China,University of Technology

The results are reported of a study of the effects of different rotor speeds and circulating oil temperatures on the rheological properties of HAF black filled SBR powder carried out using a Brabender rheometer and the results obtained compared with those for HAF black filled bale SBR. 5 refs.

CHINA

Accession no.871047

Item 78

Kautschuk und Gummi Kunststoffe

55, No.10, Oct.2002, p.535-9

SINGLE-ROTOR CONTINUOUS MIXER

Freakley P K; Fletcher J B

Loughborough,University; Carter Bros.

A new and novel continuous mixer for rubber compounds has been developed in a co-operation between the Rubber Process Engineering Centre at Loughborough University and Carter Bros. The mixing conditions can be adjusted over a wide range from the control panel to suit the rubber compound, with the aim of combining the versatility of the internal mixer with the inherent energy efficiency and consistency of a continuous system. The new mixer comprises two main elements, a compactor/feeder and a single rotor mixing unit. In the compactor/feeder a particulate pre-blend is converted to a continuum (the incorporation stage) and is then metered to the mixing unit, where it is subjected first to distributive mixing and subsequently to dispersive mixing. Separation of the distributive and dispersive mixing functions allows the latter

to be optimised to apply local, high intensity stresses to the rubber compound. A prototype with a maximum output of 150 kg/h has been built. Results to date confirm that a low rubber temperature in combination with good filler dispersion and energy efficiency is attainable. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.870606

Item 79

Industria della Gomma

45, No.10, Dec.2001, p.37-41

Italian

INTERMESHING MIXERS: VARIABLE CLEARANCE VERSUS FIXED CLEARANCE

Regalia R; Moriconi M

Techint-Pomini

A comparative study was made of the efficiency of two intermeshing rotor mixers, one with fixed clearance and the other a VIC 165 variable intermeshing clearance mixer (Techint-Pomini), in the mixing of NR, EPDM and polyepichlorohydrin compounds. The results showed that the variable clearance mixer gave reduced cycle times with equal quality of the compounds produced, and that higher fill factors were possible with this mixer. The cost advantages of the VIC 165 were also analysed.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.869436

Item 80

Industria della Gomma

45, No.9, Nov.2001, p.33-7

Italian

BERSTORFF: A COMPANY IN FULL EVOLUTION

A survey is made of rubber processing machinery produced by Berstorff, including compounding systems, extruder/gear pump combinations and machines for the direct extrusion of tyre components. Developments in machinery for the extrusion, coextrusion and foaming of thermoplastic elastomers are also described.

BERSTORFF; VMI EPE

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; NETHERLANDS; WESTERN EUROPE

Accession no.869433

Item 81

Shawbury, Rapra Technology Ltd., 2002, 20 papers, pp.226, 30cm, 012

HPE 2002. PROCEEDINGS OF A CONFERENCE HELD COLOGNE, GERMANY, 13TH-14TH NOV.2002

(Rapra Technology Ltd.; European Rubber Journal)

Twenty papers are presented at the 2nd International High Performance Elastomers conference. This second

conference covers the elastomers being used in high demand environmental applications and brings together a number of papers dealing with new fluoro and silicone elastomers in the field. Papers are divided into five sessions: Session one - The high performance elastomer industry; Session two - High performance automotive applications; Session 3 - Additives, compounding and processing; Session 4- New materials and advancing technology; Session 5 - Improving product performance and manufacturing processes.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.869423

Item 82

Macromolecular Chemistry and Physics

203, No.10-11, 29th July 2002, p.1702-14

PHASE MORPHOLOGY DEVELOPMENT IN REACTIVELY COMPATIBILISED POLY(ETHYLENE TEREPHTHALATE)/ ELASTOMER BLENDS

Loyens W; Groeninckx G

Leuven, Catholic University

Morphological properties and rheological properties of melt mixed blends of polyethylene terephthalate (PET) and ethylene propylene rubber (EPR) were used to assess the efficiency of glycidyl methacrylate and maleic anhydride functionalised polyolefin compatibilisers. It was shown that a glycidyl methacrylate functionalised copolymer, particularly the ethylene glycidyl methacrylate with 8 percent glycidyl content, was the more efficient compatibiliser, with marked enhancement of phase dispersion and interfacial adhesion. The reason for the efficiency of this material was in the formation of a graft copolymer between chain end groups of PET and the epoxy group of the methacrylate during melt mixing. Melt mixing was carried out in a twin screw extruder or a laboratory batch mixer. Characterisation of materials was by scanning and transmission electron microscopy, atomic force microscopy, capillary rheometry and fourier transform infrared spectroscopy. 44 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.868938

Item 83

Macplas

26, No.232, Oct.2001, p.51-8

Italian

MACHINES FOR RUBBER PROCESSING

A review is presented of developments by a number of companies in rubber processing machinery, including injection moulding machines (with particular reference to presses for the processing of liquid silicone rubbers), extruders, mixers and calenders.

WORLD

Accession no.866825

Item 84

Rubber World

226, No.4, 2002, p.40-5

OPTIMIZING MIXING IN THE FARREL BANBURY MIXER WITH WING FUNCTION

Borzinski F J; Valsamis L N
Farrel Corp.

Farrel has used a novel approach in developing a new line of rotor designs for the Banbury mixer product line. The mixing process taking place in a batch mixer was reduced into the basic processing functions, i.e., dispersive and extensive mixing, and these functions were then assigned to different geometrical sections of the rotors. The basic concept of a rotor composed of wings originating from either end was retained, but each rotor wing was now assigned a specific process function. Product quality, established by ODR measurements, demonstrated the ability of the new wing function technology rotors to provide high levels of product uniformity within the batch and from batch to batch. 4 refs.

USA

Accession no.864092

Item 85

Rubber World

226, No.4, 2002, p.32-9

NEW INTERMESHING MIXER VS. TRADITIONAL MIXERS

Nortey N O
Skinner Engine Co.Inc.

This article is written to update and assist compounders using the internal batch mixers and two-roll mills. The Coflow4 intermeshing rotor internal mixer has been shown analytically and experimentally to compound various materials better than all types of traditional uni-flow geared intermeshing and partial-flow rotor internal mixers. 15 refs.

USA

Accession no.864091

Item 86

Rubber World

226, No.4, 2002, p.28-31

SINGLE-ROTOR CONTINUOUS MIXING SYSTEM

Freakley P K; Fletcher J B
Loughborough,University; Carter Bros.Ltd.

Continuous mixing holds out the promise of efficient and consistent rubber processing. In this article, a new powder blender and a continuous mixer are described, followed by a presentation of results from a prototype system. A layout of the system, equipped with a roller die output device is shown. Two dissimilar compounds, SBR and EPDM, were selected for initial evaluation of the single rotor continuous mixer (SRM). The purpose of the SBR compound was to

explore the dispersive mixing behaviour of the SRM, while that of the EPDM compound was to determine its ability to deal with high filler and oil loadings. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.864090

Item 87

China Rubber Industry

49, No.8, 2002, p.485-8

Chinese

BAR CODE INFORMATION MANAGEMENT SYSTEM IN RUBBER MIXING CENTER

Wang Xian-bo; Zhao Zhi-qiang; Huang Wei-bin; Wu Jian; Ma Tie-jun; Zhao Liang-zhi
South China,University of Technology

The composition, effect and technical security classification of a bar code information management system for a rubber mixing centre (BIMSR) are described. BIMSR consists of material sector, compounding sector, mixing site sector, mixing control sector, finished product management sector, mixing centre management sector and finished product inspection sector to give intelligent control of mixing process, management of materials and quality tracing of finished product. 4 refs.

CHINA

Accession no.863915

Item 88

Kautchuk und Gummi Kunststoffe

55, No.7-8, 2002, p.388-96

NR/CARBON BLACK MASTERBATCH PRODUCED WITH CONTINUOUS LIQUID PHASE MIXING

Wang M-J; Wang Y L; Wong Y L; Shell J; Mahmud K
Cabot Corp.

The first filler-NR masterbatch made with a continuous liquid mixing process is described. The masterbatch is produced by fast mixing and mechanical coagulation of polymer with filler, and with very short exposure to high temperature. This achieves excellent performance for the material such as polymer-filler interaction is well preserved; polymer degradation is essentially eliminated; superior filler dispersion independent of filler morphology; simplified mixing with low energy consumption; dust-free operations. The technology enables a wide range of carbon blacks to be used in rubber. Significant improvements in vulcanisate properties are achieved including reduced hysteresis, improved cut-chip resistance and flex-fatigue life, and increased abrasion resistance at high filler loading, compared with their dry-mixed counter-parts. 11 refs.

USA

Accession no.863682

Item 89

Kautchuk und Gummi Kunststoffe

55, No.7-8, 2002, p.367-72

PROGRESS AND CONCEPTS FOR THE CONTINUOUS MIXING PROCESS OF NR COMPOUNDS

Amash A; Bogun M; Schuster R-H

Deutsches Institut fuer Kautschuktechnologie Ev;
Degussa AG

Compounds of powder rubber based on NR/CB are produced by using a twin-screw extruder equipped with a well-designed screw configuration. A significant increase of the output is achieved with increasing screw speed at moderate mixing temperatures, while retaining good material properties. In addition, the development of the degree of dispersion, Mooney viscosity and temperature along the extruder screw is studied. Several configurations of the latter are tested at constant parameters. A high mixing quality can be reached by one extrusion zone with appropriate mixing elements. Two extrusion concepts are proposed for the simplification of the continuous mixing process of powder rubber. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.863680

Item 90

Tire Technology International

June 2002, p.32-5

MIXED SIGNALS

Wood P

A discussion is presented on whether the mixing room is still a necessity or an increasing liability for tyre companies with the advent of an increasing range of rotor designs for batch mixers, data acquisition systems and the increasing demands of customers for traceability. Sources of compound quality errors arising from the preparation and weighing of materials before mixing and developments in batch mixers and continuous mixing are addressed and the future of the mill room is briefly considered. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.862146

Item 91

Journal of Applied Polymer Science

85, No.11, 12th Sept.2002, p.2276-82

EXPERIMENTAL INVESTIGATION OF THE MORPHOLOGY DEVELOPMENT AND MECHANICAL PROPERTIES OF WASTE ETHYLENE PROPYLENE DIENE MONOMER/POLYPROPYLENE BLEND IN MODULAR INTERMESHING COROTATING TWIN-SCREW EXTRUDER

Kim J K; Lee S H; Hwang S H

Gyeongsang,National University

To investigate the possible recycling of waste ethylene propylene diene terpolymer (EPDM), thermoplastic elastomers were prepared by blending EPDM powder with polypropylene (PP) (EPDM:PP of 70:30 to 75:25) using an intermeshing co-rotating twin screw extruder. The influences of composition, temperature and extruder configuration on the blend morphology and mechanical properties were studied. The optimum tensile strength, elongation at break and 50% modulus were achieved using two left-handed screws running at 100 rpm with three kneading disc blocks. This configuration optimised dynamic vulcanisation. 7 refs.

KOREA

Accession no.862065

Item 92

Hanover, 2001, pp.4, 29 cm, 26/6/02

BERSTORFF RUBBER TECHNOLOGY. NEW SHEAR AND STRETCHING ELEMENTS. PAPER PRESENTED AT K'01 REPRESENTATIVES' MEETING, DUESSELDORF, 24/10/01

Uphus R

Berstorff GmbH

Lines for the compounding of thermoplastic elastomers represent the core competence of Berstorff and are an important market for the company. Berstorff offers fully developed solutions in terms of machine design and process technology. The reactive compounding of rubber and thermoplastics and the simultaneous crosslinking of the rubber component on the same machine goes one step further. Reactive compounding of TPE vulcanisates, and in particular, the phase inversion process is discussed, with reference to the development of new shear and stretching elements for co-rotating twin-screw extruders by Berstorff.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.861709

Item 93

Rubber World

226, No.3, 2002, p.19/24

CONTINUOUS MIXING OF POWDER RUBBER IN A TWIN-SCREW EXTRUDER

Amash A; Bogun M; Goerl U; Schuster R-H

Deutsches Institut fuer Kautschuktechnologie eV

The results are reported of a study carried out to optimise the development of the continuous mixing process for various NR powders in a twin-screw extruder equipped with co-rotating screws. The effect of various screw elements on the development of properties, including filler dispersion and Mooney viscosity, along the extruder screw is evaluated and a screw configuration optimised for the performance of continuous compounding experiments on different powdered rubber types is illustrated. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.860596

Item 94

European Rubber Journal

184, No.7/8, July/Aug.2002, p.36

CONTINUOUS MIXING DOES WORK

Shaw D

The process of continuous mixing, as exemplified by Pirelli SpA's "MIRS", is considered in this detailed article. The process and the equipment used are fully described, and the advantages of the system - such as cost savings and better dispersion and distribution - are highlighted.

PIRELLI

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.860411

Item 95

European Rubber Journal

184, No.7/8, July/Aug.2002, p.30/2

PIRELLI PROCESS COULD REVOLUTIONISE MIXING

Shaw D

In the year 2000, Pirelli SpA of Italy unveiled its "MIRS" robotised tyre manufacturing system. Now the company has unveiled the latest addition to that system, a continuous compounding line, which it calls "CCM" (continuous compound mixer). Unlike previous Pirelli innovations, which were limited to the tyre industry, this system has potential across the whole of the rubber industry. This article makes an in depth investigation.

PIRELLI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.860410

Item 96

International Polymer Processing

17, No.2, June 2002, p.108-14

COMPUTATIONAL STUDY OF THE VELOCITY FIELD IN THE CONVEYING ELEMENT OF A KO-KNEADER WITH CFD METHOD

Mehranpour M; Nazokdast H; Dabir B

Amirkabir, University of Technology

An attempt was made to predict the velocity field in the conveying element of a Buss Ko-Kneader using computational fluid dynamics (CFD). The effects of both rotating and reciprocating motions of the screw were taken into account in three-dimensional flow analysis. It was demonstrated that this computational method could provide great insight into visualisation of the flow field in this element of a Ko-Kneader. Among the variables, the reciprocating action was found to play a significant role in enhancing the mixing performance of the Ko-Kneader by means of periodically changing the flow field and shear rate distribution in the channel. 13 refs.

IRAN

Accession no.860044

Item 97

RubberChem 2002, Proceedings of a conference held Munich, Germany, 11th-12th June 2002.

Shawbury, Rapra Technology Ltd., 2002, paper 14, p.101-4, 29 cm, 012

MULTI INGREDIENT PREWEIGHS - A NEW CONCEPT OF HANDLING RUBBER CHEMICALS

Kromminga T

Rhein Chemie Rheinau GmbH

(Rapra Technology Ltd.)

Service Technologies is a newly established service philosophy within the European rubber industry, at the heart of which are Multi Ingredient Preweighs. (MIPs). The basic idea behind the philosophy is a combination of a comprehensive product portfolio with a service mentality in which the relationship between the supplier of rubber chemicals and the manufacturer of rubber articles becomes a partnership in which each partner is able to concentrate on its individual core competency. The MIP is a physical blend of rubber chemicals pre-weighed and in batch-size form, and typically packed in a low melting bag. Without any further preparation, the bags are ready for use in compounding rubber in an internal mixer. Advantages of the use of MIPs and details of the service package around the MIPs are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
UK; WESTERN EUROPE

Accession no.859582

Item 98

International Polymer Science and Technology

29, No.6, 2002, p.T/43-6

INFLUENCE OF THE PADDLE RIDGE WIDTH OF BATCH MIXER ROTORS ON THE EFFICIENCY AND QUALITY OF THE PRODUCTION OF RUBBER MIXESShirikhev N I; Rasskazov A N; Trofimov A P; Skok V I
NIIShP

The efficiency of the mixing process and the quality of the rubber mixes in tyre rubber compounding carried out in internal mixers with oval rotors, depend to a large degree on the design of the main assemblies and the components of the internal mixer, including the rotor paddle ridge (RPRW). Results of an investigation are reported, which was carried out on a single-rotor experimental unit during the production of a model rubber mix based on butadiene-methylstyrene rubber and carbon black. It was found that the RPRW of the internal mixer and also the size of the radial gap between the wall of the mixing chamber and the rotor paddle ridge, the radius of the working surface of the rotor paddle, and the angle of entry of the materials to be mixed and the mix into the radial gap, determining the size and shape of the crescent-shaped space, are the main design factors affecting the efficiency of mix production and the mix quality. 9 refs. (Article translated from Kauchuk i Rezina, No.5, 2001, pp.23-6).

RUSSIA

Accession no.858103

Item 99

Thermoplastic Elastomers Topical Conference 2002.
 Proceedings of a conference held Houston, Tx., 27th-29th Jan.2002.
 Brookfield, Ct., SPE, Paper 7, p.77-94, 27cm, 012
HIGH SPEED TWIN SCREW EXTRUSION TECHNOLOGY FOR TPE PELLETS SHEET AND PROFILE
 Martin C
 Leistrütz
 (SPE,South Texas Section)

Twin-screw extruders are used to continuously mix and devolatilise TPE/TPO/TPV formulations that contain polymers, rubbers, fillers and liquids, and are also highly efficient at reprocessing high levels of regrind materials. End markets for these compounds include: appliance, automotive, construction, electronic, fluid delivery, food contact, hardware, medical device and sporting goods. High-speed twin-screw extruders have traditionally produced pellets, which are then processed in a second step on a single screw extruder to produce a sheet or profile, including for foamed products. The technology to bypass the pelletising step and perform compounding/devolatilising on a twin-screw extruder with direct TPE sheet or profile extrusion is now well proven. TPE formulations often benefit from the one less heat and shear history inherent with the direct extrusion process. Significant manufacturing cost savings are often realised by eliminating the pelletising step, however the throughput requirements and product mix for a particular market must be factored into the equation when determining whether direct extrusion is the preferred manufacturing method.

USA

Accession no.857606

Item 100

Kautchuk und Gummi Kunststoffe

55, No.6, 2002, p.286/92

German

ECONOMIC BENEFITS AND PROCESS ADVANTAGES OF USING A GEAR PUMP IN COMBINATION WITH A TRANSFERMIX EXTRUDER

Skibba O; Thoma O
 A-Z Formen- & Maschinenbau GmbH

The cost and processing advantages of new technology, which combines a Transfermix extruder with a gear pump, are discussed. In this process, plasticisation is carried out in the Transfermix extruder and pressure build-up is undertaken by the gear pump, allowing throughput to become virtually independent of current standard die tool pressures. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.857159

Item 101

European Rubber Journal

184, No.6, June 2002, p.30-3

TANDEM MIXER: ENERGY INPUT AND FILL FACTORS

Peter J; Rothmeyer F; Sattlegger T

In this article, developers of the Tandem Mixing concept suggest ways to optimise the mix cycle. Their research shows that tandem mixing can be cheaper than conventional mixing, provided the whole system is optimised for time and cost. 3 refs.

THYSSEN KRUPP ELASTOMERTECHNIK
 EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.856675

Item 102

161st ACS Rubber Division Meeting - Spring 2002.
 Proceedings of a conference held Savannah, Georgia, 29th April-1st May 2002.

Akron, Oh., ACS Rubber Division, 2002, Paper 56, pp.13, 28cm, 012

SYNERGY OF A THEORY OF PROCESSING, AN ELASTICITY/VISCOSITY TESTER AND A HIGH SHEAR MIXER

Watson W F
 WNP Ltd. (ACS,Rubber Div.)

A theory of processing, an elasticity/viscosity tester and a high shear mixer are discussed and a report presented on the use of the synergy between these for provision of a new general procedure for controlling purchase of raw rubbers, manufacturing products and achieving consistent and reproducible products.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.856283

Item 103

Shawbury, Rapra Technology Ltd., 2002, 20 papers, pp.174, 29cm, 012

RUBBERCHEM 2002 - THE THIRD INTERNATIONAL RUBBER CHEMICALS, COMPOUNDING AND MIXING CONFERENCE. PROCEEDINGS OF A CONFERENCE HELD MUNICH, GERMANY, 11TH-12TH JUNE 2002
 (Rapra Technology Ltd.)

Twenty papers are published here following this two day conference dedicated to the subject of rubber chemicals. Topics include: processing and mixing technology; compounding innovations; antidegradants; plasticisers; protective agents; fillers; processing additive systems; vulcanising agents; enhancement and modification technology; health and safety; environmental issues.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.855930

Item 104

Industria della Gomma

45, No.7, Sept.2001, p.59-61

Italian

**JAPANESE HEART FOR A MIXER FROM
MECCANICHE MODERNE**

Milanese B

An examination is made of technical features of the BFC series of rubber mixers produced by Meccaniche Moderne, and which incorporate intermeshing rotors developed in collaboration with Kobe Steel.

MECCANICHE MODERNE SPA; KOBE STEEL LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; JAPAN;
WESTERN EUROPE

Accession no.854877

Item 105

Indian Rubber Journal

61, March/April 2002, p.68-72

**SINGLE-ROTOR CONTINUOUS MIXER
(CARTER CONTINUOUS COMPOUNDER)**

Fletcher J B; Freakley P K

Loughborough,University; Carter Bros.

It is explained that continuous mixing holds out the promise of efficient and consistent rubber processing. In this article a new single-rotor continuous mixer, developed by Carter Bros. of the UK, is described in detail. Also, results are presented from the testing of a prototype system. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.851376

Item 106

Rubber World

225, No.6, March 2002, p.38-43

**WING FUNCTION TECHNOLOGY - A NEW
ROTOR TECHNOLOGY FOR THE FARREL
BANBURY MIXER**

Valsamis L N; Borzenski F J

Farrel

The features of a new rotor for the Banbury family of batch mixers, called the Wing Function Technology rotor, which is equipped with distributive and dispersive rotor wings are described along with the verification of the process functions of these wings by means of experimental pressure profiles for each rotor wing. The material used in the experiments was an EPDM having a Mooney viscosity of 76 ML. The effective utilisation of a mixing chamber equipped with the new rotor is confirmed using tracer profiles, the results of which are compared with those obtained using a standard Banbury type rotor. 9 refs.

USA

Accession no.851000

Item 107

Luntai Gongye

22, No.4, 2002, p.236-8

Chinese

**MLJ-300 INTELLIGENT MICRO-COMPUTER
CONTROL SYSTEM OF INTERNAL MIXER**

Zhang H; Ma T; Mai J-H

South China,University of Technology

The main functions of this control system are described. They include the semi-automatic or automatic optimisation of the mixing process, prediction of the Mooney viscosity and dispersivity of the mixture at the end of the mixing process and control of the process to meet the quality control criteria. 9 refs.

CHINA

Accession no.850468

Item 108

Revue Generale des Caoutchoucs et Plastiques

78, No.798, Oct.2001, p.98-100

French

**THERMOPLASTIC ELASTOMERS:
THE SOLUTIONS OF MACHINERY
MANUFACTURER BERSTORFF**

Uphus R

Berstorff

Studies of the processing behaviour of thermoplastic elastomers carried out by Berstorff are reported, and developments by the Company in processing methods and machinery for these materials are examined. These include extrusion compounding machinery, extruders for the production of solid profiles and for the coextrusion of profiles combining solid and foamed thermoplastic elastomers with rubbers, and a process for the extrusion of foamed profiles using water as blowing agent.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.849056

Item 109

Industria della Gomma

45, No.6, July/Aug.2001, p.37-9

Italian

**NEW INTERNAL MIXERS WITH TANGENTIAL
ROTORS**

Lualdi R

Comerio Ercole SpA

Technical features of the MCC series of tangential rotor internal mixers developed by Comerio Ercole are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.849048

*Item 110***Rubber World**

225, No.5, Feb. 2002, p.23/49

ADVANCEMENTS IN CONTINUOUS ELASTOMER PROCESSING ON TWIN SCREW EXTRUDERS

Ploski W A; Williams R K

Coperion; Aspen Research Corp.

A comparison is made of standard kneading elements with tapered kneaders using results from several case studies. These case studies relate to the compounding of foamable, carbon black filled EPDM automotive weather stripping, an EPDM roofing compound and fluoroelastomer based compounds.

USA

Accession no.848793

*Item 111***Polymer Engineering and Science**

42, No.1, Jan.2002, p.19-32

PHYSICAL-MATHEMATICAL MODEL FOR THE DISPERSION PROCESS IN CONTINUOUS MIXERS

Potente H; Kretschmer K

Institut fuer Kunststofftechnik; Bayer AG

To modify the properties of polymers, mineral fillers are frequently added during the compounding process. Because of adhesive forces, these pulverised fillers tend to agglomerate. Therefore, in order to achieve good homogenisation, it is essential not only to distribute them but also to break down the solid agglomerates. A number of relating models have been published, describing observations (agglomerate rupture, erosion, clustering) made during the dispersion process in a mostly isolated manner. New models for each observed effect have been developed and later superimposed in order to get a comprehensive model of the dispersion process. To verify the model, it is implemented into a program for the process simulation of co-rotating twin-screw extruders. It is then compared to experimental data. The results show that the model is able to describe the experimentally determined data. 25 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.846894

*Item 112***Kautchuk und Gummi Kunststoffe**

55, No.1-2, 2002, p.41-7

EFFECTS OF MIXING CONDITIONS. REACTION OF TESPT SILANE COUPLING AGENT DURING MIXING WITH SILICA FILLER AND TIRE RUBBER

Reuvekamp L A E M; ten Brinke J W; van Swaaij P J; Noordermeer J W M

Twente, University

The use of TESPT as a coupling agent in silica-rubber tyre tread compounds to enhance filler-matrix compatibility is studied under certain mixing conditions. This paper aims to show the effects of variations in the mixing time and temperature on the dynamic mechanical properties of silica-filled tyre tread compounds. The reactions described lead to different results at different temperatures and the influence of the presence of zinc oxide during mixing is also taken into consideration. 33 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

Accession no.846269

*Item 113***Kautchuk und Gummi Kunststoffe**

55, No.1-2, 2002, p.23-32

RUBBER/FILLER COMPOUND SYSTEMS IN POWDER FORM - A NEW RAW MATERIAL GENERATION FOR SIMPLIFICATION OF THE PRODUCTION PROCESSES IN THE RUBBER INDUSTRY. PART 1: POWDER RUBBER BASED ON E-SBR/CARBON BLACK

Gorl U; Schmitt M; Amash A; Bogun M

Degussa AG

Powdered rubber based on E-SBR/carbon black compounded in an internal mixer process is examined with respect to the advantages it affords in terms of environmental, handling and efficiency over conventional bale technology. This paper is the first part of a series of publications which discusses the individual rubber/filler systems in detail, and focuses on the system of carbon black-filled emulsion styrene butadiene rubber. It covers the selection of the raw materials, manufacture of products and their characterisation. 18 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.846267

*Item 114***Materie Plastiche ed Elastomeri**

66, No.4, April 2001, p.248-9

Italian

THERMOPLASTIC ELASTOMERS: FROM COMPOUNDING TO EXTRUDED PROFILES

A review is presented of developments by Berstorff in machinery for the processing of thermoplastic elastomers, including co-rotating twin-screw extruders for continuous compounding and extrusion and coextrusion lines for the production of solid and foamed profiles. Reference is also made to the development by Berstorff and Advanced Elastomer Systems of a process for the extrusion of foamed profiles using water as blowing agent.

BERSTORFF; ADVANCED ELASTOMER SYSTEMS
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.846224

Item 115

Plastics, Rubber and Composites

30, No.9, 2001, p.401-5

NEW CONCEPTS FOR CONTINUOUS MIXING OF POWDER RUBBER

Amash A; Bogun M; Schuster R-H; Goerl U; Schmitt M
Deutsches Institut fuer Kautschuktechnologie eV;
PulverKautschuk Union

Efforts to develop a continuous mixing process for NR powder compounds using a twin-screw extruder with an optimised screw configuration are described. It is shown that a significant increase in throughput rate is achievable by increasing screw speed without adversely affecting the processing and final properties of the rubber and that the screw speed, torque and cooling are crucial for the optimisation of the continuous mixing process. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.845074

Item 116

Shawbury, Rapra Technology Ltd., 2002, pp.132. 29 cms. Rapra Review Report 140, vol.12, No. 8, 2002.

NALOA

TYRE COMPOUNDING FOR IMPROVED PERFORMANCE

Evans M S

Kumho

Edited by: Ward S

(Rapra Technology Ltd.)

Rapra.Review Report 140

This report takes the form of an overview of the factors a tyre compounder or tyre engineer has to consider when developing compounds for tyres to meet the performance demands of the 21st century. Subjects covered include the components of the tyre, factors affecting its performance, formulations, compound properties, and future trends. These latter include smart materials and tyres, run-flat tyres and deflation warning systems, the use of mathematical modelling, and environmental issues, including recycling. 432 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.843248

Item 117

160th ACS Rubber Division Meeting - Fall 2001.

Cleveland, Oh., 16th-18th October 2001, Paper 108, pp.16, 012

COMPOUNDING AND EXTRUSION OF TPV'S; NEW DEVELOPMENT OF MACHINERY EQUIPMENT

Uphus R

Berstorff GmbH

(ACS,Rubber Div.)

Topics discussed include compounding and dynamic vulcanisation of thermoplastic elastomers(TPEs),

development of new shear and elongation mixing elements, compact TPE, expanded TPE, and coextrusion of rubber/TPE and hybrid die.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.843032

Item 118

160th ACS Rubber Division Meeting - Fall 2001.

Cleveland, Oh., 16th-18th October 2001, Paper 107, pp.12, 012

OPTIMIZING MIXING IN THE FARREL BANBURY MIXER WITH WING FUNCTION TECHNOLOGY(WFT) ROTORS

Borzinski F J; Valsamis L N

Farrel Corp.

(ACS,Rubber Div.)

Experimental data from final mixing studies in a Banbury Mixer model BR, using standard Banbury and the new Wing Function Technology(WFT) rotors, respectively, are presented and discussed. Product quality, established by oscillating disc rheometer(ODR) measurements, demonstrated the ability of the new WFT rotors to provide high levels of product uniformity within the batch and from batch to batch. In comparative studies between the new rotors and standard Banbury type rotors for a laboratory size mixer, product uniformity was maintained, with mixing times significantly reduced, using the WFT rotors. Results from a production size mixer, a Farrel F270 Banbury Mixer equipped with WFT rotors, also showed significant improvements in product uniformity, a reduction in standard deviation of ODR values of the order to 28% and 69% for a synthetic and a natural rubber tyre tread compound, respectively. The increase in productivity was of the order of 14% and 10%, respectively. 4 refs.

USA

Accession no.843031

Item 119

160th ACS Rubber Division Meeting - Fall 2001.

Cleveland, Oh., 16th-18th October 2001, Paper 106, pp.13, 012

WING FUNCTION TECHNOLOGY - A NEW ROTOR TECHNOLOGY FOR THE FARREL BANBURY MIXER

Valsamis L N; Borzinski F J

Farrel Corp.

(ACS,Rubber Div.)

The process functions of the distributive and dispersive rotor wings of the Wing Function Technology rotors for the Banbury Mixer were verified by means of experimental pressure profiles for each rotor wing. These profiles were established at different mixer fill levels and showed that the fill level and the pressures generated by the dispersive rotor wing were unaffected by the mixer fill level. For the distributive wing, the wing fill level and the maximum

pressure generated increased with mixer batch size. Tracer profiles confirmed the effective utilisation of the entire mixing chamber, with no areas of material of stagnation and, compared with standard type Banbury rotors, reduced mixing times for a comparable compound quality. Finally, based on the recorded pressure profiles for the two rotor wings, a mixer match size which provided a mixer fill level of the order of 80% provided best overall mixer performance. At this fill level, both rotor wings were effectively used in performing their designated process functions. 9 refs.

USA

Accession no.843030

Item 120

160th ACS Rubber Division Meeting - Fall 2001.
Cleveland, Oh., 16th-18th October 2001, Paper 93,
pp.30, 012

**COMPARATIVE STUDIES ON EFFECTS
OF TESPT AND TESP D TREATED SILICA
COMPOUNDS ON PROCESSING AND SILICA
DISPERSION DURING MIXING IN NATURAL
RUBBER**

Kwang-Jea Kim; VanderKooi J
Struktol Co.of America
(ACS,Rubber Div.)

The effects of treatment of silica with TESPT (bis(triethoxysilylpropyltetrasulphane)) and TESP D (bistriethoxysilylpropyldisulphane) on processing, dispersion and mechanical properties of each compound in a polyisoprene formulation during mixing and after vulcanisation were studied. The results obtained are discussed with particular reference to temp. and power changes during mixing, steady shear viscosity, complex viscosity, viscoelastic properties (tan delta) before and after vulcanisation, reversion resistance test, tensile properties of dumbbell specimen, tear resistance of Die C specimen, blow-out and heat build-up, SEM characterisation and abrasion resistance. A model is proposed. 55 refs.

USA

Accession no.843017

Item 121

160th ACS Rubber Division Meeting - Fall 2001.
Cleveland, Oh., 16th-18th October 2001, Paper 65,
pp.27, 012

IMPROVED MIXING OF POLYACRYLATE

Anderson A; Manley P
Zeon Chemicals LP
(ACS,Rubber Div.)

The mixing of acrylate elastomer compounds was investigated with the aim of reducing mixing time. Compounds were mixed upside down or right side up at low rpm or high rpm in a Farrell BR1600 (1.6 litres) Internal Mixer. The Mooney viscosity and tan delta were used to determine the processability of the compounds.

The results obtained showed that acrylate elastomer compounds could be mixed more efficiently at higher rpm. Mixing at the higher rpm improved the processability and carbon black dispersion. It was found that an upside down mix was the best method for improving the quality of the mix and reducing mix time in the laboratory mixer. 11 refs.

FARRELL CORP.
USA

Accession no.842995

Item 122

Revue Generale des Caoutchoucs et Plastiques

78, No.796, June/July 2001, p.58-9

French

LITTLE EXTRAS OF CONTINUOUS MIXING

Biron M

The advantages and limitations of the continuous mixing of rubbers are discussed. Reference is made to the MVX series of mixers and associated computer control systems manufactured by Farrel.

FARREL; BERSTORFF
EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;
GERMANY; UK; USA; WESTERN EUROPE

Accession no.842596

Item 123

Industria della Gomma

45, No.4, May 2001, p.42-3

Italian

**BERSTORFF: COMPLETE PROCESSING LINES
FOR THERMOPLASTIC ELASTOMERS**

Types of extruders manufactured by Berstorff for the processing of thermoplastic elastomers are reviewed. These include extrusion compounding lines and machinery for the extrusion and coextrusion of water blown foam profiles.

BERSTORFF GMBH; MANNESMANN PLASTICS
MACHINERY GROUP; ADVANCED ELASTOMER
SYSTEMS
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
USA; WESTERN EUROPE

Accession no.842558

Item 124

Kautchuk und Gummi Kunststoffe

54, No.12, 2001, p.684-7

**INTERMESHING ROTORS WITH VARIABLE
CLEARANCE TO MIX COMPOUNDS**

Pomini L; Jacobi M
Pomini Rubber & Plastics

The advantages are discussed of a mixing technology which uses intermeshing rotors with variable clearance to improve both product quality and productivity. The ability of the VIC mixer to adjust the clearance between

the rotors is shown to offer significant advantages such as faster loading, viscosity control and energy savings. Three different compounds based on EPDM, or SBR or NBR rubber are considered. The cooling capacity of the mixer also enhances the temperature control of the rubber and enables the processing of the compound in a single stage, using a nearly isothermic condition when loading and mixing the curing agent. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.840569

Item 125

Polymer Engineering and Science

41, No.12, Dec. 2001, p.2266-80

INFLUENCE OF FILLERS AND OIL ON MILL PROCESSABILITY OF BROMINATED ISOBUTYLENE-CO-PARAMETHYLSTYRENE AND ITS BLENDS WITH EPDM

Kumar B; De P P; De S K; Bhowmick A K

Indian Institute of Technology; ExxonMobil Chemical India Ltd.; ExxonMobil Research & Engineering Co.

The milling behaviour of a brominated isobutylene-paramethylstyrene copolymer and its blends with EPDM was investigated using various techniques, including viscosity measurements, use of the theoretical model of Tokita and peel adhesion testing of rubber to metal adhesive force. The effects of adding various fillers (carbon black and silica), filler loading, processing oil concentration, temperature, friction ratio and silica particle size on milling behaviour were examined. Measurements were also carried out to determine the critical nip gap at which a front to back roll transition occurred and an attempt made to optimise the mill parameters to produce a smooth and regular band. 14 refs.

INDIA

Accession no.839392

Item 126

Polyolefins 2001. Conference proceedings.

Houston, Tx., 25th-28th Feb. 2001, p.411-30

ELONGATIONAL MIXING IN SINGLE SCREW EXTRUDERS

Luker K

Randcastle Extrusion Systems Inc.

(SPE, South Texas Section; SPE, Thermoplastic Materials & Foams Div.; SPE, Polymer Modifiers & Additives Div.)

A report is presented on the development of a 50/1 single-screw extruder with novel elongational mixing and a comparison of this extruder with a 24/1 single-screw extruder equipped with a Union Carbide mixer. Data from trials, which involved flood feeding and starve feeding, conducted on a thermoplastic elastomer, LDPE and blends, processed in these machines are included.

USA

Accession no.834930

Item 127

International Polymer Science and Technology

28, No.8, 2001, p.T/20-3

MIXING CONDITIONS DURING THE MIXING OF POLYMERIC MATERIALS

Anisimov P V; Yasev V A; Sveshnikov A N; Mikhailov A V

OOO NPK; Yaroslavl', State Technical University

An examination is made of the mixing process with reference to the mixing conditions relating to rubbers, which are determined by the size of the interface of the mixed components or by the interface-related overall shear strain. The use of powder technology for the preparation of rubber mixes and also mixing with the use of liquid rubbers is said to promote the most rapid reorientation of the interfaces of the systems being mixed. The variant technologies used for the preparation of rubber mixes are compared in terms of effectiveness. 10 refs. (Article translated from *Kauchuk i Rezina*, No.1, 2001, p.16).

RUSSIA

Accession no.834234

Item 128

Nippon Gomu Kyokaishi

No.2, 2001, p.75-81

Japanese

RECENT DEVELOPMENTS IN RUBBER MIXING EQUIPMENT AND MIXING TECHNOLOGY

Inoue K

The author describes improvements in batch mixers (internal mixers and new mixing mechanisms, six-bladed rotor operation and tests), developments in rubber mixing equipment, and continuous mixing tests on powder-form EPDM. 24 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.833373

Item 129

Nippon Gomu Kyokaishi

No.2, 2001, p.64-9

Japanese

CURRENT TRENDS AND PROBLEMS OF RUBBER MIXING TECHNOLOGY

Miasaka K

The author discusses changes in materials, changes in equipment (rotor type, rotor speed, data collection systems), mixing control (energy, temperature, time, thermal history) and mixing methods (previous mixing methods, carbon black dispersion control). 14 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.833371

Item 130

Nippon Gomu Kyokaishi

No.2, 2001, p.57-63

Japanese

STUDY OF THE RUBBER INTERNAL MIXER

Toh M

The author discusses problems relating to mixing in a closed biaxial mixer, optimum blades for mixers, voids and compounding behaviour, kneading and heat transfer in a mixer. 38 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.833370

Item 131

European Rubber Journal

183, No.5, NMay 2001, p.20-3

MIX CONTROLLER OPTIMISES MIX CYCLE IN REAL TIME

Shaw D

The secret of Trelleborg AB's mixing success, namely a mixer control system, which utilises sophisticated mathematical modelling and signal processing techniques to achieve real-time adaptive control of the mixer, is revealed. The mode of operation of this system, called MixCont, is detailed and Trelleborg's experience with operating the system is described.

TRELLEBORG AB

EUROPEAN COMMUNITY; EUROPEAN UNION;
SCANDINAVIA; SWEDEN; UK; WESTERN EUROPE

Accession no.833162

Item 132

Tire Technology International

Annual Review, 2001, p.114-6

ITS ALL IN THE MIX

Sunderlin U

Hagglunds Drives AB

The features and technical benefits of the Hagglunds drive concept for tangential internal mixers are described. The drive concept with power unit and hydraulic motor directly mounted on the machine is illustrated and white area analysis data from three different samples produced in an internal mixer equipped with an adaptive drive concept, called Maximum Rotor Control, and in a internal mixer utilising standard settings with a fixed rotor speed ratio, are presented and discussed.

EUROPEAN UNION; SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.833101

Item 133

Kauchuk i Rezina (USSR)

No.1, 2001, p.16-8

Russian

MIXING CONDITIONS DURING MIXING OF POLYMERIC MATERIALS

Anisimov P V; Yazev V A; Sveshnikov A N; Mikhailov A V

A theoretical study is described of different mixing regimes that can be used for mixing of polymeric materials, and a comparison between these and "ideal" mixing is given. Particular attention is paid to the mixing of powder rubbers. 10 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.832980

Item 134

Rubber and Plastics News

31, No.2, 20th Aug. 2001, p.29-32

TEMPERATURE KEY IN MIXING SILICA TYRE COMPOUNDS

Heiss G; Berkemeier D; Haeder W M; Rinker M

Krupp Rubber Machinery Inc.; Krupp Elastomertechnik GmbH

An overview of the mixing machinery currently available for the manufacture of silica compounds and the requirements for the design of an internal mixer for the production of these compounds is presented. A comparison is made of different mixers and the replacement of a 270-litre tangential mixer with a 250-litre intermeshing mixer to make use of the advantages of intermeshing internal mixers is demonstrated. 12 refs. (International Tyre Exhibition & Conference, Akron, USA, Sept.12-14, 2000).

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
USA; WESTERN EUROPE

Accession no.830402

Item 135

Journal of Applied Polymer Science

81, No.13, 23rd Sept.2001, p.3198-203

STUDY OF CARBON BLACK DISTRIBUTION IN BR/NBR BLENDS BASED ON DAMPING PROPERTIES: INFLUENCES OF CARBON BLACK PARTICLE SIZE, FILLER, AND RUBBER POLARITY

Sirisinha C; Prayoonchatphan N

Mahidol University

Using a dynamic mechanical thermal analysis technique the effects of fillers and rubber polarity on the distribution of filler in butadiene/nitrile rubber blends were investigated. Carbon black and silica were the fillers investigated. Filler migration between polymers was also shown. 12 refs.

THAILAND

Accession no.829908

Item 136

RUBBERCHEM 2001 - THE INTERNATIONAL RUBBER CHEMICALS, COMPOUNDING AND MIXING CONFERENCE. Proceedings of a conference

held Brussels, 3rd-4th April 2001.

Shawbury, Rapra Technology Ltd., 2001, Paper 12, pp.11. 012

MIXING - AN ENTHUSIASTS VIEW

Wood P R

(Rapra Technology Ltd.)

An update on information originally included in the 1996 RAPRA review report on rubber mixing is presented. Comparison between the mixing actions of intermeshing and tangential mixers is made, with the mixing action of several new designs of rotor discussed. Developments in continuous mixing of rubber materials are examined with consideration being given to the disadvantages specific to rubber compounding. Optimisation of mixing for maximum compound quality is discussed, with preparation of materials and post-mixer processing included as factors in achieving this quality. 7 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.829483

Item 137

RUBBERCHEM 2001 - THE INTERNATIONAL RUBBER CHEMICALS, COMPOUNDING AND MIXING CONFERENCE. Proceedings of a conference held Brussels, 3rd-4th April 2001.

Shawbury, Rapra Technology Ltd., 2001, Paper 3, pp.7. 012

NEW PRINCIPLES OF MIXING CONTROL

Sarbatova M; Petersson U; Brassas S

MixCont AB; Trelleborg Industri AB

(Rapra Technology Ltd.)

A mixing quality management system is described and its use for mixers with non-controllable rotor speed and ram pressure and mixers with controllable rotor speed is reported. The MixCont control module, the Procon weighing and time-temp. mixer control system and the data processing toolkit are discussed.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; SCANDINAVIA; SWEDEN; UK; WESTERN EUROPE

Accession no.829474

Item 138

Journal of Polymer Engineering

Vol.21, No.2-3, March-June 2001, p.251-6

ANALYSIS OF RUBBER MIXING PROCESS IN THE TRANSFERMIX EXTRUDER

Haberstroh E; Kremers A; Krusche A

Institut fuer Kunststoffverarbeitung

Mixing processes in different extruders were evaluated for the continuous incorporation of liquids into rubber compounds. A 60 mm Transfermix extruder and a 90 mm pin barrel extruder both produced good results. The Transfermix extruder seemed to be more promising for this application because when this was used, up to 8 wt% of liquid could be incorporated into the compounds in

a controlled and reproducible way. However, wall slip and sliding effects in the compound occurred for both extruders, which greatly reduced the mixing quality because of their effects on the flow conditions in the extruder. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.828711

Item 139

Kitchener, Ont., c.2001, pp.6. 28cms. 9/7/01

CUSTOM MIXING : WE MIX QUALITY, PERFORMANCE, SERVICE AND PRICE

AirBoss Rubber Compounding

AirBoss Rubber Compounding presents general information on its history, strengths, equipment, and capabilities. The company specialises in custom rubber mixing for the pneumatic and solid tyre, retreading, conveyor belting, automotive parts, and appliance industries. Recipes are specifically developed in-house or supplied by customers. Details are given of processing equipment used at the Kitchener plant, together with information on laboratory equipment and testing services.

CANADA

Accession no.828035

Item 140

Kitchener, Ont., c.2001, pp.1. 28cms. 9/7/2001

AIRBOSS DISPERSION

AirBoss Rubber Compounding

Information is presented on AirBoss dispersion techniques. Extensive blending is used throughout the mixing process including injecting waxes and other ingredients in liquid form precisely into each masterbatch. Blending from four masterbatches ensures optimum homogeneity in the final mix, while use of mixers such as the Skinner CoFlow assure effective dispersion of carbon black. Use of a Dispergrader 1000NT for dispersion analysis provides visual and digital proof of the thoroughness of AirBoss techniques.

CANADA

Accession no.828034

Item 141

International Polymer Processing

16, No.2, June 2001, p.87-99

'NEW-GENERATION' CO-FLOW INTERMESHING INTERNAL MIXER

Nortey N O

Skinner Engine Co.

The CoFlow4 intermeshing rotor internal mixer was shown analytically and experimentally to be a better compounder than any type of traditional uni-flow geared intermeshing and partial-flow rotor internal mixers. From customer trials and concise mixing study, the CoFlow4 mixer was

shown to use less power peak and specific energy than the traditional mixers. It also exhibited the advantages of better mixing quality, increase in productivity, better control of rotor heat transfer, longer wear life for dust-stop seals, wide range of process materials, and capabilities for single-pass and multiple-pass mixing. The CoFlow4 mixer retrofitted the traditional mixers at substantially lower purchase cost than all traditional uni-flow geared intermeshing 3-nog rotor internal mixers, but slightly higher purchase cost than the traditional tangential 4-wing rotor internal mixers. 14 refs.

USA

Accession no.827620

Item 142

Antec 2001.Conference proceedings.

Dallas, Texas, 6th-10th May, 2001, paper 499

PROCESSABILITY STUDIES OF SILANE TREATED SILICAS AND CARBON BLACKS IN EPDM MATRIX

Kim K-J; White J L

Akron,University

(SPE)

Silica, treated with silane coupling agents of varying chain lengths, was compounded with ethylene-propylene-diene terpolymer at 100 C for time periods of 60-900 s, using an internal mixer, and the silica filled systems compared with carbon black filled systems. Agglomerate particle sizes in the prepared materials were determined using scanning electron microscopy. Shear viscosities were measured, and extrusion characteristics were evaluated by determining the die swell on extrusion through a 1.5 mm capillary die. Treated silica systems exhibited lower viscosity, smaller agglomerate sizes and reduced swell compared with untreated silica systems. The silane with the shortest aliphatic chain length gave the smallest agglomerate size. Treated silica systems had higher agglomerate sizes and viscosities compared with carbon black filled systems. 18 refs.

USA

Accession no.827229

Item 143

Dordrecht, Kluwer Academic Publishers, 1999, pp.ix, 638, 24cm, 42

RUBBER TECHNOLOGY - THIRD EDITION

Akron,University

Edited by: Morton M

This handbook provides all the information necessary for selecting, handling and using the right elastomers for the desired products. The twenty chapters have each been prepared by acknowledged authorities who are writing on their particular fields of expertise. This third edition has been completely updated to reflect current developments and trends and includes a brand new chapter on thermoplastic elastomers. Chapter headings include: Introduction to

polymer science; The compounding and vulcanisation of rubber; Fillers - Carbon black; Fillers - Nonblack fillers; processing and vulcanisation tests; Physical testing of vulcanisates; Natural rubber; Styrene-butadiene rubbers; Polybutadiene and polyisoprene rubbers; Ethylene-propylene rubbers; Butyl and halobutyl rubbers; Nitrile and polyacrylic rubbers; Neoprene; Hypalon; Silicone rubber; Fluorocarbon elastomers; Polyurethane elastomers; Thermoplastic elastomers; Miscellaneous elastomers; reclaimed rubber; Latex and foam rubber; Rubber-related polymers - PVC and PE. Each chapter is well referenced.

ACS,RUBBER DIV.

EUROPEAN COMMUNITY; EUROPEAN UNION;

NETHERLANDS; USA; WESTERN EUROPE

Accession no.826530

Item 144

Kautchuk und Gummi Kunststoffe

54, No.6, 2001, p.327-33

SOME CONSIDERATIONS ON OPTIMUM MIXING WITH RESPECT TO THE FULL DEVELOPMENT OF RUBBER-CARBON BLACK TECHNOLOGY

Leblanc J L

Paris,Universite Pierre et Marie Curie

Starting from simple considerations about the basic objectives of mixing, with reference to recent results for rubber-filler morphology, attention was paid to fundamental aspects of this processing step. Investigations into the kinetic aspects of carbon black dispersion in rubber and the relationships that could be demonstrated between bound rubber and flow properties showed that these were important criteria in understanding the complexity of rubber mixing. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

Accession no.825069

Item 145

159th ACS RUBBER DIVISION MEETING - SPRING 2001. Held Rhode Island. 24th-27th April 2001..

Akron,Oh., 2001, Paper No.7, pp.13. 012

QUALITY AND UNIFORMITY OF AEROSPACE ELASTOMERS

Clark R C

International Polymer Technologies Inc.

(ACS,Rubber Div.)

Criteria that influence the mixing process of elastomers are discussed, together with their relationship to achieving quality and uniformity in a cost-effective manner and to putting a system in place to achieve optimum results. It is shown, with particular reference to suppliers of seals for aerospace applications, that these mixing concepts need to be incorporated into the strategic plans because cooperation is required between all departments of a company. 8 refs.

USA

Accession no.824930

*Item 146***Rubber World**

224, No.4, July 2001, p.40-5

CONTINUOUS VERSUS BATCH PROCESSING OF RECYCLED RUBBER AND PLASTIC BLENDS

Liu H S; Mead J L; Stacer R G

Massachusetts, University

An experimental investigation is described, which has been carried out to scale-up a series of recycled rubber/PP blends developed for internal batch mixing for use as thermoplastic elastomers or rubber-toughened plastics. Scale-up was accomplished using an intermeshing, co-rotating twin screw extruder. Resultant blends were characterised with respect to rheological properties relevant to processing, phase morphology and mechanical properties. It was found that if the processing conditions were modified in an attempt to mimic parameters of the batch mixer, blends with similar rheological and mechanical properties could be produced. Image analysis revealed that even though there is agreement with respect to physical properties, the internal mixer still provides a superior degree of dispersion as quantified by the intensity of segregation. 30 refs.

USA

*Accession no.824400**Item 147***Rubber World**

224, No.4, July 2001, p.34-9

MIXING OF SILICA COMPOUNDS FROM THE VIEW OF A MIXER SUPPLIERBerkemeier D; Haeder W; Rinker M; Heiss G
Krupp Elastomertechnik GmbH; Krupp Rubber Machinery Inc.

Trends in the use of silica in tyre formulations as a coupling agent are discussed with reference to developments in mixing machinery to best process the compounds. Because of the chemical reaction during the mixing process, the internal mixer acts as a chemical reactor in which the batch temperature control must be very accurate. In addition to the dispersion of filler in the compound, the reaction must be achieved. An overview is presented of current mixing available mixing equipment for producing silica compounds and the different demands placed on the mixing process are examined. Different mixer systems are compared and further requirements of the mixer itself and the control system are discussed. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.824399**Item 148***Rubber World**

224, No.4, July 2001, p.26-7

METERING AND MIXING MODULAR SYSTEM FOR LIQUID SILICONE RUBBER

Bauer G

2KM North America

The PFM-LSR metering and mixing system has been developed by 2KM to overcome some of the technical limitations which exist for the injection moulding of liquid silicone rubber. PFM-LSR technology is claimed to offer such advantages as: exact metering directly onto the injection screw to eliminate pressure losses; the variable shortest mixing distance which eliminates the need for a material pressure reduction valve; variable material feed; and a modular concept with simple expansion possibilities. These features are described.

NORTH AMERICA

*Accession no.824397**Item 149***Tire Technology International**

June 2001, p.48-51

THE WASTE PROBLEM - CUREDBrown C J; Brown D A; Hodgkinson N M; Watson W F
Watson Brown HSM Ltd.

The results are reported of a series of experiments carried out to evaluate HSM technology for recycling scrap rubber tyres. The test results and data were analysed using ECHIP experimental design software to identify important variables and generate response surface maps showing the effects of variables on each response. The data show through small-scale experiments that rubber can be recycled using a simple mechanical process, giving materials, which almost match the original physical properties, while containing a large amount of previously cured rubber. Details are also provided on current research and developments at Watson Brown Ltd.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.823042**Item 150***Industria della Gomma**

44, No.8, Oct.2000, p.45-7

Italian

SOME CONSIDERATIONS ON THE CLOSED MIXER

Milanese B

Meccaniche Moderne SpA

A study of the flexure of rotors in a continuous mixer with two counter-rotating, non-intermeshing rotors is reported. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.821966**Item 151*

Antec 2001.Conference proceedings.

Dallas, Texas, 6th-10th May, 2001, paper 64

MECHANICAL MIXING IN PIN SCREW EXTRUDERS: EXPERIMENTAL AND NUMERICAL ANALYSIS

Avalosse Th; Rubin Y; Epinat L; Slachmuylders E
Polyflow sa; Manufacture Francaise des Pneumatiques Michelin
(SPE)

The mixing capabilities of three extruder configurations used for rubber processing were compared experimentally and also theoretically using commercial software. The screw configurations evaluated were: a simple, continuously flighted single screw; a single screw with an interrupted flight; and a pin barrel screw. The use of uninterrupted flights reduced the pumping efficiency, which was not further reduced by the addition of pins. There was good qualitative agreement between the calculated and measured residence time distributions, confirming that the grooved screw provided enhanced mixing, which was further improved by the use of a pin barrel. 7 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;
FRANCE; WESTERN EUROPE

Accession no.821564

Item 152

IRC 2001. Proceedings of a conference held
Birmingham, 12th.-14th. June.
Birmingham, IOM Communications, 2001, p.237-255.

EXTRUSION HEAD WITH MIXING DEVICE AND ADJUSTABLE SHEAR EFFECT

Hasse H
(Institute of Materials)

A patented newly developed mixing system with adjustable shear effect is described which is claimed to meet the demands of the rubber processing industry for ways of improving the mixing of the extrudate. The invention refers to an extrusion head with mixing part and adjustable shear effect whereby the head can be used for homogenising, mixing and shearing of the supplied material, e.g. elastomers, polymer melts and other mixable viscous and pasty materials. The extrusion head can be connected by flange to any feeding system, for example extruders, gear extruders, piston-type extruders or pressure systems for mediums. The mixing system itself has no extrusion effect, therefore it is necessary to feed the material continuously. By the use of variable drive and different sizes, the mixing effect is adjustable and thus can be adapted to the compound or medium to be processed. Its use is demonstrated with various rubber compounds including EPDM, SBR, ECO, and FKM.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.820057

Item 153

IRC 2001. Proceedings of a conference held
Birmingham, 12th.-14th. June.
Birmingham, IOM Communications, 2001, p.212-222.

SINGLE ROTOR CONTINUOUS MIXER

Freakley P K; Fletcher J B
Loughborough,University; Carter Bros.(Rochdale) Ltd.
(Institute of Materials)

In this paper the need for a new continuous mixer is established, followed by a description of the design and presentation of preliminary results from a prototype system. A short review of batch and continuous mixers is included, with reference to design characteristics and capabilities, and details of advantages and disadvantages associated with each type. The single rotor continuous mixer (SRM) was designed with reference to both batch internal mixers and to existing continuous mixers. Its design and capabilities are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.820054

Item 154

European Rubber Journal

183, No.7, July/August 2001, p.32-3

CONTINUOUS AND REACTIVE MIXING GETS EC FUNDING

White L

Continuous mixing/extrusion of rubber and reactive mixing of silica-filled tyre compounds will come under the spotlight in a new European industry/academic research project. The polymer technology institute at the University of Paderborn (KTP) is the lead organisation in this three-year European Commission-funded rubber processing project, called SATPRO, which started in April. The SATPRO project has two tasks: development of a silanisation reactor for silica-filled compounds; and development of direct extrusion for continuously mixing and shaping rubber. KTP is just winding up two earlier EC-funded (BRITE-EURAM III) rubber research projects. One is on improving quality in mixing (Mini Derucom) and the other aims for better process understanding in extrusion of black- and silica-filled mixes (Prodesc).

PADERBORN,UNIVERSITAT

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.819117

Item 155

Rubber Chemistry and Technology

74, No.1, March/April 2001, p.1-15

RELATIONSHIPS BETWEEN MIXING METHOD, MICROSTRUCTURE AND STRENGTH OF NR: BR BLENDS

Clarke J; Clarke B; Freakley P K
Loughborough,University

Much published literature on the way in which phase morphology and filler distribution affect blend properties is contradictory or confusing. Experiments are carried out to elucidate the relationships and to determine whether the

use of compatibilisers or special mixing techniques might have a beneficial effect on NR:butadiene rubber (NR:BR) blend properties. NR:BR blends are prepared using both a masterbatch method and a single-stage mixing method. A cure system which gives even distribution of crosslinks between the phases is used. The morphology, tensile strength and tear strength properties of the blends are measured. Results indicate a high degree of compatibility with fine textured blends domain sizes being quickly and easily produced, even from masterbatches of very different viscosities. Strength properties of these fine-textured masterbatch blends can be predicted by applying the simple rule of mixtures to properties of individual compounds mixed under the same conditions. Although in particular situations a coarse morphology can result in high tear resistance values, for most applications a due textured morphology gives the most satisfactory overall tensile and tear strength properties. For blends mixed in a single-stage process, development of a fine textured morphology is much quicker than that of filler dispersion. For NR:BR blends containing an optimum cure system it is concluded that the mixing cycle should be chosen to optimise filler dispersion and that use of a compatibiliser will not significantly shorten the mixing cycle or improve the properties of the blend. 16 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.818141

Item 156

Rubber World

224, No.2, May 2001, p.45-8

CONTINUOUS MIXING OF POLYMERIC COMPOUNDS

Borzinski F J

Farrel Corp.

The increased availability of free-flowing forms of raw materials and the introduction of newer designs of continuous processing machinery will open up a new dimension of mixing technology for the rubber industry. Whether one chooses the batch or continuous approach to one's mixing requirements, if the choice is available, the suitability of the process must satisfy the purpose for which the compound has been developed. The advantages and disadvantages of batch mixing and continuous mixing are discussed. Several types of continuous mixers are available. The FCM continuous mixer is a twin rotor counter rotating device, the MVX (mixing venting extruder) consists of a mixer containing two delta shaped counter rotating rotors, close coupled to a pumping extruder, while the FTX is a co-rotating twin screw extruder.

USA

Accession no.816770

Item 157

Nippon Gomu Kyokaishi

73, No.12, 2000, p.653-9

Japanese

EFFECT OF MIXING METHOD ON THE STRAIN ENERGY DENSITY FUNCTION OF CARBON BLACK REINFORCED RUBBER

Yamashita Y; Kawabata S

The study investigates the effect of various mixing methods on the gamma function, i.e. the strain energy density function. 11 refs.

Accession no.816517

Item 158

China Rubber Industry

48, No.3, 2001, p.161-7

Chinese

STUDY ON MIXING PROCESS AND MECHANISM OF TWO-ROTOR CONTINUOUS MIXER

Xie Lin-sheng; Miao Guo-bing; Chen Xiao-hong

Jiangsu, Institute of Petrochemical Technology

The mixing process and mechanism of a two-rotor continuous mixer were investigated and the mathematical and physical models of the mixing process were established. The results showed that the primary parameters which contributed to the mixing process included the rotor combination (the length of rotor convergency sections), the rotor speed, the clearance between the top of the wing and the inner wall of the mixing chamber, the shape of inserted block and the opening stroke of discharge door. 4 refs.

CHINA

Accession no.813831

Item 159

Journal of Applied Polymer Science

80, No.13, 24th June 2001, p.2474-82

INFLUENCE OF SOME ADDITIVES ON STATE-OF-MIX, RHEOLOGICAL, TENSILE, AND DYNAMIC MECHANICAL PROPERTIES IN SBR COMPOUNDS

Sirisinha C; Sittichokchuchai W

Mahidol University; Thailand, Polymer Technology R & D Centre

The influence of additions of processing oil, slip agent and dispersing agent on the mixing, and on the rheological, tensile and dynamic mechanical properties of styrene-butadiene rubber (SBR) was investigated. Extrudate swell of SBR containing processing oil or dispersing agent was mainly dependent upon the degree of mixing, but was dependent upon wall slip in compositions containing the slip agent. Plasticisation was the major factor controlling the dynamic mechanical properties in compositions containing processing oil, whilst the degree of crosslinking and dilution effects were the main factors with dispersing agent-containing compositions. The dynamic mechanical properties of compositions containing slip agent were influenced by both the degree of crosslinking and mixing. The tensile properties were mainly dependent upon

plasticisation in processing oil-containing compositions, but upon the degree of crosslinking in those containing slip and dispersing agents. 15 refs.

THAILAND

Accession no.813681

Item 160

Rubber Technology International

March 2001, p.44-7

SPLITTING THE UNSPLITTABLE

Brown C J; Brown D A; Hodgkinson N M; Watson W F
Watson Brown HSM Ltd.

A new approach to recycling scrap rubber using Watson Brown HSM technology promises a simple and cost-effective process which can retrieve high percentages of the original material characteristics, opening up the possibility of a true rubber recycling industry. In previous papers, the company envisioned a commercial process via mechanochemistry. For cured materials, it has been shown that a sufficiently extended rubber network will rupture preferentially at cross-links. This work has been patented and the machine, which has the productivity of an internal mixer with the capability of imposing shear comparable to that of the tight nip of a two-roll mill, termed a High Stress Mixer. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.810039

Item 161

Rubber Technology International

2000, p.99-101

ROTOR FRICTION RATIO AND ITS EFFECT ON MIXING CONTROL

Milanese B

Meccaniche Moderne Spa

The friction ratio between the rotors of a tangential-type internal mixer as a possible control parameter for the mixing process is studied and discussed. No refs.

POMINI

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.807902

Item 162

Rubber Technology International

2000, p.80-2

ON-LINE WEIGHING IN THE PREPARATION OF MATERIALS

Becker W

Motan-Fuller GmbH

A semi-automatic and a fully automatic system for the weighing of chemicals going into rubber compounds are described. The semi-automatic system involves manual weighing of ingredients by the operator off-line into

low melt batch inclusion bags. The bags are then heat or ultrasonically sealed, labelled and/or bar coded then manually inventoried close to the mixer. In the fully automatic off-line system, materials are weighed directly from storage bins, charged into low melt bags and sealed automatically. These bags are manually inventoried close to the mixer. Both systems are equipped with process control systems which include recipe management, lot traceability and production planning software. No refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.807897

Item 163

Rubber Technology International

2000, p.34-7

EFFECTS OF SILANES IN RUBBER PRODUCTS WITH A HIGH SILICA LOADING

Ansarifar M A; Nijhawan R

Loughborough, University

When added to a conventional accelerator/sulphur compound of NR containing 60 pphr precipitated amorphous white silica, the bifunctional organosilane bis(3-triethoxysilylpropyl)tetrakisulphane (TESPT) had a profound effect on the viscosity and cure properties. The Mooney viscosity decreased when 7 pphr silane/60 pphr silica was mixed with the compound. The scorch time shortened when 3 pphr silane/60 pphr silica was added to the mix and the optimum cure time was also reduced when 7 pphr silane/60 pphr silica was introduced into the rubber. The rate of cure of the mix accelerated with 7 pphr silane/60 pphr silica. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.807886

Item 164

Macromolecular Materials and Engineering

Vols.284-5, Dec.2000, p.64-9

QUALITY ASSURANCE IN THE RUBBER MIXING ROOM - PREDICTION OF THE RUBBER COMPOUND PROPERTIES THAT ARE RELEVANT FOR THE ELASTOMER PRODUCT PROPERTIES

Ryzko P; Haberstroh E

IKV

Quality assurance in rubber processing is discussed. A process parameter based method was developed for choosing the rubber compound characterisation methods that are relevant for predicting the compound properties which are relevant to the properties of the finished products. 19 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.807877

Item 165

Industria della Gomma

44, No.3, April 2000, p.106-8

Italian

FRICITION RATIO BETWEEN ROTORS AND MIXING CONTROL

Milanese B

The friction ratio between the rotors of tangential mixers is examined as a parameter for the control of the mixing process. Reference is made to internal mixers developed by Meccaniche Moderne in collaboration with Kobe Steel.

MECCANICHE MODERNE SPA; KOBE STEEL LTD.; POMINI

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; JAPAN; WESTERN EUROPE

Accession no.803918

Item 166

Iranian Journal of Polymer Science and Technology

13, No.3, Autumn 2000, p.19-27

Persian

SCALE-UP OF RUBBER MIXING USING UNIT WORK METHOD

Naderi G; Ghoreishy M H

Iran, Polymer Institute

This research paper is devoted to the application of unit work method for the scale-up of a rubber mixing process in Banbury-type internal mixers. Mooney viscosity and carbon black dispersion factors were selected as the parameters for the determination of the state of mixing. Based on a specific compound formulation, these parameters were measured in three mixers with different chamber sizes. The method indicates the operating points of a bigger size mixer can be accurately obtained from the experimental data obtained on a small size mixer. 6 refs.

IRAN

Accession no.803132

Item 167

European Rubber Journal

183, No.1, Jan.2001, p.26-7

HOLROYD ASSOCIATES PROPOSE CHANGES TO TYRE INDUSTRY

Holroyd E

This article suggests that the tyre industry has been walking up a blind alley for the last 50 years or more, because of its method of constructing tyres. It is argued that a tyre does not need to use separate steelcord and fabric reinforcement, but instead that compounds need to be made much stronger. The Holroyd Cold Mixer is powered by a custom-designed extruder screw with two mixing zones to offer good dispersive and distributive mixing. The energy input is vastly reduced and a significant saving is made in the mixing cost per kilo. The latest machine developed by Holroyd Associates is a continuous mixer/extruder which produces fully-mixed compound in a single-pass operation at room temperatures or even below.

HOLROYD ASSOCIATES LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.799083

Item 168

Nippon Gomu Kyokaishi

73, No.8, 2000, p.442-9

Japanese

PROBLEMS OF HEAT GENERATION AND HEAT TRANSFER IN RUBBER MIXING

Toh M

A discussion is presented of the phenomena of heat generation and transfer and the effect of changes in temperature on the mixing of rubber in an internal mixer. 17 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.797717

Item 169

Journal of Applied Polymer Science

78, No.8, 21st Nov.2000, p.1555-65

A FRACTAL APPROACH TO THE MIXING-MICROSTRUCTURE-PROPERTY RELATIONSHIP FOR RUBBER COMPOUNDS

Hirata M

Bridgestone Corp.

The application of fractal methods to the study of mixing rubber compounds, the carbon black dispersion thereby achieved, and the fracture surfaces generated in broken tensile test samples is described. Relationships between the fractal analysis of each of these application areas are examined and are compared to conventional methods for examining mixing-microstructure-property relationships such as mixing energy, black dispersion measurement by electrical conductivity and optical methods, and tensile strength. It is shown that the fractal dimension decreases in each case with increased mixing, improved carbon black dispersion and increasing tensile strength. Relationships between amount of mixing, state of mix and fracture surfaces are found to be simple linear or quadratic. 6 refs

JAPAN

Accession no.796707

Item 170

Journal of Applied Polymer Science

78, No.8, 21st Nov.2000, p.1551-4

COMPARISON OF INTERMESHING ROTOR AND TRADITIONAL ROTORS OF INTERNAL MIXERS IN DISPERSING SILICA AND OTHER FILLERS

Koolhiraan C; White J L

Akron, University, Inst. of Polym. Engineering

A study of the mixing characteristics of intermeshing and tangential rotors on rubber compounds filled with silica, black and talc shows that the intermeshing rotors more effectively disperse and distribute the fillers and produce compounds with lower viscosity. Dispersion was assessed by studying the change in agglomerate size with mixing time using a scanning electron microscope, distributive mixing using a flow visualisation method and viscosity by measurement with a biconical rotational viscometer. 15 refs

USA

Accession no.796706

Item 171

China Synthetic Rubber Industry

23, No.6, 2000, p.362-5

Chinese

LOW HARDNESS EPDM/POLYPROPYLENE THERMOPLASTIC DYNAMIC VULCANIZATES. I. PREPARATION TECHNOLOGY BY A TWIN-SCREW EXTRUDER

Chonggang W; Yujun Z; Yajuan S; Zhiqiang C; Congpeng X

Beijing, University of Chemical Technology

A low hardness EPDM/PP blend thermoplastic dynamic vulcanisate was produced by reactive compounding on a twin screw extruder. The effect of the dynamic vulcanisation rate on the average rubber particle diameter, and the average rubber phase crosslinking density of extruded vulcanisates was investigated. 6 refs.

CHINA

Accession no.794759

Item 172

Kautchuk und Gummi Kunststoffe

53, No.10, Oct.2000, p.566-73

German

RELMA - A QUALITY ASSURANCE DEVICE IN THE MIXING ROOM

Keuter H; Ackfeld D; Limper A

Paderborn, Universitat

The RELMA method is a laser induced emission spectral analysis, which is applicable as an instrument for quality assurance in the rubber mixing room. With the RELMA technique, relative element concentrations and their distribution can be determined in a macroscopic scale in usual cycle times of internal mixers. Therefore, quality statements about the compound or even end products can be drawn very fast. Within this paper the optimised RELMA method will be presented and some examples for the application will be shown. In the second part of the application, the RELMA method as a quality assurance instrument for liquids (plasticisers) and disperse solids (carbon black) will be described. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.792612

Item 173

High Performance Elastomers 2000. Conference proceedings.

Berlin, Germany, 10th-11th Oct.2000, paper 6

BENEFITS OF DOUBLE MIXING HIGH PERFORMANCE ELASTOMERS

Febery W

Clwyd Compounds Ltd.

(Rapra Technology Ltd.; European Rubber Journal)

A brief history of mixing high performance elastomers at Clwyd Compounds is presented. It is important to look back as decisions taken then had a significant effect on the level of quality and the mixing regime in place today. Major factors causing compound variation in high performance elastomer compounds are discussed, as is the Clwyd approach to compounding high performance elastomers. Three case histories demonstrate that by narrowing the rheological spread and enhancing dispersion, improvements in the areas of process efficiency, reduced scrap, machine downtime, faster cure cycles and compound flexibility can be expected. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.792368

Item 174

International Polymer Science and Technology

27, No.8, 2000, p.T/22-6

INFLUENCE OF THE MAIN DESIGN CHARACTERISTICS OF A BATCH MIXER ON THE EFFECTIVENESS OF PREPARATION OF RUBBER MIXES

Shikhirev N I; Rasskazov A In; Trofimov A P; Skok V I

Moscow, Scientific Research Institute of the Tyre Industry

Design factors affecting the effective mixing of a carbon black filled rubber are investigated and tested with reference to rubber mix preparation in a batch internal mixer with oval rotors. Design aspects considered include the size of the radial gap between the wall of the mixing chamber and the rotor blade, the radius of the working surface of the rotor blades, and the rotor speed. Changes occurring during mix preparation were assessed visually, and also from the amount of carbon black introduced into the polymer and the amount of carbon black and mix in the crescent-shaped space of the mixing chamber. The quality of the mix was assessed from the degree of dispersion and uniformity of distribution of the carbon black in the polymer during the testing of 15 specimens. 20 refs. Translation of Kauchuk i Rezina, No.1, 2000, p.19

RUSSIA

Accession no.790295

Item 175

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 62

**NEW TECHNOLOGY TANGENTIAL N.T.T.
DEVELOPMENT OF TANGENTIAL ROTORS
WITH THE USE OF NUMERICAL AND
EXPERIMENTAL METHODOLOGIES**

Regalia R

Techint-Pomini

(Nordic Council of Rubber Technology)

Starting from the 1970s and 1980s, the development of internal mixers for discontinuous processes has undergone a rapid evolution dictated both by the need for higher quality of the compounds produced and the request for high productivity to combat rising costs. A continuous evolution in rotor shapes is being observed, both for the so-called 'intermeshing' rotors and the more traditional 'tangential' types. To understand what a certain shape of rotor can potentially offer, it is necessary to study the flow field generated inside the mixing chamber. It is best to use methods that can give sufficiently rapid answers and that allow the analysis of the many geometric parameters involved with the shape of the rotor. It is possible to establish which way to follow to optimise the shape. Computational fluid dynamics methods have been widely employed in the development of NTT tangential rotors. Further experiments allow the results obtained by calculus to be validated. 13 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.787096

Item 176

IRC 2000. Conference proceedings.

Helsinki, Finland, 13th-15th June 2000, paper 39

REACTIVE MIXING OF RUBBER AND SILICA

Reuvekamp A E M; Ten Brink J W; Van Swaaij P J;

Vancso G J; Noordermeer J W M

Twente, University

(Nordic Council of Rubber Technology)

For most applications, rubbers are reinforced with active fillers. Usually carbon blacks or silica particles are used to enhance properties and service life. An advantage of silica compared to carbon black is: silica gives lower hysteresis loss, which for tyre applications leads to a lower rolling resistance and consequently fuel savings. The compatibility of hydrophilic silica with the hydrophobic polymer matrix is low. Filler-matrix compatibility can be enhanced by adding a bi-functional coupling agent. The filler surface will only be partly activated, and this can create problems for the properties of the final product. The objective is to examine the influence of processing parameters during mixing and vulcanisation - fill factor, rotor speed, order of adding ingredients - on the filler-matrix-coupling. Irreproducible conditions, combined with different possibilities of adding the coupling agents to the filler/rubber substrate are no doubt major factors in the reproducibility of silica-reinforced rubber compounds. Strong evidence is obtained that the ultimate temperature during the mixing stage governs the reaction mechanism

of the coupling agent: formation of a silica-rubber bond vs. the action as a curing agent. This evidence is obtained via mechanical and dynamical testing. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; WESTERN EUROPE

Accession no.787073

Item 177

Tire Technology International

2000, p.135/42

IN THE MIX

Wood P

Tire Technology International

This article is intended to be a reference and a guide to good mixing room practice, and of particular relevance to tyre manufacturers. Aspects of the mixing process considered include raw materials consistency; compound preparation and weighing; the importance of process control; material transfer and feeding; batch size and fill factors; use of different rotor speeds during mixing; and control of mixing.

Accession no.785690

Item 178

Shawbury, Rapra Technology Ltd., 2000, pp.vi,408.

150.00. ISBN 185957 2073. 26cms. 14/9/00. 813

SCIENCE AND PRACTICE OF RUBBER MIXING

Nakajima N

Akron, University

This book organises the enormous amount of knowledge that exists among manufacturers and individual operators working within the rubber industry into a coherent whole based on scientific principles. Subjects covered include mill processability, mixing of rubber, characterisation using dilute solution methods, viscoelastic characterisation of gum rubber and compound, energy aspects of mixing rubber and post-mixer processes. Each chapter is fully referenced and extensively illustrated.

Accession no.784996

Item 179

Patent Number: US 6057392 A1 20000502

**THERMOMECHANICALLY MIXING RUBBER
COMPOUNDS CONTAINING AN ALKYL (C12-
C22) ESTER OF A FATTY ACID**

Wideman L G; Sandstrom P H

Goodyear Tire & Rubber Co.

A method is disclosed for processing a rubber composition comprising thermomechanically mixing the rubber composition while maintaining a rubber temperature in a range of from 160 deg C to 190 deg C for a period of time ranging from 4 to 8 minutes, wherein said rubber composition is characterised by (i) 100 parts by weight of at least one sulphur vulcanisable elastomer containing olefinic unsaturation; (ii) 10 to 250 phr of a filler selected

from the group consisting of silica, carbon black and mixtures thereof; and (iii) 0.5 to 50 phr of an ester of a formula wherein R1 is selected from the group consisting of alkyls having from 16 to 18 carbon atoms and alkenyls and alkadienyls having from 16 to 18 carbon atoms; and R2 is selected from the group consisting of alkyls having from 12 to 22 carbon atoms.

USA

Accession no.784443

Item 180

Rubber Chemistry and Technology

73, No.2, May-June 2000, p.240-52

THE EFFECTS OF CERTAIN RECIPE INGREDIENTS AND MIXING SEQUENCE ON THE RHEOLOGY AND PROCESSABILITY OF SILICA- AND CARBON BLACK-FILLED TIRE COMPOUNDS

Schaal S; Coran A Y; Mowdood S K
Akron,University; Pirelli Tire LLC

The work was carried out to study the effects of curing agents, fillers such as silica and the effects of mixing sequence and scheme on the rheological and processability characteristics of tyre compounds stored at different temperatures prior to testing. 15 refs.

USA

Accession no.783003

Item 181

International Polymer Science and Technology

27, No.5, 2000, p.T/1-T/5. (Translation of Gummi Fasern Kunststoffe, No. 3, 2000, p.158)

PRODUCTION MIXER WITH VARIABLE INTERMESHING CLEARANCE

Limper A; Moessinger J

The performance is tested of a new type of mixer with variable intermeshing clearance, the VIC, in which the distance between the rotors can be varied to meet the mixing requirements of different formulations. As such, the user has the possibility of choosing distributive or dispersive mixing techniques. Its performance is investigated against that of a traditional mixer, using an EPDM mix. Results indicated that with this particular test compound, the mixer with adjustable clearance between the rotors was not able to achieve processing advantages, details of which are discussed. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.779948

Item 182

Rubber Chemistry and Technology

72, No.5, Nov./Dec.1999, p.807-28

MODELING DISPERSIVE MIXING OF RUBBER COMPOUNDS

Clarke J; Petera J

Loughborough,University; Lodz,Technical University

The dispersive mixing process of filler deagglomeration was studied with the ultimate aim of improving mixer geometry by using a mathematical model for rubber mixing. Specially-designed elongational flow experiments were used to achieve dispersive mixing under conditions of known stress and strain rate history. It was found that the deagglomeration process was satisfactorily described by a first order differential equation with the rate constant proportional to the power density experienced by the compound during mixing. The kinetic model was implemented in original finite element software to obtain a two-dimensional simulation of mixing in a twin rotor internal mixer. It was concluded that the two-dimensional simulation was not only a necessary precursor to three-dimensional modelling, but would also be useful for relating cross-sectional rotor geometry to efficiency of filler deagglomeration and, hence, dispersive mixing. 22 refs.

EASTERN EUROPE; EUROPEAN COMMUNITY; EUROPEAN UNION; POLAND; UK; WESTERN EUROPE

Accession no.778375

Item 183

Patent Number: EP 1005969 A1 20000607

ROTOR FOR MIXING ELASTOMERS HAVING A VARIABLE FLANGE OR FLIGHT ANGLE

Regalia R

Techint Compagnia Tecnica Internazionale SpA

This comprises a first section of greater axial length, defining a thrusting flange and a second section of smaller axial length, defining a counter-thrusting flange. At least one of the flanges has an angle of entry into the mixture, which is varied along its extension.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE; WESTERN EUROPE-GENERAL

Accession no.777703

Item 184

Indian Rubber Journal

Vol.48, 2000, p.122-8

MIXING OF SILICA/SILANE FILLED RUBBER COMPOUNDS

The mixing of highly filled silica rubber is discussed with reference to the linking of a bifunctional organosilane to the silica. The reaction mechanism is investigated for four different silanes for the in-situ modification of silica. A study is made of the silane reaction following the ethanol formation; the influence of the dump temperature, the influence of silane concentration, the silica/silane reaction following the shear modulus tan tones, and consequences for compounders. 23 refs.

DEGUSSA-HUELS

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.776981

Item 185

Tire Technology International

June 2000, p.20/8

IN THE MIX

Wood P

This article is intended to be a reference and a guide to good mixing room practice. The mill room environment, compound preparation, material transfer and feed, batch size and fill factor, effective use of the mixer, feeding the mixer, use of different rotor speeds during mixing and control of mixing are discussed.

USA

Accession no.775774

Item 186

China Rubber Industry

47, No.5, 2000, p.278-82

Chinese

OPTIMAL DESIGN OF INTERNAL MIXER ROTORS

Liang J-z

South China, University of Technology

The results are reported of a study of the main geometrical parameters for Banbury mixer rotors carried out to reduce specific energy consumption of rubber compounds and increase the axial circulating flow of rubber compounds in the mixing chamber. 7 refs.

CHINA

Accession no.774171

Item 187

Gummi Fasern Kunststoffe

53, No.3, March 2000, p.158-61

German

PRODUCTION MIXER WITH VARIABLE INTERMESHING ROTOR CLEARANCE

Limper A; Moessinger J

The authors compare the performance of a variable intermeshing clearance mixer, which offers the possibility of varying the intermeshing clearance between the rotors in addition to the usual adjustable process parameters, with that of conventional mixers with intermeshing rotors. 3 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.773787

Item 188

Italian Technology

No.1, May 2000, p.82

PLANETARY TWIN-STAGE PLASTIFYING MACHINE

The planetary twin-stage plastifier from Plas Mec overcomes some limits of a conventional single-screw

or twin-screw extruder and represents an innovative and flexible solution when granulating PVC, thermoplastic elastomers, PE and PP. The system comprises of a forced-feeding system, a planetary plastifier and a single-screw expelling extruder. The TRR series of turbomixers is for cold mixing of either powder or granulate polymers with pigments or additive admixing. Applications include concentrated masterbatches, compounding in general, coating powder and premixing of any kind of material.

PLAS-MEC SRL

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.772662

Item 189

Kauchuk i Rezina (USSR)

No.1, 2000, p.19-23

Russian

INFLUENCE OF THE BASIC DESIGN CHARACTERISTICS OF A BATCH INTERNAL MIXER ON THE EFFECTIVENESS OF PREPARATION OF RUBBER MIXES

Shikhirev N I; Rasskazov A N; Trofimov A P

A special model mixing chamber was designed, and the mixing process was studied using different design parameters, rotor speed and mixing time. 20 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

Accession no.771829

Item 190

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 16A

POWDER RUBBER - NEW RAW MATERIAL GENERATION FOR THE SIMPLIFICATION OF THE PRODUCTION PROCESSES IN THE RUBBER INDUSTRY

Gorl U; Schmitt M

Pulverkautschuk Union GmbH

(ACS, Rubber Div.)

The development of a continuous compounding process for power-efficient and low-cost production of rubber compounds of high and consistent quality certainly is a great challenge, but also a chance for the rubber industry. A prerequisite for this is to convert the rubber and filler into a state in which both components are present in already homogeneously dispersed form in one phase. The development and production of free-flowing rubber/filler batches in powder form - generally called powder rubber - is certainly one of the most promising approaches to achieve the above-mentioned objectives. The various development methods leading to the various powder rubber systems as they are necessary for wide introduction of this new product form and processing

technology into the rubber industry require an individual treatment of the different rubber/filler variants as regards raw material selection, production and compounding technology. Investigations of the E-SBR/carbon black system have previously been described. These results and the experience gained are described, with emphasis on the introduction of a new powder rubber system based on NR/carbon black. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.771657

Item 191

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 14

ON THE DEPENDENCY OF TYRE PERFORMANCE AND THE DEGREE OF MIXING

van Raepenbusch P; Pessina R; Nichetti D
Pirelli Pneumatici SpA
(ACS,Rubber Div.)

Tyre performance is not only related to its architecture and compound formulations, but more so on the way the compound ingredients are mixed together and its process history downstream. The processing engineer has to define not only the order in which ingredients are introduced but also specific time/temperature and or energy profile the compound must be subjected to produce the desired and repeatable tire performance. Mixing equipment needs more sophisticated controls enabling complex recipe to be performed including enough artificial intelligence capabilities to 'adapt and steer' the recipe in a real time mode for any materials or process variations. 'Black book' science is just not good enough anymore. The process engineer today relies on sound statistical design of experimentation to build up the base knowledge to feed predictive tools to assist in his day-to-day task. The final viscoelastic properties of silica tread compounds are correlated to the degree of mixing. Some light is also shed on the relationship between input mixing energy and tyre properties, such as rolling resistance, wet and dry grip. 10 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.771654

Item 192

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 13

MODELLING OF THE MIXING PROCESS AND ONLINE PREDICTION OF THE RUBBER COMPOUND AND MOULDED PART PROPERTIES WITH INTELLIGENT PROCESS ANALYSIS TECHNOLOGIES

Haberstroh E; Ryzko P

IKV

(ACS,Rubber Div.)

The growing quality requirements and increasing cost pressure being imposed on rubber products are making it necessary for the rubber processing industry to assure and document the product quality. Present day control concepts for compound production are seldom based on the actual parameters of the process and are frequently unable to detect disturbances such as time deviations or changes in the thermal conditions which have an influence on the compound properties. Both are presented, the development and testing of a measuring and control system that allows the online characterisation of rubber compounds, recording data and fault reporting based on measured process parameters with the support of intelligent methods, like neural networks, different mathematical classification methods and stepwise linear regression analysis. The results show that these methods are capable of learning and reacting to changing conditions in the mixing chamber. This analysis and prediction technique leads to a high accuracy of prediction of the viscoelastic rubber compound properties. The results of the properties prediction are able to give the producer important information for further rubber processing steps and about the properties of the rubber parts. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.771653

Item 193

157th ACS Rubber Division Meeting - Spring 2000. Preprints.

Dallas, Tex., 4th-6th April 2000, paper 6

MIXING OF SILICA COMPOUNDS FROM THE VIEW OF A MIXER SUPPLIER

Berkemeier D; Haeder W; Rinker M; Heiss G
Krupp Elastomertechnik GmbH; Krupp Rubber Machinery Inc.
(ACS,Rubber Div.)

The introduction of tyre tread compounds with high silica loadings together with the application of silane in the early nineties demanded an adapted mixing process for such compounds. Silane as an additional chemical ingredient in the recipe is used as a coupling agent between silica and polymer. During mixing the silane reacts with the silica and develops open movable chemical bridges which are able to bond filler and polymer during curing. Because of the temperature dependency of the chemical reaction the temperature history of the batch during the mixing process is now of crucial importance. Historically, tangential internal mixers are used in the tyre industry for the production of tread compounds. On the other hand, intermeshing systems are preferred in the technical rubber industry. Referring to a defined empty volume inside the mixer, these machines have a larger cooling surface compared with tangential mixers of equal size. Therefore, intermeshing internal mixers demonstrate

a better heat sensitivity, and the batch temperature can be controlled more efficiently. This feature gives the intermeshing internal mixers a considerable advantage for the production of silica tread compounds in the tyre industry, as well. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
USA; WESTERN EUROPE

Accession no.771646

Item 194

157th ACS Rubber Division Meeting - Spring 2000.
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 5

FARREL MVX MIXING VENTED EXTRUDER

Purdy G; Rapetski W A

Farrel Corp.

(ACS,Rubber Div.)

Batch mixing is the rubber manufacturers traditional way of compounding the rubber, for technical rubber goods and pneumatic tyres. A continuous process for compounding rubber is described. Continuous processing is well known in the oil and chemical industry. The plastics industry generally uses continuous processing as its normal *modus operandi*. The rubber processing industry is also very largely based on the products of the oil refinery and chemical industries who use continuous processing to make rubbers and at the end of the process compress the rubber into large bales and lumps to suit the existing batch mixing processes used in the rubber industry.

USA

Accession no.771645

Item 195

157th ACS Rubber Division Meeting - Spring 2000.
Preprints.

Dallas, Tex., 4th-6th April 2000, paper 4

DEVELOPMENT OF THE 6-WING ROTOR FOR INTERNAL MIXERS

Yamada N; Takakura K; Inoue K

Kobe Steel Ltd.

(ACS,Rubber Div.)

Kobe Steel has a considerable experience with internal mixers, and the development of rotors, such as the 4-wing H 'swirl' rotor. Over 400 mixers with 4-wing H rotors are in operation worldwide. In recent years, increased quality requirements for rubber products, combined with higher productivity, are being demanded by end users. In response, Kobe Steel has developed a rotor with a new mixing mechanism. This new mechanism is called 'Various Clearance Mixing Technology' (VCMT), and it is applied to design the new 6-wing rotor called the 6WI. This rotor has three long wings and three short wings. Unlike other rotors, the clearance between rotor tip and mixer wall varies circumferentially and longitudinally. The result is better cooling performance, higher specific energy consumption, more efficient mastication, and

higher dispersive and distributive mixing. These rotors are also excellent at pulling the material into the chamber. The net effect is improved carbon dispersion and increased productivity. Kobe Steel's development of this new technology, along with performance characteristics of both the laboratory and production size mixers utilising it, are described. 5 refs.

JAPAN

Accession no.771644

Item 196

TPE's 2000. Conference proceedings.

Philadelphia, Pa., 28th-29th Sept.1999, p.171-85

COMPOUNDING OF RUBBER CONCENTRATE THERMOPLASTIC VULCANISATES

Finerman T M; Vandendriessche L; Pfeiffer J E;

Kirkendall K

Advanced Elastomer Systems LP

(SPE,Thermoplastic Elastomers Special Interest Group;
SPE,Philadelphia Section)

Rubber concentrate thermoplastic vulcanisates (rubber concentrate TPVs) are dynamic vulcanisates which contain a high concentration of crosslinked rubber and a low concentration of plastic. Rubber concentrates are intended to be further compounded with typical ingredients, such as oil, filler, PP, PE, stabilisers and process aids. As the rubber is already crosslinked, no curatives are needed in the compounding of the rubber concentrates. The specific selection of compound ingredients is dependent on the application requirements, raw material costs and process limitations. Emphasis is placed on rubber concentrate TPVs which are based on crosslinked EPDM rubber in a PP matrix. These rubber concentrate TPVs are designed for ease of compounding. The compounder thus has maximum flexibility in developing custom compounds for their thermoplastic elastomer applications. Key relationships between compound formulation and product performance are discussed. 11 refs.

USA

Accession no.771580

Item 197

Kunststoffe Plast Europe

89, No.12, Dec.1999, p.27-8

English; German

MIXING CONTROL WITH THE AID OF A CONDUCTIVITY SENSOR

Poltersdorf B

Brabender OHG

The electrical conductivity of plastics and elastomers plays a different role for the processing operation than it does when the final product is in service. (German version of this paper, which includes illustrations, is on p.83).

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.764391

*Item 198***Rubber Technology International**

1999, p.114/23

MIXING QUALITY - ACHIEVING THE BEST

Wood P R

This article is intended to be a reference and a guide to good mixing room practice in the rubber industry. It describes how increased attention to detail in the mixing operation, such as the use of consistent raw materials, good housekeeping, batch volume, accuracy of ingredients and mixing control, can result in an improved end product. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.763122

*Item 199***International Polymer Processing**

14, No.4, Dec.1999, p.315-21

MODELLING THE DISTRIBUTIVE MIXING IN AN INTERNAL BATCH MIXER

Hutchinson B C; Rios A C; Osswald T A

Wisconsin, University

A new mixing index was developed to analyse the particle position history of an internal batch mixer. Due to its simplicity when dealing with moving boundary problems, the boundary element method was used to model the fluid flow and track particles. Numerous geometries could be modelled and compared on a basic workstation. The mixing index was first applied to Couette flow. Analytical and boundary element simulation results compared well. The method was then used to analyse the mixing capabilities of a Banbury mixer with different speed ratios. The mixing index was also used to compare the mixing capabilities of triangular mixing lobes versus typical Banbury type. 13 refs.

USA

Accession no.761979

Item 200

Patent Number: EP 979714 A1 20000216

ROLLER MIXER-HOMOGENISER FOR RUBBER

Lualdi R

Comerio Ercole SpA

A method for mixing/homogenising a batch of rubber mixture in a roller mixer by recirculating the rubber to the inlet of the roller mixer while laterally shifting at least part of the recirculating rubber mixture is disclosed. It involves continuously detaching the rubber laminated between the mixing rollers without permitting any banking of the rubber on the rollers surface, recirculating the whole batch of rubber in the form of a laminated tape along a closed path, remotely from the rollers and on conveyor means and homogenising it by transversely pushing the edges of the running tape toward each other while falling back

between the rollers by an opposed pair of belt conveyors independently shiftable toward and away from each other, while cooling the tape of mixture along said closed path of recirculation from and to the rollers. The relative positioning of the homogenisation belt conveyors and two containment side plates and the action of means of interrupting the continuity of the tape and of reversal of the direction of the motion of a first belt conveyor downstream of the rollers are coordinated to discharge a homogenised rubber tape of desired width and thickness, at the end of the mixing/homogenising treatment.

EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE-GENERAL

Accession no.760730

*Item 201***China Rubber Industry**

47, No.1, 2000, p.33-6

Chinese

INFLUENCE OF RUBBER FRICTION ON MIXER PERFORMANCE

Li Y; Yu M; Li R

Qingdao Institute of Chemical Technology; Yinchuan China Strategy (Great Wall) Rubber Co.Ltd.

A theoretical model of rubber adhesion friction has been developed based on the microscopic and phenomenological analysis. By analysing and verifying the model experimentally, some new ways for improving mixer performance have been provided: (a) warm cooling water should be used in the mixer temperature control to make the mixer work under optimum conditions; (b) the surface materials of mixing chamber and rotors should be rationally chosen to change material surface energy and increase friction force on them; (c) when the compound is processed under higher ram pressure, shallow grooves or stripes should be made on inner mixing chamber wall and in the same direction as that of rotor axis to increase the real contact area and improve the mixing effect. 6 refs.

CHINA

Accession no.760653

*Item 202***China Rubber Industry**

47, No.1, 2000, p.28-32

Chinese

INFLUENCE OF RAM CONFIGURATION ON MIXING PROCESS

Wang C; Cheng Y

Qingdao Institute of Chemical Technology; Beijing, University of Chemical Technology

The influence of the ram configuration on the mixing process was investigated through the testing of three different ram configurations for X(S)M-1.7 internal mixer. It was found through the analysis of maximum consumed power, mixing time, capacity, specific energy consumption, dumping temperature, carbon black dispersivity and

physical properties of the compound that the optimum ram configuration suitable for X(S)M-1.7 internal mixer was "e" configuration. 3 refs.

CHINA

Accession no.760652

Item 203

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 138

ADVANTAGES OF OIL-LESS DUST STOPS FOR BANBURY MIXERS

Laczek L; Reardon J

HyComp Inc.

(ACS,Rubber Div.)

Thermoset polyimides offer a combination of properties which make them ideal for use as oil-less self-lubricating dust stops. High mechanical strength at elevated temperatures combined with negligible creep allows fabrication of direct replacements for aluminium bronze dust stops. These materials have lower coefficients of friction and higher useable service temperatures than engineered thermoplastic materials. This advantage is even more significant in larger mixers with larger dust stops which reach higher linear speeds. Thermoset polyimide dust stops offer greater strength, improved dimensional stability, higher temperature and a lower coefficient of friction than engineering thermoplastics. Polyimides can offer economic savings, improved quality and extended wear life over aluminium bronze dust stops.

USA

Accession no.759726

Item 204

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 114

VARIABLE FRICTION DRIVES FOR MIXERS AND ROLL MILLS

Lattstrom L I

Hagglunds Drives Inc.

(ACS,Rubber Div.)

The knowledge accumulated by Hagglunds Drives from 25 years experience of roll mill drives can now also be used on mixer drives. The concept of 'Variable Friction Drives' is simple. One separate drive per roll is connected to a power unit that creates torque speed/control. The hydraulic motor is then connected directly on to the roll shaft and no gearbox is required. The power unit has a standard fixed speed AC electric motor connected to a hydraulic pump with variable flow in order to regulate the speed of the roll. By monitoring the pressure in the system the torque can be controlled. A hydraulic drive is a quiet and efficient solution requiring less space than a conventional gear drive. Moreover, maintenance is kept to a minimum by only requiring changes of oil filters. Aspects described

include the concept, a comparison of high torque-low speed (variable) drives, frequency controlled AC motors and direct hydraulic drives.

USA

Accession no.759705

Item 205

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 113

OPERATIONAL CHARACTERISTICS OF THE FARREL SHAW INTERMIX INTERNAL MIXER

McGuinness A; Ghafouri S N

Farrel Ltd.

(ACS,Rubber Div.)

The various features made to date in the design, processing and operational characteristics of the interlocking rotor system using the Farrel Shaw Intermix internal mixer are described. The harmful by-product of high speed mixing is the rapid rise of mixed material temperature, and for the purpose of maintaining a high viscosity and level of shear stress, considerable emphasis is placed upon cooling efficiency for effective mixing. The advantages of the NR5 rotors with improved cooling capacity are discussed and an insight given into its compounding practice. The interlocking rotor technology is undoubtedly the most efficient for technical rubber producers. By way of analogy the tyre manufactures using tangential rotor technology have also found interlocking rotor technology interesting and offers new mixing concepts, particularly with the development of silica compounds. The continued increase in the utilisation of silica in the tyre manufacturing industry has raised questions regarding traditional processing techniques. It is explained why the Intermix can provide an efficient way for handling silica-filled compounds. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.759704

Item 206

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, Fl., 21st-23rd Sept.1999, paper 111

VARIOUS CLEARANCE MIXING TECHNOLOGY

Thompson B J; Norman D A

Kobelco Stewart Bolling Inc.

(ACS,Rubber Div.)

The internal batch mixer continues to hold its position of importance in polymer mixing and especially rubber mixing. Although there are many variables that influence the performance of a mixer, rotor design is widely considered the single most important design element. The design and operating parameters of a rotor greatly affects the productivity of an internal intensive mixer and the quality of the mixed product. With that in mind,

Kobelco has successfully developed and introduced a new rotor/mixing concept called 'Various Clearance Mixing Technology' (VCMT). Kobelco's patented VCMT is applied to internal batch mixers, continuous mixers and twin-screw extruders. The introduction of a new six-wing tangential rotor for the internal intensive batch mixer is described. The rotor is designated as the '6WT', and utilises the VCMT mixing mechanism. 2 refs.

USA

Accession no.759703

Item 207

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, FL., 21st-23rd Sept.1999, paper 110

CONTINUOUS MIXING OF POWDER ON A TWIN SCREW EXTRUDER

Uphus R ; Olaf S; Schuster R U

Deutsches Institut fuEr Kautschuktechnologie eV
(ACS,Rubber Div.)

One of the basic requirements for the continuous mixing of rubber compounds is the continuous-feed state of all the ingredients. Although this is the case for a number of compounding materials like chemicals, carbon blacks and plasticiser oil, it is not true of the main polymer components traditionally supplied in the form of bales. Due to this traditional form of supplying polymers, batch mixing is nowadays the most widespread technology. Due to success in the production of new powder rubber grades based on emulsion polymerised SBR, NBR and NR, among others, and the gas-phase polymerisation of EPDM, the continuous mixing process has received increasing attention during the past year. Real progress is seen in the new types of powdered rubbers which, due to their free-flowing properties, are capable of meeting the conditions for continuous feeding, while, at the same time, combining a constant rubber-filler ratio with a high initial degree of filler dispersion. The development of a continuous mixing technology optimised for the new generation of powder rubbers is described. The main targets of this development are to establish screw configurations for high dispersive mixing efficiency, to gain maximum homogeneity of the entire mix and to optimise the throughput for a given temperature. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.759702

Item 208

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, FL., 21st-23rd Sept.1999, paper 183

PRACTICAL METHOD TO ELIMINATE FLAWS CAUSED BY CARBON BLACK SURFACE HUMIDITY - ITS EFFECTS ON IMPROVING MIXING PROCESS AND RUBBER COMPOUND FATIGUE PROPERTIES

Eftekhary A; Abyaneh A A

Kerman Tire & Rubber Co.

(ACS,Rubber Div.)

There are many suggestions to obtain optimum rubber compound mixing quality, most of them focussing on improvement of compound dispersion, particularly that of carbon black. Elimination of intrinsic compounds flaws has a considerable impact and acts as a controlling parameter in improving rubber compound final properties, especially fatigue resistance. Such flaws, which mostly can be observed by microscopic visualisation, are results of different phenomena such as high susceptibility of carbon black to moisture adsorption, which causes non-homogeneity in the rubber matrix. A practical method is introduced to eliminate the flaws by feeding hot carbon black into the mixer. This approach not only eliminates the compound flaws, it also improves dispersion and mixing quality. The advantages of this method are presented through experimental test results. 13 refs.

IRAN

Accession no.759439

Item 209

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, FL., 21st-23rd Sept.1999, paper 178

EFFECT OF COMPOUND PROCESSING ON FILLER FLOCCULATION

Wang T; Wang M J; Shell J; Chung B; Tokita N

Cabot Corp.

(ACS,Rubber Div.)

The effect of the mastication of carbon black-filled NR masterbatches prepared by liquid phase mixing/coagulation process and dry mixing process on dynamic properties of uncured compounds and vulcanisates is investigated. Intensive mastication leads to a lower G' and G'' along with a depressed strain dependence of these moduli, indicating an improved microdispersion in the uncured compounds. It is also found that in contrast to uncured compounds, a higher G' and G'' and a more developed Payne effect, i.e. a poorer microdispersion, are observed for the vulcanisates prepared with the intensively masticated masterbatches. This phenomenon is attributed to the flocculation or agglomeration of carbon black aggregates during vulcanisation. The flocculation rate is substantially increased upon mastication, which is related to the reduction of the molecular weight of the polymer matrix and bound rubber content, resulting in the decreased viscosity of the compounds. 16 refs.

USA

Accession no.759434

Item 210

156th ACS Rubber Division Meeting - Fall 1999.

Conference preprints.

Orlando, FL., 21st-23rd Sept.1999, paper 139

SELECTION OF DOWNSTREAM EQUIPMENT IN THE MIXING ROOM

Haeder W M

Krupp Elastomertechnik GmbH

(ACS,Rubber Div.)

Rubber compounds are almost exclusively prepared in batches in internal mixers. This method affords mixing lines in the rubber industry a high degree of flexibility. Modern internal mixers are also capable of processing all forms of rubber presently supplied (bales, pellets, strips, etc.). Continuously operating mixing systems (e.g. twin-screw extruders) cannot cope with this diversity. However, downstream of the internal mixer, extruders are dominating the processes in the mixing room and in rubber product manufacture. They are discussed in detail.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.759401

*Item 211***Kunststoffberater**

43, No.3, 1998, p.16-9

German

MEASURING IN LIQUID COMPONENTS OFFERS POTENTIAL

Haberstroh E; Kiel A

Aachen,Institut fur Kunststoffverarbeitung

The main focus of this study is research into rubber on a multi-cut transfer extruder. In order to optimise the mixture process in rubber processing, an extruder can also take on special tasks during a mixing operation. Continuous mixing of liquids is of particular interest. Experiments conducted at the Institut fuer Kunststoffverarbeitung (Institute for Processing Plastics) in Aachen regarding measuring in processing oil into a multi-cut transfer extruder mixer have shown that quantities of liquid that can be measured in and steady distribution of liquids in the basic mixing of rubber strongly depend on mould back pressure. 6 refs.

BUNDESMINISTERIUM FUER

WIRTSCHAFT UEBER DIE

ARBEITSGEMEINSCHAFT INDUSTRIELLER

FORSCHUNGSVEREINIGUNGEN EV

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.749907

Item 212

155th ACS Rubber Division Meeting, Spring 1999. Conference Preprints.

Chicago, Il., 13th-16th April 1999, Paper 6, pp.26

QUALITY CONTROL OF THE DISCONTINUOUS COMPOUNDING PROCESS IN A RUBBER INTERNAL MIXER BY REGRESSION AND NEURAL NETWORKS PROCESS MODELS

Ryzko P; Haberstroh E

IKV

(ACS,Rubber Div.)

Mathematical models of the internal mixing process for the on-line prediction of rubber compound viscosity and viscoelastic properties were developed on the basis of multiple linear regression and artificial neural networks. The models gave high levels of accuracy when applied to predicting the properties of SBR and NR/SBR/polybutadiene compounds produced using mixers of three different sizes. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

Accession no.749824

*Item 213***International Polymer Science and Technology**

25, No.11, 1998, p.45-51

MODELLING OF THE HEAT EXCHANGE AND DISPERSION FLOW OF A RUBBER MIX IN A ROTARY MIXER CHAMBER

Baranov A V; Balinov A I

Moscow,Gubkin Oil & Gas Institute

The mathematical modelling of rubber mixes in mixer chambers is reviewed. A model for the heat exchange and flow of rubber mixes was developed using a cylindrical coordinate system, assuming laminar flow at low Reynolds numbers, and that the mix was a viscous fluid obeying a power law, in which the viscosity depends not only upon temperature but also upon the degree of dispersion of the filler. It was assumed that the degree of filler dispersion was dependent upon the specific energy consumption. Predictions for the degree of dispersion of carbon black were in agreement with experimental data. 28 refs.

RUSSIA

Accession no.748881

*Item 214***Journal of Applied Polymer Science**

73, No.1, 5th July 1999, p.75-83

EFFECT OF MIXING TIME ON THE RHEOLOGICAL, MECHANICAL, AND MORPHOLOGICAL PROPERTIES OF POLY(VINYL CHLORIDE)-EPOXIDISED NATURAL RUBBER BLENDS

Ishiaku U S; Ismail H; Mohd Ishak Z A

Penang,Universiti Sains Malaysia

Epoxidised natural rubber was blended with poly(vinyl chloride), in the ratio of 50:50, using a Brabender Plasticorder at a temperature of 150 C, and two alternative rotor speeds. The rheological, mechanical, and morphological properties of the blends were related to the mixing time. It was concluded that the plastograms, and their relationships with the dynamic mechanical, morphological, and tensile properties could be used to optimise the blending conditions. 30 refs.

MALAYSIA

Accession no.748856

Item 215

Antec '99. Volume II. Conference proceedings.
New York City, 2nd-6th May 1999, p.1720-4. 012

STATISTICS OF MIXING DISTRIBUTIONS IN FILLED ELASTOMERS PROCESSED BY TWIN SCREW EXTRUSION

Birinci E; Yazici R; Kalyon D M; Michienzi M; Murphy C; Muscato R

Stevens Institute of Technology; NSWC (SPE)

Continuous processing of filled elastomers by twin-screw extrusion and achievement of viable mixing distribution characteristics present formidable challenges. A thermoplastic elastomer, HyTemp, is plasticised with DOA and filled with ammonium perchlorate powder and additives. It is found that the extruder geometry, the order of ingredient addition and die pressurisation have profound effects on the mixing distribution characteristics of the elastomer-based extruded profiles. The mixing distribution characteristics are quantitatively determined by X-ray diffraction techniques. 16 refs.

USA

Accession no.748705

Item 216

Rubber World

220, No.5, Aug.1999, p.22/39

TWIN ROLL MIXING REVOLUTION

Greenhalgh P N

Dare J.R.,Ltd.

The design is described of developments in two roll mills by J.R. Dare Ltd. Problems with cross-contamination, too high drives, and nip adjustment were addressed in the design of a new mill. The new mill design incorporates smooth stainless steel side frames, sealed roller bearings, lightweight spring loaded material guides in contact with the rolls, thermally efficient rolls, a colour touch screen PLC access unit and hydraulic nip control. They are compact in design and quiet running. A patented roll reversal system for automating the mix cycle (Mix Assist) has also been incorporated, plus a unique automatic safety test feature.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.747564

Item 217

International Polymer Science and Technology

26, No.1, 1999, p.T/42-6

MIXING WITH A COMBINATION OF BANBURY MIXER AND ROLLS

Yamaguchi Y

According to Twelve Lectures in Applied Rubber Processing Technology, 'Rubber is a big, broad-minded character. Whatever powder and oil we throw in, it unflinchingly swallows the lot and carries on much as

before'. In the rubber factory, it is possible to be assisted and sometimes frustrated by this intriguing propensity of rubber. Recently, however, the advent of new fillers and polymers and increases in productivity has complicated matters. The latest trends in tyre rubber formulation and some improvements in rubber mixing aimed at improving quality and productivity in relation to these trends are described. 3 refs.

JAPAN

Accession no.745524

Item 218

Antec '99. Volume II. Conference proceedings.

New York City, 2nd-6th May 1999, p.1703-7. 012

INFLUENCE OF MIXING CONDITIONS AND COMPOSITION ON THE PHASE STRUCTURE AND PROPERTIES OF THERMOPLASTIC OLEFIN BLENDS

Dharja A

Solvay Engineered Polymers

(SPE)

The morphology and mechanical properties of PP/EPDM blends were studied in relation to mixing conditions and blends composition. Correlations between mixing temperature and flow and morphology are discussed. 15 refs.

USA

Accession no.744524

Item 219

Tire Technology International

Annual Review, 1999, p.119/26

ENHANCING INTERNAL BATCH MIXING

Nortey N O

Skinner Engine Co.

Rotor performance determines the efficiency of mixers, with traditional intermeshing and non-intermeshing machines each offering benefits and disadvantages. By taking the best from both types, a new generation oversized tangential mixer with a novel rotor design is said to offer higher productivity, better strength and improved performance. Details are given. 8 refs.

USA

Accession no.743867

Item 220

Tire Technology International

Annual Review, 1999, p.110/15

MCTD EXTRUDER TECHNOLOGY

Fischer F W; Hohl M W

A-Z Formen- & Maschinenbau GmbH

Both the rubber and tyre industries rely on screw extrusion as a means of mixing, homogenising, plasticising and shaping a great variety of elastomeric compounds. Historically, there has been a great diversity of design in

order to incorporate these different operations into a single screw conveying system with the earliest efforts dating back to the beginning of the century. These early designs were hot-feed machines, where the rubber compound was first preheated by mill mastication and thereafter fed into the extruder. Recent developments in extruder technology are allowing processing by cold-feed units of some highly filled elastomers that until recently could only be processed by hot-feed extruders, if at all. Some emphasis is placed on those introduced by A-Z Formen- & Maschinenbau. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.743865

Item 221

European Rubber Journal

181, No.7-8, July/Aug.1999, p.16

NEW MIXER TECHNOLOGY AVAILABLE FOR TESTING

Shaw D

Voith Verfahrenstechnik has developed and built a full-scale rubber mixer based on entirely different design and operational principles from existing internal mixers. The company is offering the first Pressmixer as a stand-alone mixing unit, but expects to do the engineering work to integrate it with downstream process equipment. Although the mixer has a nominal volume of 100 litres, it can mix batches from around 20 litres up to 80 litres in volume. Pressmixer is said to perform all mixing functions and to make "difficult" compounds easy to mix.

VOITH VERFAHRENSTECHNIK GMBH & CO.KG

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.743016

Item 222

Industria della Gomma

43, No.2, March 1999, p.17-23

Italian

CONTINUOUS MIXING OF GAS PHASE EPDM

Results are presented of studies of the continuous mixing in a twin-screw extruder of granular free-flowing EPDM obtained by gas phase polymerisation.

WERNER & PFLEIDERER

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.742581

Item 223

Industria della Gomma

43, No.1, Jan./Feb.1999, p.17-20

Italian

CO-ROTATING TWIN-SCREW EXTRUDERS IN THE CONTINUOUS MIXING OF CROSSLINKABLE ELASTOMERS

Maris SpA

The continuous mixing of rubbers in co-rotating twin-screw extruders is examined, and technical features of the extruders are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.740629

Item 224

Revue Generale des Caoutchoucs et Plastiques

No.774, Feb.1999, p.59-60

French

MIXING CAPACITY OF ELASTOMERS

Boccaccio G; Rouault E

CTTM-IRAP

Results are presented of a study of the mixing behaviour of different NR grades using micromixers. The grades were classified according to their sensitivity to mechanochemical degradation during mastication and their behaviour during the incorporation of carbon black. 2 refs.

HAAKE GMBH

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; GERMANY; WESTERN EUROPE

Accession no.740592

Item 225

Kunststoffe Plast Europe

89, No.6, June 1999, p.9-11; p.48/52

COMPOUNDING AND EXTRUDING ELASTOMERS

Lauhus W P

At K'98, rubber compounding machinery and extruders with improved processing features and performance were exhibited. The main focus was on optimisation and refinement of existing processes. Equipment covered includes batch and internal mixers, continuous mixers, extruders, roll mills and calenders, and compression presses. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.739474

Item 226

Patent Number: US 5891486 A 19990406

AUTOMATIC MILLING APPARATUS

Geyer P

An extrusion apparatus for processing, mixing and extruding thermoplastic and rubber materials includes a feed hopper feeding two barrier type extruders. Extrusion rotors include diagonal grooves with a barrier which has a restrictive clearance or gap relative to the extruder barrel bore. Fine material can pass through this gap, but larger material is led to a downstream end of the grooves. An abrasive barrel surface opposite the downstream end of the grooves grinds this larger material until it can pass or

lead off through the smaller gap. Stationary knives located downstream of the abrasive section cut the exiting material into flakes. The barrel and barrier sections are conical and the size of the gap can be changed by relative movement between the barrel and the barriers. The extruders can operate adiabatically so that there is no change in extrusion temperature with speed and the volume of process flow.

USA

Accession no.737421

Item 227

Kautchuk und Gummi Kunststoffe

52, No.5, May 1999, p.359/67

SIMULATION OF FLOW IN AN INTERMESHING INTERNAL MIXER. ROLE OF CLEARANCE BETWEEN ROTOR AXES AND ROTOR FLIGHT-CHAMBER CLEARANCE

Kim P S; White J L

Akron, University, Inst. of Polym. Engineering

A simulation of flow in intermeshing counter-rotating rotor internal mixers is presented, and the calculations are used to illustrate the differences in flow behaviour between intermeshing rotors of varying designs. Special attention is given to the influence of changing the clearance between the rotors and varying the clearance between the rotor tips and the internal mixer chamber wall. 28 refs.

USA

Accession no.735020

Item 228

International Rubber Exhibition and Conference 1999. Conference proceedings.

Manchester, 7th-10th June 1999, Machinery paper 10.

TEMPERATURE CONTROL SYSTEMS FOR INTERNAL MIXERS

Wall R

Carter Bros.

(Crain Communications Ltd.)

Over the years, steady improvements have occurred with the internal mixer in terms of increased throughput rates for all types of compounds. Improvements in rotor design and a better knowledge of mixing techniques have placed ever greater demands on manufacturers to meet modern day requirements for efficiency, strength and value for money. Not least of all these considerations, suppliers and users have needed to be mindful that with increased throughputs, temperature control capabilities of the internal mixer have had to keep pace with other developments. A history is presented of the development of internal mixer design and temperature control over the last century, through to the sophisticated temperature control units demanded in the 1990s.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.734480

Item 229

International Rubber Exhibition and Conference 1999. Conference proceedings.

Manchester, 7th-10th June 1999, Machinery paper 6.

PRESSMIXER FOR RUBBER COMPOUND

Holzmueller A; Hoffmann W; Rittner T; Hatvan B

Voith Verfahrenstechnik GmbH & Co.KG

(Crain Communications Ltd.)

Pressmixer technology is based on an Austrian patent, according to which mixing systems have been designed and manufactured at the machine factory of Voith in St. Polten for about five years. The Pressmixer has long been used in various designs as a discontinuous mixing unit for mixing and homogenisation in a wide viscosity range, for example in the polymer processing industry. Based on this patented operating principle, a Pressmixer unit was recently developed specially for use in the rubber industry, whose design differs significantly from technologies currently used for the manufacture of rubber compounds. The operation and design features of this special Pressmixer unit are explained, and the knowledge and results in technology and process design gained so far in a laboratory-scale system are presented. An evaluation of representative trial mixes, including comparisons with established mixing technologies, is given.

AUSTRIA; WESTERN EUROPE

Accession no.734478

Item 230

International Rubber Exhibition and Conference 1999. Conference proceedings.

Manchester, 7th-10th June 1999, Materials paper 8.

HOT CARBON BLACK - ITS EFFECTS ON MIXING QUALITY AND RUBBER COMPOUND FINAL PROPERTIES

Abbasy Abyaneh A; Eftekhary A

Kerman Tire & Rubber Co.

(Crain Communications Ltd.)

Mixing processes and their relative effective parameters on the rubber compound final properties have been investigated for decades. In this respect carbon black dispersion in rubber matrix has been studied through different approaches to obtain in particular the optimum properties of finished products. The effect of preheating of carbon blacks on the mixing quality and physical and mechanical properties of rubber compound is investigated. A shorter mixing time and better final properties are obtained. Reduction of mixing time due to shorter incorporation time and increases in tensile strength are observed. Regarding the dispersion grading results, a higher dispersion grade is gained from heated carbon blacks at a specific time. Noticeable resistance against crack propagation during Demattia tests and lower heat build up in Goodrich Flexometer tests are the other advantages of hot fed carbon blacks. In addition, with regard to the advantages of mixing at high temperature in dynamic mixing processing, it is believed that such

good results should be traced back to the effect of high temperature on activating carbon blacks' surface groups. Preheating of carbon blacks can provide activated blacks without reduction in rubber viscosity, which is not favourable in mixing processes due to its bad influence on dispersion rating. 9 refs.

IRAN

Accession no.734469

Item 231

International Rubber Exhibition and Conference 1999. Conference proceedings. Manchester, 7th-10th June 1999, Automotive/Manufacturing paper 11.

ENTER THE INTERNET: COMPOUNDING BY REMOTE ACCESS

Urbanik D

Eclipse Technical Software Service BV
(Crain Communications Ltd.)

The implementation of new computer and software technology in laboratory automation systems for the rubber industry is described. Computers have found their place in the research and QC laboratories of the rubber industry, and most of these machines are connected together by a local area network. This provides a way of sharing information and also allows integration of development, testing and production data acquisition into one set of databases, as found in the ECLIPSE systems for many years now. The next generation of ECLIPSE Laboratory Information Management Systems is described, together with the new functionality and new database techniques used.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; WESTERN EUROPE

Accession no.734461

Item 232

Antec '99. Volume III. Conference proceedings. New York City, 2nd-6th May 1999, p.2964-8. 012
QUALITY CONTROL OF THE DISCONTINUOUS COMPOUNDING PROCESS IN A RUBBER INTERNAL MIXER BY REGRESSION AND NEURAL NETWORKS PROCESS MODELS

Ryzko P; Haberstroh E

IKV

(SPE)

The discontinuous processes in the rubber manufacturing are sensitive to low deviations in the processing method. The main reasons for these deviations are the fluctuations into the process parameters or deviations of the quality of raw materials or the manual operations. Online quality prediction of rubber compounds based on mathematical models for the mixing process in an internal mixer is an important step in direction of quality control. For most applications, the models based on regression or neural networks lead to quality predictions of over 90% for

various compounds and machine sizes. Such a measure and control unit has been successfully tested at a laboratory mixer. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.734278

Item 233

St. Polten, c. 1999, pp.4. 12 ins. 9/6/99.

MIXING TECHNOLOGY PRESSMIXER DMX/GI
Voith J.M.,AG

The functions are outlined of the Pressmixer DMX/GI, a specialist mixer for speciality mixing. Details are given of the feeding process, mastication and filler incorporation, dispersing and homogenising, and the discharge of the finished mixed product.

AUSTRIA; WESTERN EUROPE

Accession no.733682

Item 234

St. Polten, c. 1999, pp.8. 12 ins. 9/6/99.

German; English

VOITH MIXING TECHNOLOGY

Voith J.M.,AG

An introductory brochure from Voith is presented which gives details of the company's mixing equipment. Recent developments described include a vacuum charger for high volume fillers, a docking system, and the DMX 2000 Pressmixer, the largest in the series, features a mixing vessel volume of 2000 litres and a discharging pressure of up to 20 bar. A description is included of the Pressmixer production line.

AUSTRIA; WESTERN EUROPE

Accession no.733681

Item 235

Antec '99. Volume 1. Conference proceedings. New York City, 2nd-6th May 1999, p.225-9. 012

NEW TWIN SCREW ELEMENT DESIGN FOR ELASTOMER COMPOUNDING

Burbank F R; Jackson S M

Krupp Werner & Pfleiderer Corp.
(SPE)

A mixing element design is described which reduces the shear heat build-up often associated with the processing of elastomers in twin screw extruders. The geometry of the element retains the self-wiping characteristics usually found with fully intermeshing, co-rotating twin screw compounders, whilst reducing the maximum pressure in the apex area. Results are given for the processing of carbon black reinforced ethylene propylene diene terpolymer. 2 refs.

USA

Accession no.731002

Item 236

Patent Number: EP 911359 A1 19990428

CONTINUOUS PROCESS FOR PRODUCING RUBBER MATERIAL CONTAINING SILICA FILLER AND TYRES INCORPORATING THIS MATERIALCaretta R; Pessina R; Proni A
Pirelli Pneumatici SpA

The process utilises a plant consisting of a twin-screw mixer in which various components of the blend, including the polymer base, silica and silane, are introduced, a cooling device fed continuously by the mixer and a single-screw extruder fed continuously by the blend leaving the cooling device and by a vulcanising system. Tread bands may be produced from the blend, which is added in measured amounts and at defined points along a path for mixing and advancing the blend. Use is made of alternating phases, mainly involving mixing, with a high level of absorption of mechanical work, with phases mainly involving advance of the blend, with a reduced level of absorption of work, while controlling the heat profile of the blend along the entire mixing and advance path by determining the local values of a number of physical parameters, which are taken as characterising the heat profile of the blend, at least at defined points on the path.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.730279

*Item 237***International Polymer Science and Technology**

25, No.9, 1998, p.T/46-9

PRODUCTION OF ELASTOMER COMPOSITES BY ACTIVATING MIXINGBritov V P; Rebnitskii A V; Sevast'Yanov L K;
Bogdanov V V
St.Petersburg, Technological Institute

The term activating mixing is applied to mechanochemical reactions taking place under a shear field. From equations derived previously for vibromills and ultrasonic degradation, a parameter is established to determine the energy density or shear strain at which a reaction will commence. The theory is shown to apply to oligomeric carboxyl-terminated NBR/epoxy adhesives and the degradation of NR in solution. 6 refs.

RUSSIA

Accession no.729168

*Item 238***China Synthetic Rubber Industry**

22, No.2, Mar.1999, p.109

EFFECT OF IMPELLER ON MIXING OF FLOATING-PARTICLE IN STIRRED TANKSXu Shi'ai; Feng Lianfang; Gu Xueping; Wang Kai
Zhejiang, University

The mixing of floating particles is encountered in the stripping process of polybutadiene rubber solution. It was

revealed that three-stage impellers were beneficial to the mixing of three-phase; gas-liquid-floating particle systems at aspect ratios of 1.6. The combination of impellers suitable for this system were given.

CHINA

Accession no.726419

*Item 239***Italian Technology**

No.3, Oct.1998, p.88

MIXERS AND PLANETARY EXTRUDERS

The exhibits of Plas Mec at K'98 include a mixing plant for the production of PVC dry blend combimix, designated HC. This machine is composed of a turbomixer series TRM and high efficiency horizontal cool mixer of the series HEC. In addition to its traditional turbomixer, which allows for the production of 7-10 mixes per hour, the HEC range of coolers offers the ideal solution for all production needs in the field of soft and rigid PVC dry blend. The HEC cooler demonstrates proven cooling efficiency, allowing for elevated production and quality standards. Material can be stored at lower temperatures as it is also cooled in the core. Cleaning and maintenance time is kept to a minimum as the lid can be fully opened to allow easy access to all internal parts. An interesting development is the planetary extruder model TPE, produced in sizes to satisfy all levels of production and application. Details are given.

PLAS-MEC

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.724387

*Item 240***Industria della Gomma**

42, No.5, June 1998, p.29-33

Italian

ASSOGOMMA TECHNICAL CONFERENCE ON CONTINUOUS MIXING

De Tuoni E

A summary is given of papers presented at a conference on the continuous mixing of rubbers held in Milan by Assogomma on 7th May 1998. A number of developments in materials, mixers, extruders and feeding systems were discussed.

ASSOGOMMA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE; WORLD

Accession no.721793

*Item 241***Industria della Gomma**

42, No.5, June 1998, p.16-20

Italian

CONTINUOUS PROCESSING OF HIGH VISCOSITY COMPOUNDS

Pomini L

Pomini SpA

The structure and mode of operation of the LCM long continuous mixer developed by Pomini for rubber mixing are described, and applications in the formulation of low viscosity cable compounds and high viscosity tyre tread compounds are examined. A new rotor design combining both tangential and intermeshing geometry and its advantages in the processing of high viscosity formulations are discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY;
WESTERN EUROPE

Accession no.721791

Item 242

Rubber World

219, No.5, Feb. 1999, p.18/54

**INTENSIVE MIXER PREVENTATIVE
MAINTENANCE PROGRAM**

McNabb (Jnr.) R W; Smith T
Skinner Engine Co.

The importance of preventative maintenance to ensure the reliability of intensive mixers is discussed, and typical maintenance schedules are advised. Aspects considered include inspection techniques, dust stop removal and installation, lapping, and troubleshooting.

USA

Accession no.720654

Item 243

Kauchuk i Rezina (USSR)

No.4, 1998, p.38-45

Russian

**MODELLING OF HEAT EXCHANGE AND
DISPERSION FLOW OF A RUBBER MIX IN A
ROTARY MIXER CHAMBER**

Baranov A V; Balinov A I
Moscow, Gubkin Oil & Gas Institute

A discussion is presented of the mathematical modelling of heat exchange and dispersion flow in a rubber mixer. 28 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.720515

Item 244

Kautchuk und Gummi Kunststoffe

52, No.1, Jan.1999, p.15-20

German

**ANALYSIS METHODS FOR THE PREDICTION
OF RUBBER COMPOUND QUALITY FOR
MIXING IN INTERNAL MIXERS**

Haberstroh E; Ryzko P

The development of process models for the mixing process in an internal mixer for the prediction of compound properties is shown. In the first approach to modelling, use is made

of regression analysis. By way of an alternative, artificial neural networks are examined as a means of modelling. In the course of these studies, the mixing process is modelled both with standard compounds on a laboratory extruder and with production compounds on industrial internal mixers, employing both analysis methods. The results show that the two modelling methods permit the Mooney viscosity to be predicted with a high level of accuracy, of approximately 90%, as a function of the application in question. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.719214

Item 245

Kautchuk und Gummi Kunststoffe

51, No.12, Dec.1998, p.865-7

**DETECTION OF INTERFACIAL LAYERS IN
ELASTOMER SAMPLES BY NMR IMAGING**

Blumler P; Litvinov V; Dikland H G; van Duin M
Aachen, RWTH; DSM Research BV

The detection of interfacial layers in EPDM samples by NMR imaging is reported. Although the samples were prepared on laboratory scale equipment, it is very likely that similar structures will be caused by folding and pressing processes in typical rubber mixing methods. Spin-echo and gradient-echo techniques were used to differentiate between voids and inhomogeneities inside the elastomer by characteristic changes of the magnetic susceptibility. Layer-like structures were observed which result from folding of the material during the mixing process. Although these layers are glued together by the flow and tack of the material, the interface remains different from the bulk. A healing of the interface is possibly slowed down because of the high entanglement density in EPDM. The existence of such interfacial layers may have significance for other analytical methods which probe bulk properties as well as for failure analysis. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
NETHERLANDS; WESTERN EUROPE

Accession no.718676

Item 246

Nippon Gomu Kyokaishi

71, No.9, 1998, p.578-82

Japanese

**MIXING METHOD COMBINING BANBURY
MIXER AND ROLLER**

Yamaguchi Y
Toyo Gomu Kogyo KK

New mixing methods combining a Banbury mixer and open roll mixing which have been used for the production of tyre compounds are studied and compared. 3 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.716744

Item 247

Nippon Gomu Kyokaishi

71, No.6, 1998, p.348-53

Japanese

GENERAL COMPOUNDING AND BASIC PROPERTIES OF ACRYLATE RUBBER

Tsugawa D; Abe M

Nippon Zeon KK

The effect of mixing time and temperature in a Banbury mixer on the conductivity and physical and mechanical properties of carbon-filled and silica-filled acrylate rubber is discussed. 5 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.716698

Item 248

Kauchuk i Rezina (USSR)

No.3, 1998, p.35-8

Russian

PREPARATION OF ELASTOMER COMPOSITIONS BY ACTIVATING MIXING

Britov V P; Rebnitskii A V; Sevast'yanov L K;

Bogdanov V V

St.Petersburg, Technological Institute

The authors discuss the theory of "activating mixing", when the energy transmitted to mix components is expended not only on dispersion and homogenisation but also on the initiation of chemical interactions between the components. The infrared spectra and physico-mechanical properties of various blends of rubbers are shown, and the possibility is established of using activating mixing in processes for obtaining epoxy-rubber compositions and for the modification of polyisoprene in solution. 8 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.716686

Item 249

China Synthetic Rubber Industry

22, No.1, 1999, p.16-22

Chinese

MIXING CHARACTERISTIC AND HEAT TRANSFER PERFORMANCE IN COMBINED IMPELLER WITH TWIN SHAFTS AND TWO DISSIMILAR PADDLES

Wang Liangsheng; Dai Gance

East China, University of Science & Technology

An impeller with twin shafts and two dissimilar paddles was designed with reference to existing problems of heat and mass transfer in the Chinese synthetic rubber industry.

The flow pattern, mixing characteristics and heat transfer performance of this combined impeller were studied on the basis of laboratory cold simulation tests. The results were expected to form the foundation for the development of the combined impeller. The equation of the power number and the heat transfer coefficient were obtained by experiment. Factors affecting the mixing time and segregation index were analysed. 8 refs.

CHINA

Accession no.716359

Item 250

Gummi Fasern Kunststoffe

50, No.9, 1997, p.710-11

German

RESEARCH ON SILICA-CONTAINING MIXES FOR TYRE TREADS

Berkemeier D

Krupp Elastomertechnik

The questions of the most advantageous mixing system for the production of silica mixes, optimum mixing process and the use of conical twin-screw extruders for processing of silica-containing tread mixes are discussed. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.713629

Item 251

IRC '98. Conference Proceedings.

Paris, 12th-14th May 1998, p.209-10. 012

French

METHODOLOGY FOR THE PRACTICAL SIMULATION OF LARGE-SCALE MIXING WITH LABORATORY EQUIPMENT

Guerbe L; Freakley P K

Paulstra; Loughborough, University

(AFICEP; Societe de Chimie Industrielle)

The use of a laboratory mixer in the simulation of industrial scale internal mixing of rubbers is described. The formulation used in the study was a carbon black filled blend of polybutadiene, NR and SBR. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; UK; WESTERN EUROPE

Accession no.710612

Item 252

China Rubber Industry

45, No.12, 1998, p.707-10

Chinese

NEW PHYSICAL SIGNIFICANCE OF POWER GRAPH IN RUBBER MIXING

Zhang Hai; Bao Zhoubo; Chen Wei

South China, University of Technology

The physical significance of the power graph in rubber mixing was considered on the basis of the rheological theories of the internal mixer and of rubber mixing. It was proposed that the physical significance was determined from the power graph in the rubber mixing process where the optimal mixing process, lower slippage, the correct mix viscosity and the optimum time of addition of oil were obtained. 4 refs.

CHINA

Accession no.709635

Item 253

Kauchuk i Rezina (USSR)

No.3, 1996, p.19-24

Russian

EFFECT OF THE RADIUS OF THE WORKING SURFACE OF THE ROTOR BLADE IN A BATCH INTERNAL MIXER ON THE EFFECTIVENESS OF FORMATION AND THE QUALITY OF THE MIXES

Shikhirev N I; Rasskazov A N; Trofimov A P; Ugretsova O V; Skok V I

Using an experimental single-rotor mixer for the formation of a model mix based on SKMS-30ARKM-27 butadiene-methylstyrene rubber, the authors studied the amount of carbon black introduced into the mix, the degree of dispersion and the torque as a function of the time to complete mixing with different rotor radii. 6 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

RUSSIA

Accession no.708280

Item 254

China Rubber Industry

45, No.11, 1998, p.643-6

Chinese

STUDY ON POLYPROPYLENE CARBONATE(PPC)/SBR BLEND. II. INFLUENCE OF MIXING PROCEDURE ON BLEND PROPERTIES

Ye Xiaoguang; Pang Hao; Huang Yuhei; Lin Guo; Cong Guangmin
Guangzhou, Institute of Chemistry

The effect of the mixing procedure on the properties of PPC/SBR blend was investigated. The results showed that the ageing effect on the TS of PPC/SBR blend was eliminating by using a specific mixing procedure, while the activity of the curing system increased. The modulus and hardness of the blend increased and its tensile set at break decreased as PPC/SBR blend was pre-mixed. A longer conditioning time (up to 12 h) had a beneficial effect on the properties of the blend. An increase in the number of mill runs had no significant effect on blend properties. 6 refs.

CHINA

Accession no.708147

Item 255

Gummi Fasern Kunststoffe

49, No.6, June 1996, p.470-3

German

CONTINUOUS PRODUCTION OF RUBBER MIXTURES ON TWIN-SCREW EXTRUDERS

Capelle G

Hermann Berstorff Maschinenbau GmbH

The possibilities of saving on production costs by the installation of twin-screw extruder mixing systems for the continuous production of rubber mixes are considered. It is reported that in 1995 in West Europe alone more than 3 million tonnes of rubber compounds were produced, nearly half of which were used for the manufacture of tyres and industrial rubber goods. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.707950

Item 256

IRC '98. Conference proceedings.

Paris, 12th-14th May 1998, p.203-8. 012

RECENT DEVELOPMENTS IN THE MODELLING OF RUBBER MIXING

Manas-Zloczower I

Case Western Reserve University

(AFICEP; Societe de Chimie Industrielle)

Mixing is a key step in rubber processing affecting material properties, processability and cost. Modelling the mixing process in real mixing equipment through flow simulations is not an easy task. Major obstacles include the very complex geometry of the mixing equipment, the time dependent flow boundaries and the difficulties involved in selecting the appropriate indexes to quantify the mixing process. Key to a fundamental understanding of the mixing process and its optimization is the clear distinction between 'dispersive' and 'non-dispersive' mixing mechanisms and identification of the important process characteristics enhancing realisation of these mechanisms. In a multiphase system, dispersive mixing involves the reduction in size of a cohesive minor component such as clusters of solid particles or droplets of a liquid. Distributive mixing is the process of spreading the minor component throughout the matrix in order to obtain a good spatial distribution. In any mixing device, these two mechanisms may occur simultaneously or stepwise. In order to facilitate a quantitative analysis of the mixing process, it is important to develop a framework within which one can differentiate among various equipment designs or processing conditions. Some recent developments in modelling the mixing process are presented. 9 refs.

USA

Accession no.706228

Item 257

Plastics Extrusion Technology. 2nd edition.
Munich, Hanser Publications, 1997, p.3-42. 82

COMPOUNDING LINES

Hermann H; Kapfer K
Werner & Pfleiderer GmbH
Edited by: Hensen F

Compounding is required to turn plastics raw materials into processable compounds for specific applications, and involves the use of various unit operations. In compounding thermoplastics, thermosets and elastomers are considered. In terms of unit operations, compounding consists of combining processes such as: the mixing of polymers with additives and thoroughly dispersing these ingredients; reinforcing polymers with glass or carbon fibres or natural fibres such as flax, sisal or hemp seed; blending and alloying of various polymers with each other; blending of polymers of similar molecular structure but significantly differing molecular weight; the homogenising of simple polymer melts, or achieving desired flow behaviour by using controlled shear conditions; reactive extrusion. Compounding also deals with separation processes such as: removal of volatiles, filtering of polymer melts to separate particulate impurities; and pelletising, the step needed to arrive at an easily handled and properly processable particulate form of the compound. In general, all these unit operations assume melting of the polymer, and therefore take place in a high-viscosity phase. Details are given. 47 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
WESTERN EUROPE

Accession no.704000

*Item 258****Nippon Gomu Kyokaishi***

68, No.4, 1995, p.238-243

Japanese

**STUDIES OF RUBBER MIXING. PART 3.
FACTORS INFLUENCING BIT**

Urabe N; Takatsugi H; Ito M; Toko H; Nakada M
Fujikura Rubber KK; Shimmai Ind.KK; Bridgestone
KK; Tokai Carbon KK; Nippon Roll Manufacture KK

Using the mixing method described in the previous paper in this series, which produces reproducible data, the authors investigated each factor that affects the black incorporation time. Various carbon blacks, oil-extended rubber and oil were used as the materials in the tests. The mixing conditions used were the rotational speed, rotational ratio of the rotor, fill factor and ram pressure. The authors studied the effect of these factors on the black incorporation time by the new theory based on static electricity phenomena and rubber viscoelasticity. 7 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.703578

*Item 259****Nippon Gomu Kyokaishi***

68, No.3, 1995, p.171-177

Japanese

**STUDIES OF RUBBER MIXING. PART 2.
RELATION BETWEEN BIT AND CARBON
BLACK DISPERSION**

Unabe N; Takatsugi H; Ito M; Toko H; Fukui M
Fujikura Gomu Kogyo KK; Shinmei Kogyo KK;
Bridgestone KK; Kokai Carbon KK; Nippon Roru
Seizo KK

A study is described of the mixing of SBR-carbon black system in an internal mixer. The effects of addition of zinc oxide and increase in temperature on the black incorporation time are compared. 8 refs. Articles from this journal can be requested for translation by subscribers to the Rapra produced International Polymer Science and Technology.

JAPAN

Accession no.703570

Item 260

154th ACS Rubber Division Meeting - Fall 1998.

Conference preprints.

Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 70. 012

**ENHANCED MIXING IN THE INTERMESHING
BATCH MIXER**

Nortey N O
Skinner Engine Co.
(ACS,Rubber Div.)

A new breakthrough concept of an intermeshing mixer is developed using the good features of non-intermeshing (tangential) and intermeshing mixers. A pair of rotors of this new mixer has higher fill factor and productivity than all the conventional intermeshing rotors used in the polymer processing industry. A pair of the new rotors has higher quality, higher productivity and better strength than all conventional non-intermeshing rotors. A detailed analysis of processing material behaviour in a mixer is used to compare the new mixer against the conventional intermeshing and non-intermeshing mixers. A pair of the new intermeshing rotors replaces all sizes of the non-intermeshing rotors at a low cost. 8 refs.

USA

Accession no.701905

Item 261

154th ACS Rubber Division Meeting - Fall 1998.

Conference preprints.

Nashville, Tn., 29th Sept.-2nd Oct.1998, paper 19. 012

NEW INSIGHTS INTO THE MIXING PROCESS

Stone C R; Menting K H; Hensel M
Flow Polymers Inc.; Schill & Seilacher GmbH & Co.
(ACS,Rubber Div.)

Some compounding ingredients tend to be included out of habit. Stearic acid is such an ingredient. Little is published and it is suspected that little is known about the influence

of stearic acid on the mixing process. Whilst developing mixing cycles to achieve the maximum benefit from process aids for silica filled SBR/BR blend passenger tread compounds, the surprisingly critical function played by stearic acid is discovered. A study of the mixing energy versus time graphs and the relationship between total mix energy and dump temperature of fixed time mix cycles clearly shows the critical nature of the influence of stearic acid. An aliphatic zinc soap used in place of stearic acid is found to improve filler dispersion and the processing properties of the compound, while having little or no adverse effects on the physical properties. Rapid viscoelastic testing is carried out using an RPA machine from Alpha Technologies. The techniques developed by Coran and Donnet are also applied. The data generated gives extra information regarding the filler dispersion and rheological properties of the compounds. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.701857

Item 262

ITEC '96 Select. Conference proceedings..
Akron, Oh., 1996, p.224-8. 6T

**NEW AND INNOVATIVE MIXERS HELP MAKE
CONTINUOUS MIXING A REALITY**

Melotto M A

Farrel Corp.

(Rubber & Plastics News)

Mixing technologies used in the rubber industry are examined with reference to batch and continuous processes. The rubber industry has been slow to adopt continuous mixing due to the limited availability of free-flowing forms of elastomers and rubber compounding ingredients necessary for a continuous process. New free-flowing forms of EPDM and metallocene products will be niche products capable of being mixed in continuous processes and will drive the change to continuous mixing in the rubber industry, it is claimed. Advantages and disadvantages of continuous mixing are examined, followed by descriptions of three types of continuous mixing machines from Farrel.

USA

Accession no.701557

Item 263

ITEC '96 Select. Conference proceedings..
Akron, Oh., 1996, p.199-203. 6T

**ALTERING MIXING METHOD IMPROVES
TRACTION AND ROLLING RESISTANCE**

Welsh F E; Richmond B R; Emerson R J

Continental Carbon Co.; Emcon Inc.

(Rubber & Plastics News)

A Dynamic Reactive Mixing technique, (DRM) has been developed which is claimed to improve rolling resistance, wet traction and treadwear resistance by the use of a three

pass mixing cycle in which the second pass consisted of an extended high temperature treatment. Concerns relating to the DRM procedure with reference to the extra time, storage and handling required for the extra pass and the associated storage times between passes, has led to the undertaking of a study to determine if the same improvement in properties could be achieved with less penalty in mixing capacity. It was determined that a heat treatment at the end of the first of a two pass mixing procedure, could produce properties essentially matching those of a three pass DRM procedure which incorporates a heat treatment in the second pass. 3 refs.

USA

Accession no.701552

Item 264

Industria della Gomma

41, No.7, Sept.1997, p.53-5

Italian

**EXPERIENCE AND INNOVATIONS WITH A
BRITISH BUILT INTERPENETRATING MIXER**

Davenport I; Ghafouri S

Shaw F., & Co.Ltd.

The structural features and working principles of Francis Shaw's Intermix interpenetrating mixers are examined. Reference is made to studies of the effects of combinations of silica and carbon black in tyre tread compounds prepared using these mixers.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.698982

Item 265

Tyretex '98. Conference proceedings.

London, 15th-16th June 1998, paper 5. 6T1

**SMART MIXER CONTROL SAVES TIME AND
MONEY**

Yarwood R G

Chronos Richardson Ltd.

(Rapra Technology Ltd.; European Rubber Journal)

Chronos Richardson has been at the forefront of the control of internal mixers for more than 25 years. Over those years the control system platform has evolved from small fixed sequence controllers to PCs offering tremendous capability for advanced control functionality. Although the associated materials handling has not gone through the same quantum leap technologically, it has however maintained a steady progression of systematic improvements, which have also had an impact on process time and cost saving. Tyre and general rubber goods manufacturers are coming under increasing pressure for even greater operational efficiency. Any reductions that can be made to the mixer cycle time, or any improvements to product quality or production efficiency, have to be adopted in order to survive. Some of the recent techniques that Chronos Richardson has used to help increase productivity are examined, including

software techniques behind advanced mixer control algorithms and new mechanical handling techniques to improve efficiency in the mixing room.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.697366

Item 266

Polymer

39, No.20, 1998, p.4915-21

MATHEMATICAL MODELLING OF THERMOPLASTIC NATURAL RUBBER MELT FLOW IN A DOUBLE FEED EXTRUSION SYSTEM

Azhari C H; Sahari J; Li Qing
Kebangsaan, University

A mathematical model was presented for studying the melt flow behaviour of thermoplastic natural rubber (TPNR) in a double feed extrusion system. The model predicted the processing parameters in the feed and main extruders, from which the optimum processing conditions for TPNR were obtained. The double feed system enabled better mixing to occur in the main extruder. 20 refs

MALAYSIA

Accession no.696579

Item 267

Danbury, Ct., c.1998, pp.22. 12ins. 1/10/98.

GRANULAR GAS-PHASE EPDM, THE ROUTE TO EFFICIENT MIXING. PAPER PRESENTED AT THE INTERNATIONAL RUBBER CONFERENCE - IRC '96, MANCHESTER, JUNE 17-21, 1996

Italiaander T
Union Carbide Corp.

The advent of gas-phase fluidised bed polymerisation technology for the production of EPDM produces rubber in a unique free-flowing granular form, which provides new routes to effective and simplified rubber mixing processes. A description is given of the benefits of granular EPDM in both intermeshing and tangential mixers using a pragmatic mixing model to show its mixing latitude. It was concluded that fill factor, followed by starting temperature and rotor speed are the most important parameters for mixing granular EPDM, and automatic metering and feeding tests also confirmed the major process simplification potential using gas-phase EPDM.

USA

Accession no.696505

Item 268

RubberTech China '98. Conference proceedings..
Shanghai, China, 24th-26th March, 1998, paper 28. 012
BANBURY MIXER AND INTERMIX FOR MIXING TECHNICAL RUBBER GOODS
Melotto M A

Farrel Corp.

(Rapra Technology Ltd.; Crain Communications Ltd.)

The development of the Banbury and Intermix mixers is described, and the fundamental differences in rotor design are explained. The growth in the optimisation of the Banbury mixer is said to be in response to the growth in the tyre industry, for which the Banbury mixer has become the mixer of choice. Advantages and disadvantages of the use of intermeshing and tangential rotor design mixers are examined and the focus of attention is on the critical requirements common to mixing technical rubber goods compounds, and how they should be addressed.

CHINA; USA

Accession no.696411

Item 269

Polymer Testing '97. Day 4: Durability of Rubber.
Conference proceedings.

Shawbury, 7th-11th April 1997, Paper 6. 9T

DISPERSION CONTROL FOR RUBBER MANUFACTURERS

Andersson L O; Persson S; Skoog L
OptiGrade AB

(Rapra Technology Ltd.; Plastics & Rubber Weekly; European Plastics News)

In order to be commercially competitive, quality control systems are necessary in production lines. Although this task is tedious, it is essential. Each part of the process must be identified in order to plan how to deal with the problem. A necessary step is to incorporate measuring systems that continuously or at certain intervals monitor the process performance. Finally it is necessary to integrate all individual systems in a network, an overall supervisory control and monitoring system. It is believed that the carbon black and silica dispersion rating for rubber materials is one such parameter. The most important reason for a rubber manufacturer starting up and systematically working with dispersion control is to achieve better process economy. The basic concept is to use a minimum effort, still meeting the customer's expectations on rubber compounds. Fulfilling customer expectations is an obvious goal, but if this is done at the expense of longer mixing times it will cause increased costs, tying up production capacity with less profit as the end result. For some polymer types, there is also a risk that the material will be negatively affected by the prolonged mixing time. 10 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE

Accession no.694723

Item 270

Mixing of Rubber.

London, Chapman & Hall, 1997, p.221-35. 813

EVALUATING THE PERFORMANCE OF INTERNAL MIXERS

Valsamis L N; Canedo E L; Donoian G S
Farrel Corp.

Edited by: Grossman R F
(Halstab)

High intensity batch mixers trace their origin back to 1835, when the first roll mills were used by Edwin Chaffe for mixing rubber. The Banbury high intensity batch mixer followed in 1916. Many design changes to these basic rubber mixing devices have been implemented, particularly to improve the efficiency of dispersion of carbon black. But the underlying principle of operation remains unchanged. It is the repeated passage of compound through regions of high shear stress, followed by intimate mixing of the sheared material within the batch. Because of torque and heat transfer limitations, only a small portion of the compound is subject to high stress at any one time, but the overall rotor configuration ensures that the entire compound passes repeatedly through the high stress region. The applications of calculated parameters to commercial batch mixers is considered, along with the effects of rotor tip clearances. A new rotor design is also discussed and compared with standard two- and four-wing rotors. 36 refs.

USA

Accession no.694515

Item 271

Mixing of Rubber.

London, Chapman & Hall, 1997, p.211-20. 813

CONTINUOUS MIXING

Sorcinelli G J

Farrel Corp.

Edited by: Grossman R F

(Halstab)

The benefits of mixing rubber compounds continuously, rather than via a batch process, include the potential for improved statistical process control, because of the development of a steady state, and improved possibilities for automation. The first attempts to develop a continuous mixer for rubber date back to the 1950s, following many years of reliance on the Banbury internal mixer. This led to the introduction in 1960 of the Farrel continuous mixer. It consists of a counter-rotating twin-screw extruder having overall length to diameter ratio (LID) of about 5. The feed zone is equipped with a hopper for metering a preblend of ingredients. This is followed by a mixing zone where the sections of the screws mimic Banbury rotors. The most common rotor design features three mixing sections. The final component is an adjustable discharge gate.

USA

Accession no.694514

Item 272

Mixing of Rubber.

London, Chapman & Hall, 1997, p.201-9. 813

MIXING FLUOROELASTOMER (FKM) COMPOUNDS

Mastromatteo R

Cri-Tech Inc.

Edited by: Grossman R F

(Halstab)

Fluoroelastomers form a class of unique polymers, now enjoying increased use because of their extreme resistance to high temperatures and a variety of aggressive fluids. Although these elastomers use unique activator and cure systems, compounding variables are limited, and in some respects, fluoroelastomers are easy to formulate. The properties imparted by some of the compounding ingredients are extremely sensitive to moisture absorption as well as to particle size variation; these must be carefully controlled. Mixing is reasonably straightforward using internal mixers equipped with modern control systems. Aspects covered include special considerations, raw materials, typical formulations, internal mixing, mill mixing and accounting methods.

USA

Accession no.694513

Item 273

Mixing of Rubber.

London, Chapman & Hall, 1997, p.187-200. 813

MIXING OF TYRE COMPOUNDS

Hannon M J

Uniroyal Chemical Co.

Edited by: Grossman R F

(Halstab)

Tyre compounds are generally based on unsaturated diene polymers reinforced with carbon black, and vulcanised by an accelerated (usually a sulphenamide) sulphur system. The ingredients are normally mixed in a minimum of two steps. Polymers, carbon black, zinc oxide, stearic acid and any antiozonant or antioxidant system are put in the first step; curatives go in the second. The second step uses a lower temperature than the first step; this allows the stock (compound) to retain a window of processing safety. A typical first step starts with the polymers added at time zero, carbon black goes in at 30 s, and oil is added at 90 s; the dump temperature is 160 deg.C. A typical second step, or final step, has all the first pass and curatives put in at time zero, with a dump temperature of 110 deg.C. The following topics of particular interest to technologies mixing tyre components are covered: rework, phase mixing, viscosity reduction of NR and the measurement of mixing efficiency.

USA

Accession no.694512

Item 274

Mixing of Rubber.

London, Chapman & Hall, 1997, p.173-85. 813

MIXING ETHYLENE-PROPYLENE DIENE RUBBER

Chodha C S; Kontos E G

Uniroyal Chemical Co.

Edited by: Grossman R F
(Halstab)

Not only are synthetic elastomers produced with a range of fundamental elastomeric properties so as to perform satisfactorily in service, they are also designed to ensure that typical formulated compounds are mixed and fabricated into their final shapes with comparative ease. That is to say, synthetic elastomers now possess controlled processing properties. The processing properties built into an elastomer may now be tailor-made to achieve easier and faster mixing and processing, controlled die swell, smooth surface appearance, etc. In the case of EPDM, tailor-made processing properties can be achieved by controlling the average composition (ethylene:propylene ratio), the molecular weight and its distribution, the diene type and its level and, to some degree, the monomer sequence distribution. Changes in the polymerisation recipe and reaction conditions may require months or years of development work before they achieve the desired processing attributes while retaining or improving the fundamental elastomeric properties. 2 refs.

USA

Accession no.694511

Item 275

Mixing of Rubber.

London, Chapman & Hall, 1997, p.163-71. 813

MIXING WIRE AND CABLE COMPOUNDS

Bluestein A C

Berlington Associates Inc.

Edited by: Grossman R F

(Halstab)

In many respects the mixing of wire and cable rubber and plastics compounds is not very different from mixing compounds for other uses. In all cases the mixing process is often considered an art, and mixing wire insulation is considered to be a peculiar form of witchcraft. Few believe that scientific principles and fundamental physical phenomena are involved in every step of the process, whether or not they are understood by the many practitioners of the art. Although there have always been attempts to understand, quantify and control the phenomena involved, there has been a substantial increase in these efforts in the recent past. The development of new materials and improved mixing equipment has been a more gradual process. Aspects covered include the use of tempered water in cooling, power-controlled mixing and energy conservation. 27 refs.

USA

Accession no.694510

Item 276

Mixing of Rubber.

London, Chapman & Hall, 1997, p.125-62. 813

MIXING PROCEDURES FOR SPECIFIC COMPOUNDS

Grossman R F

Halstab

Edited by: Grossman R F

(Halstab)

A selection of compounds that have been mixed successfully in a No.11D Banbury using the procedures is described. These compounds are selected so as to illustrate or typify the features of mixing that must be kept in mind by the rubber technologist. The relationship between mixing and formulating, or perhaps revising a formulation, is described. These elements of rubber technology can never be compartmentalised.

USA

Accession no.694509

Item 277

Mixing of Rubber.

London, Chapman & Hall, 1997, p.103-23. 813

OPERATION AND MAINTENANCE OF MIXING EQUIPMENT

Salma S R

Farrel Corp.

Edited by: Grossman R F

(Halstab)

The operation and maintenance of rubber mixing equipment are described. Aspects covered include the inspection of Banbury mixers, mixer maintenance and lubrication, anticipation of the required service, dust stop maintenance, SSA dust stops and hydraulic dust stops on Banbury mixers.

USA

Accession no.694508

Item 278

Mixing of Rubber.

London, Chapman & Hall, 1997, p.91-102. 813

ADDITIVES THAT AFFECT MIXING

Ohm R F

Vanderbilt R.T.,Co.Inc.

Edited by: Grossman R F

(Halstab)

Most additives that affect mix procedures are reactive chemicals. To run a chemical reaction successfully in a Banbury internal mixer or other equipment, three variables need to be controlled: time, temperature and stoichiometry (the ratio of the reactants). The effect of these variables on the chemical peptising of NR, SBR, polychloroprene (CR) and Thiokol polysulphide are discussed. Other topics include additives to increase viscosity, when to add zinc oxide, filler treatments and bin storage problems. 10 refs.

USA

Accession no.694507

Item 279

Mixing of Rubber.

London, Chapman & Hall, 1997, p.71-90. 813

STATISTICAL PROCESS CONTROL FOR INDUSTRIAL MIXING

Del Vecchio R J

Technical Consulting Services

Edited by: Grossman R F

(Halstab)

Rubber compounds have been mixed routinely for well over 150 years using a variety of types of equipment, most notably the two-roll mill and the internal mixer. These are batch processes which are sensitive in varying degrees to raw materials; there may be 5-20 raw materials in a given compound, all of which can vary appreciably in characteristics (especially polymers such as natural rubber). Other important factors are the mixing process itself, the type and condition of the equipment, the order of adding the ingredients and the time when each is added, the time and temperature exposure and the technique of the operator. It is therefore scarcely surprising that achieving a high degree of consistency over time among batches of any formulation has been difficult. For the past few decades, the main tool for fast and easy property checks of batches of mixed rubber has been the oscillating disc rheometer (ODR), which is still in wide general use. The use of the ODR and the interpretations of its data through routine statistical process control techniques are described. Emphasis is placed on manual techniques, which may then be adapted for use with software. 5 refs.

USA

Accession no.694506

Item 280

Mixing of Rubber.

London, Chapman & Hall, 1997, p.57-70. 813

QUALITY CONTROL AND THE MIXING PROCESS

Grossman R F

Halstab

Edited by: Grossman R F

(Halstab)

Some of the factors that repeatedly enter into the mixing of rubber compounds are relatively straightforward: the raw materials used must be consistent; the same mix procedure must be followed, with the same heat and shear history throughout the process; contamination must be avoided. Other factors are less obvious, but nevertheless important: the compound should be formulated so as to minimise the effect of small variations in processing, and to minimise the chances for errors in composition. The type of mixing procedure (the order in which the ingredients are added) should be appropriate to the formulation of the ingredients and to the design of the internal mixer, so as to minimise the dependency of compound properties on small process variations. Finally, the mixer itself must be well maintained (clearances within specifications, proper

circulation of coolant, etc.) for a consistent product to be obtained. Emphasis is placed on the measurement of the consistency of raw materials and finished compound.

USA

Accession no.694505

Item 281

Mixing of Rubber.

London, Chapman & Hall, 1997, p.49-56. 813

MILL MIXING

Grossman R F

Halstab

Edited by: Grossman R F

(Halstab)

Mixing rubber compounds on a two-roll mill is common in the following situations: when the first-pass mix is accelerated, typically by a fabricator, as part of the preparation for moulding calendering, etc.; small batches of specialty compounds are mixed; the compound is accelerated on the mill after being dropped from an internal mixer; and entirely ordinary rubber compounds are mixed on a mill for no other reason than the equipment exists and has always been present. Other reasons of convenience may also pertain: mills are consistent with low ceiling height restrictions, etc. Most of these make little sense in the larger framework of optimising output at consistent high quality. The optimum equipment and procedure strongly depend on the particular objective, as well as on the types of compounds to be mixed.

USA

Accession no.694504

Item 282

Mixing of Rubber.

London, Chapman & Hall, 1997, p.25-48. 813

MIXING CYCLES AND PROCEDURES

Grossman R F

Halstab

Edited by: Grossman R F

(Halstab)

The goal in mixing is to provide compositions with useful properties, suitable processability and as high a level of consistency as possible. In almost all applications, there are criteria for the attributes that characterise whether a composition is suitably mixed; the criteria may vary, but they exist nonetheless. And it is almost always the case that these criteria must be met with optimum efficiency; i.e. with the maximum output per expenditure of capital and energy. Currently, a first approximation is that a general-purpose rubber compound will cost about one cent/lb/minute in the internal mixer; covering energy, labour, stack losses and disposal costs. With very large mixers, running costs may be slightly lower; with speciality compounds, somewhat higher. Fully overheaded costs (including depreciation) may approach two cents/lb/minute. A highly automated system with computerised controls, automatic

weighing and delivery, will draw 3-4 cents/lb/minute. The same numbers apply if a custom compounder is used to do the mixing. As a result, efforts spent to design mix cycles that are both effective and efficient are very worthwhile. Emphasis is placed on unit operations in mixing, single-pass versus multiple-pass mixing, types of mix cycle and analysis of changes to the mixing procedure. 4 refs.

USA

Accession no.694503

Item 283

Mixing of Rubber.

London, Chapman & Hall, 1997, p.1-24. 813

MIXING MACHINERY FOR RUBBER

Melotto M A

Farrel Corp.

Edited by: Grossman R F

(Halstab)

The art and science of mixing rubber are described. Those unfamiliar with the mechanics of the industry often attribute artistic practice to the ingredients and process techniques involved in manufacturing rubber articles. Others who have experienced the frustration when a composition does not quite meet a required physical property, lacks an anticipated attribute, or processes unsatisfactorily for no apparent reason, only to uncover remedies that are as difficult to explain as the symptoms - they will understand the phrase 'art and science'. These occurrences do not detract from the scientific achievements that have driven the art of mixing to its current level of sophistication. In order to understand the reasons for the techniques and types of machinery employed in mixing, some familiarity with raw materials, their physical forms, functions in the compound and behaviour during processing must be obtained. Emphasis is placed on two-roll mills, internal batch mixers, continuous mixers, Banbury mixers and operating variables.

USA

Accession no.694502

Item 284

Tire Technology International

June 1998, p.51-8

MIXING WITH THE BEST - A CHOICE OF ROTORS

Wood P

Tire Technology International

It is explained that the introduction of silica into tyre formulations, and the growing commercial pressure to reduce the number of mixing stages, has increased interest in intermeshing rotors. This article presents an independent review of the types of rotor, to determine which best suits the developing needs of the tyre industry.

USA

Accession no.691902

Item 285

London, Chapman & Hall, 1997, pp.xvii,242. 17/6/97. 24cms. 813

MIXING OF RUBBER

Halstab

Edited by: Grossman R F

This book has been developed over several years in conjunction with the Farrel Corp./Connecticut Rubber Group course as a means of educating the hands on compounder and end user. Topics covered include mixing machinery for rubber, mixing cycles and procedures, additives that affect mixing, mixing procedures for specific compounds, continuous mixing and evaluating the performance of internal mixers.

Accession no.691369

Item 286

European Polymer Journal

34, Nos.5/6, May/June 1998, p.671-5

PREPARATION AND PROPERTIES OF SAN/EPDM/CHLORINATED PE(CPE) TERNARY BLENDS

Hwang I J; Lee M H; Kim B K

Kyungnam,Junior College; Pusan,Regional Small & Medium Business Office; Pusan,National University

Melt blends of SAN with EPDM and CPE were prepared in a twin-screw compounding machine. The morphological textures of the blends were determined from SEM, and mechanical and rheological properties were measured using an Instron Rheometrics dynamic spectrometer and Rheometrics mechanical spectrometer. SEM revealed that the blend was heterogeneous. The use of an EPDM alone failed to give any significant increase in the toughness of brittle SAN. A combination of the two rubber modifiers (EPDM and CPE), however, produced a synergistic toughening mechanism. TS and flexural strength decreased almost linearly with increasing amount of EPDM and/or CPE, but EB increased. 28 refs.

KOREA

Accession no.687777

Item 287

Industria della Gomma

41, No.3, April 1997, p.21-4

Italian

CHARACTERISTICS AND ADVANTAGES OF NEW ROLL MILLS

Brogli A

Meccaniche Moderne SpA

The operation of two-roll mills used in the rubber industry is described, and computer control and automation systems for such machines are examined. The structure and dimensions of Duplocom mills manufactured by Meccaniche Moderne are illustrated.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.686321

Item 288

Industria della Gomma

41, No.3, April 1997, p.17-20

Italian

HAGGLUNDS HYDRAULIC DRIVES APPLIED TO RUBBER MACHINERY

Zoia L

Hagglunds Srl

Hydraulic drives produced by Hagglunds are described, and examples are given of their use in rubber processing machinery such as mixers, calenders and extruders.

HAGGLUNDS DRIVES AB; POMINI SPA; FARRELL CORP.; COMERIO ERCOLE SPA; LAMPERTI; MECCANICHE MODERNE SPA; WELDING ENGINEERS INC.; BUZULUK
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; SCANDINAVIA; SWEDEN; USA; WESTERN EUROPE

Accession no.686320

Item 289

Industria della Gomma

41, No.2, March 1997, p.15-7

Italian

VSS: THE IDEAL LINK BETWEEN INTERNAL MIXER AND BATCH-OFF

Gheorghita V; Pomini L

Pomini SpA

The use in rubber mixing lines of the VSS (Vertical Screw Sheeter) developed by Pomini is described. The machine consists of a hopper, a vertical extruder with two conical, counter-rotating non-intermeshing screws arranged in V formation, and an open mixer, all of which are placed beneath an internal mixer.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.686263

Item 290

Tire Technology International

1998, p.195-6

PROVIDING AUTOMATIC MIXING

Comerio Ercole SpA

Comerio Ercole SpA, an Italian company specialising in complete plants and single machines for the mixing and calendaring of rubber generally, and for the conveyor belt and tyre industries in particular, has produced, after two years of development, a prototype automatic mixing centre that is currently running a series of production tests on a wide range of compounds. This article supplies details of the advantages and features of the fully automated mixing system that has no need for manual intervention, but is capable of delivering repeatable compound quality. Options include variable speed and friction, and a pneumo-hydraulic floating weight.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.685087

Item 291

Tire Technology International

1998, p.74-6

MEDIA PLAST 50 - A THREE-IN-ONE ADDITIVE

Kettlitz Chemie GmbH & Co.KG

Kettlitz-Mediaplast 50 is a completely new additive designed especially for rubber compounds containing natural rubber, including tyre compounds. This comprehensive article supplies a detailed analysis of this new product which works as a homogenising, dispersing and masticating agent with a positive influence on rubber compound flow and displays a number of improvements which aid efficiency and help to reduce production costs. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.685063

Item 292

153rd ACS Rubber Division Meeting - Spring 1998. Conference preprints.

Indianapolis, In., 5th-8th May, 1998. Paper 66. 012

INTERNAL MIXER MANAGER

Moreira L A F

(ACS, Rubber Div.)

An attempt is made to provide an internal mixer in good mechanical condition, whether old or new, of modern production means and control with improved reliability. Before the days of programmable logical controllers, the internal mixer was provided with electromechanical timers that allowed the operator to control the time of mixture of each group, of an analogical ammeter and manual levers for the control of the current. This system, besides the lack of control, generated operation problems. With the installation of PLCs in the panels of the internal mixer, this problem was solved. Current PLCs cannot control the amperage of the motors and are incapable of registering the exit data to control the equipment. The Internal Mixer Manager, an integrated system comprising an electric panel, a PLC, a communication system, programming software, laboratory control, a standard PC and management software, is described.

BRAZIL

Accession no.683277

Item 293

Rubber World

218, No.2, May 1998, p.34-6

RECYCLING OF VULCANISED FACTORY WASTE

Brown C J; Watson W F

Watson Brown HSM Ltd.

Most vulcanising processes produce significant amounts of waste and rejects. Scrap must be rendered soluble in the compounded stock in order to be recyclable. Only then can it be dispersed to the molecular level and thereby give a

stock with elastic and viscous properties comparable to the stock alone. A high shear mixer was designed and tested to see if it could solubilise pieces of rubber vulcanisate in conjunction with added material to form a rubbery matrix. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.680651

Item 294

China Rubber Industry

45, No.4, 1998, p.229-32

Chinese

IMPROVING DISPERSIBILITY OF RUBBER MIX

Zhang H; He D; Ma T; Zhu F; Shao R; Cai D; Zou M; Wu Y; Zhou Y

South China, University of Science & Technology; Guangzhou Zhujiang Tire Co.Ltd.; Guilin Tyre Factory

Factors affecting rubber mixing are briefly discussed including deformation value, applied stress, mixing viscosity, and cohesion of filler agglomerates. 5 refs.

CHINA

Accession no.678498

Item 295

China Synthetic Rubber Industry

21, No.2, 1998, p.109-12

Chinese

PROCESSING AND RHEOLOGICAL PROPERTIES OF ACTIVATED WASTE RUBBER POWDER COMPOUNDS

Zhao S; Bai G; Wu Y; Zhou W; Zhou Y

Beijing, University of Chemical Technology

Details are given of the processing and rheology of waste rubber powder and activated waste rubber powder compounds. Data are given for vulcanisation, mechanical properties and extrusion die swell. 3 refs.

CHINA

Accession no.676882

Item 296

Patent Number: US 5641835 A 19970624

PROCESS FOR PRODUCING SILOXANE MODIFIED POLYOLEFIN COPOLYMERS AND PRODUCTS COMPRISING THE COPOLYMER

Smith S D; Wnuk A J; Gerber M S

Procter & Gamble Co.

A process for producing siloxane modified polyolefin copolymers and products made of the copolymers are disclosed together with details of the general formula for the copolymers. The process for obtaining siloxane modified copolymer consists of: reactively extruding organosiloxanes having reactive terminal groups with polyolefins having reactive groups, the molar ratio of the functional groups being from about 1:1 to about 1:100,000

in a substantially solvent-free environment at a temperature from about 150 deg C to about 350 deg C for not more than 1 hour at 50 to 350 rpm.

USA

Accession no.671797

Item 297

Kautchuk und Gummi Kunststoffe

51, No.2, Feb.1998, p.129-33

COMPUTER CONTROL OF INTERNAL MIXERS FOR MORE CONSISTENT EPDM COMPOUNDS

Jourdain E P

It is shown that computer usage not only improves the reproducibility of the mixing cycle, but also by monitoring the rotor speed and the thermal exchanges, the mixing becomes more consistent. For an EPDM with a bimodal molecular weight distribution, a high green strength and a fast carbon black dispersion, advanced control of the mixing energy is used to show how the batch to batch reproducibility of a 70 Shore A compound is improved. It results in reducing the compound Mooney viscosity variation to less than that of the EPDM raw material. Therefore a tighter control of the rheology of the different mixed batches is obtained. This leads to better productivity by more consistent extrusion and lower scrap level. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.670435

Item 298

Journal of Applied Polymer Science

65, No. 12, 19th Sept. 1997, p.2447-56

SYNTHESIS, BY REACTIVE EXTRUSION, OF HIGH MOLAR MASS EPOXY PREPOLYMERS CONTAINING RUBBER PREFORMED PARTICLES

Taha M; Perrut V; Roche A A; Pascault J P

Lyon, Institut National des Sciences Appliquées

High molar mass epoxy prepolymers containing rubber dispersions based on carboxyl-terminated butadiene-acrylonitrile copolymer were prepared from initially miscible solution of low molar mass epoxy prepolymers, bisphenol A and carboxyl-terminated NBR. During chain extension inside a twin screw extruder due to epoxy-phenoxy and epoxy-carboxy reactions, a phase separation process occurs. Epoxy-phenoxy and epoxy-carboxy reactions were catalysed by triphenylphosphine. The effect of reaction parameters (temperature, catalyst, reactant stoichiometry) on the reactive extrusion process were analysed. The structure of the prepolymers showed low branching reactions (2-5%). Low molar mass prepolymers had a Newtonian rheological behaviour. Cloud-point temperatures of different reactive liquid butadiene acrylonitrile random copolymer/epoxy resin blends were measured for different rubber concentrations. Rubber

particles remained insoluble in a range of temperature from room temperature to 180C, typical of temperatures used for epoxy curing reactions. Prepolymers containing different rubber concentrations were cured using dicyandiamide as the hardener. Adhesion of the resulting networks to aluminium alloy increased with rubber concentration. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE;
WESTERN EUROPE

Accession no.669924

Item 299

Industria della Gomma

40, No.4, May 1996, p.65-6

Italian

ANALYSIS OF MIXING EFFICIENCY IN RUBBER PROCESSING

Manas-Zloczower I

Case Western Reserve University

Results are presented of a finite element analysis study of the efficiency of the dispersive and distributive mixing of rubbers in variable intermeshing clearance and transfer mixers. 11 refs.

POMINI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA;
WESTERN EUROPE

Accession no.666968

Item 300

Patent Number: US 5622755 A 19970422

PHOTOGRAPHIC FILM CASSETTE

Mizuno K; Nabeta T; Shimizu M

Fuji Photo Film Co.Ltd.

A pair of flanges are mounted on a spool of a photographic film cassette so as to come into contact with end faces or outermost convolution of a film roll wound on the spool, so that a film leader can be advanced out of the cassette shell by rotating the spool in an unwinding direction. The flanges are formed from a polyphenylene ether group resin composition, which is composed by mixing styrene group resin with polyphenylene ether resin in a weight ratio from 60:40 to 10:90, and mixing 6 to 19 parts by weight of elastomer per 100 parts by weight of said mixture of styrene group resin and polyphenylene ether resin.

JAPAN

Accession no.665183

Item 301

Elastomery

No.3, 1997, p.3-11

Polish

GRANULAR GAS-PHASE EPDM. THE ROUTE TO EFFICIENT MIXING

Italiaander T

Union Carbide Benelux NV

The benefits of granular EPDM in both intermeshing and tangential mixers using a mixing model are described. Mention is made of automatic metering and feeding tests. 4 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;
WESTERN EUROPE

Accession no.663221

Item 302

China Synthetic Rubber Industry

20, No.6, 1997, p.335-7

Chinese

MODELLING OF MIXING PROCESS IN TWO ROTOR CONTINUOUS MIXER

Xie Linsheng; Miao Guobing; Chen Xiaohong

Jiangsu, Institute of Petrochemical Technology

A model for conveying molten material in the mixing section of a rotor of a two-rotor continuous mixer was proposed. Factors which have influence over the conveying and mixing of molten material were discussed. The conveying of molten material was related to the appearance of rotor flights, viscosity of molten materials and the differential pressure in the mixing section of the rotor. The mixing of molten material was related to the length of apex region, the appearance of rotor flights and rotor speed. 3 refs.

CHINA

Accession no.662832

Item 303

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 116, pp.24. 012

DISTRIBUTIVE MIXING IN VARIABLE INTERMESHING CLEARANCE MIXERS: SIMULATION AND EXPERIMENTS

Yao C H; Manas-Zloczower I; Regalia R; Pomini L

Case Western Reserve University; Techint-Pomini

(ACS, Rubber Div.)

Distributive mixing performance in Pomini's variable intermeshing clearance (VIC) internal mixers was studied numerically and verified experimentally. A fluid dynamics analysis package using the finite element method was used to simulate flow patterns in the original laboratory size mixer (VIC 1) and a new design with an enlarged mixing chamber (VIC 2). Mixing was studied numerically by tracking the evolution of particles originally gathered as clusters. The results of numerical simulations were checked against experimental data for the mixing of SBR and silicone rubber in order to validate the model. The VIC 2 design showed consistently better distributive mixing than the VIC 1 version. Increasing the inter-rotor clearance improved mixing in both designs, but mixing was adversely affected in the VIC 2 mixer by enlarging the gap size in the bridge region to too great an extent.

13 refs.

POMINI SPA

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA;
WESTERN EUROPE

Accession no.659558

Item 304

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 102, pp.39.
012

**OPTIMIZING MIXING PERFORMANCE
THROUGH FILLER DISPERSION CONTROL**

Andersson L O; Sunder J; Persson S; Nilsson L
OptiGrade AB; RADO Gummi GmbH; Svedala-Skega AB
(ACS,Rubber Div.)

Results are presented of studies undertaken to evaluate the use of filler dispersion control as a means for optimising rubber mixing processes. By image analysis of a freshly cut uncured rubber surface and classification of the number and size of agglomerates, it was possible to predict the extrusion performance of a compound, and a clear relationship was established between the maximum agglomerate size and the extrusion performance. 40 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
SCANDINAVIA; SWEDEN; USA; WESTERN EUROPE

Accession no.659546

Item 305

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 101, pp.16.
012

INTERMESHING MIXER TECHNOLOGY

McNabb R W
Skinner Engine Co.Inc.
(ACS,Rubber Div.)

Components of intermeshing rotor internal mixers are examined, and recent developments in rotor design and temperature control and hydraulically loaded plungers are reviewed.

SHAW F.,& CO.LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA;
WESTERN EUROPE

Accession no.659545

Item 306

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 100, pp.15.
012

**TECHNICAL AND TECHNOLOGICAL TRENDS
IN RUBBER MIXING**

Pohl J W
Krupp Plastics & Rubber Machinery
(ACS,Rubber Div.)

A survey is made of trends in internal mixers for use in the rubber industry, and developments by Krupp Elastomertechnik and some other leading machinery manufacturers are examined. Aspects discussed include the operation of tangential and intermeshing rotors, wear resistant materials for mixer components, the replacement of pneumatic rams with hydraulic rams, optimisation of the mixing process through the use of variable speed drives, and developments in mixing technology for the preparation of silica filled tyre tread compounds. 20 refs.

KRUPP ELASTOMERTECHNIK; POMINI SPA;
KOBELCO STEWART BOLLING INC.; FARREL
CORP.; MIDWEST-WERNER & PFLEIDERER INC.;
SHAW F.,& CO.LTD.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY;
ITALY; UK; USA; WESTERN EUROPE

Accession no.659544

Item 307

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 89, pp.23.
012

**HDM TANGENTIAL ROTORS: TECHNICAL
FEATURES AND TECHNOLOGICAL ASPECTS**

Pomini L
Pomini SpA
(ACS,Rubber Div.)

The design and operational features of Pomini's HDM (high distributive mixing) tangential rotors are described, and results are presenting of rubber mixing trials which compared their performance with that of two-wing and four-wing rotors. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA;
WESTERN EUROPE

Accession no.659534

Item 308

152nd ACS Rubber Division Meeting, Fall 1997.

Conference Preprints.

Cleveland, Oh., 21st-24th Oct.1997, Paper 88, pp.27.
012

**ADVANCED TECHNOLOGY IN INTERNAL
MIXERS AND RELATED PROCESSING
EQUIPMENT**

Klein S G
Kobelco Stewart Bolling Inc.
(ACS,Rubber Div.)

Some developments in machinery and ancillary equipment for internal mixing in the rubber industry are examined. Studies of rotor designs undertaken by Kobelco Stewart Bolling are reviewed.

USA

Accession no.659533

Item 309

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 87, pp.30.
012

**OVERVIEW OF VARIABLES AFFECTING
BATCH MIXING IN A TANGENTIAL MIXER**

Borzinski F J
Farrel Corp.
(ACS,Rubber Div.)

An examination is made of variables affecting the efficiency of rubber batch mixing processes, including compound formulation changes, batch weight and fill factor, applied batch pressure, mixing procedures (single step, multiple pass, masterbatching), mixer speed and temperature, form and temperature of feed materials and the presence of moisture. It is shown that an improved control over the mixing process can be achieved through an understanding of these variables and the use of innovations such as a ram position indicator and a computer data logging system. 5 refs.

USA

Accession no.659532

Item 310

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 86, pp.25.
012

**SELECTING AND SPECIFYING FEEDING
AND WEIGHING SYSTEMS FOR INTENSIVE
INTERNAL BATCH MIXERS**

Gooch L R; Pascuzzo F A
Gooch Engineering Associates; Hancock Engineering
Inc.
(ACS,Rubber Div.)

A review is presented of factors to be taken into account when determining requirements for feeding and weighing systems for batch mixing operations. Systems for handling rubbers, major and minor additives and liquid additives are examined. The integration of batching system controls with the overall control of compounding operations and the impact of quality control and assurance are discussed. An approach to the development of performance based specifications for such systems is presented. 4 refs.

USA

Accession no.659531

Item 311

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 85, pp.25.
012

MADE-TO-MEASURE MIXING ROOMS

Heiss K G
Krupp Plastics & Rubber Machinery

(ACS,Rubber Div.)

The concept and design of mixing rooms and their influence on the quality of rubber compounds are discussed. Mixers, downstream equipment and materials handling and control systems are examined, and factors to be considered in the modernisation of mixing operations are reviewed.

USA

Accession no.659530

Item 312

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 60, pp.21.
012

SCIENCE OF MIXING OF RUBBER

Nakajima N
Akron,University,Inst.of Polym.Engineering
(ACS,Rubber Div.)

The science of rubber mixing is discussed in relation to polymer molecular architecture and viscoelastic properties. Mixing mechanisms and models of mixing processes are also examined. 25 refs.

USA

Accession no.659510

Item 313

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 59, pp.11.
012

**SCIENCE OF MIXING OF RUBBER: MATERIAL
PROBLEMS**

Yamaguchi Y
Yokohama Rubber Co.Ltd.
(ACS,Rubber Div.)

Some problems associated with rubber mixing are examined, including scorching due to stagnation, edge roughness of sheeted rubber and inhomogeneous dispersion of carbon black. These phenomena are discussed in relation to the deformation behaviour, fracture characteristics and rheological properties of compounds. 6 refs.

JAPAN; USA

Accession no.659509

Item 314

152nd ACS Rubber Division Meeting, Fall 1997.
Conference Preprints.
Cleveland, Oh., 21st-24th Oct.1997, Paper 58, pp.25.
012

**ADVANCED TECHNOLOGY IN INTERNAL
MIXERS**

Klein S G
Kobelco Stewart Bolling Inc.
(ACS,Rubber Div.)

The structure and operation of internal mixers for use in the rubber industry are examined, and developments in rotor design by Kobelco Stewart Bolling are described.

USA

Accession no.659508

Item 315

IRC '97. Conference proceedings.

Kuala Lumpur, 6th-9th Oct.1997, p.1041-5. 012

MIXING CHARACTERISTICS OF INTERNAL MIXER

Toj M; Gondoh T; Mori T; Satoh H; Kuratsu M; Mishima M

Kurume, College of Technology; Sumitomo Heavy Industries Ltd.

(Rubber Research Institute of Malaysia)

The mixing characteristics of an internal mixer equipped with new type rotors were investigated. After mixing BR rubber with ZnO powder for certain period of time, a small amount of the rubber is taken out of the reservoir in the mixer. The concentration of ZnO in the rubber sample is measured by atomic absorption analysis to measure dispersion in the rubber. The degree of mixing achieved by using the mixer equipped with new type rotors having a concave rear part is compared with that of the conventional rotor. 2 refs.

JAPAN

Accession no.658850

Item 316

Rubber India

49, No.2, Feb.1997, p.41-6

INTRODUCTION TO PRACTICAL RUBBER COMPOUNDING

Sangtani S

Seed Rubber Products

This comprehensive article supplies a detailed explanation of rubber compounding processes, ingredients and formulations. The article covers information on vulcanising agents, activators, retarders and accelerators, different types of fillers, and processing aids such as tackifiers, blowing agents and flame retardants. 8 refs.

INDIA

Accession no.658066

Item 317

Rubber Technology International

1997, p.185-7

BATCH-OFF PROCESS IN MILLROOM RECONSIDERED

Reurslag D G H; Clark J T

VMI Epe Holland BV; VMI Americas Inc.

In the past, the handling of compounds after mixing has been a labour-intensive sub-process, but today there is still ample room for productivity improvements. For many

companies and 'business units', the batch-off sub-process is the last (and very essential) production step before the delivery of the compound, in whatever shape, to internal or external customers. The current wishes and requirements concerning batch-off equipment are of a much higher level than in the past. They have also become more diverse. The reasons for the current boom in technical developments for the batch-off process are discussed.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; USA; WESTERN EUROPE

Accession no.657670

Item 318

Rubber Technology International

1997, p.177-83

GRANULAR GAS PHASE EPDM CONTINUOUS MIXING BECOMES REALITY

Italiaander T

Union Carbide Benelux NV

The outcome of a series of continuous mixing studies carried out in a co-rotating intermeshing twin-screw extruder is discussed. Widely differing compounds are evaluated ranging from high to low Mooney rubber-rich to filler-rich, sulphur vulcanisation to peroxide cure. Extruder feeding takes place either by dry blends or individual ingredient feed streams or a combination of both. The outcome confirms the significant potential of granular gas phase EPDM for continuous mixing and new routes to end-use production.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION;
WESTERN EUROPE

Accession no.657669

Item 319

Rubber Technology International

1997, p.172-6

TANGENTIAL ROTORS - INDEPENDENT REVIEW

Wood P R

While it is true that the intermeshing rotor is increasingly popular for the batch mixing of high quality general rubber compounds, it is also true that most rubber mixing takes place across the world in machinery equipped with tangential rotors. Many developments have occurred in the field of tangential rotors; details are given of these developments, why they have taken place and their benefits.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.657668

Item 320

Rubber Technology International

1997, p.89-93

FATTY ACID ZINC SALTS AND AROMATIC/ALIPHATIC RESINS: THEIR EFFECT ON

ENERGY CONSUMPTION DURING MIXING

Pysklo L; Wilkonski P

Poland, Rubber Research Institute

One of the ways of reducing energy consumption during mixing and processing of rubber compounds is the use of zinc salts of saturated and unsaturated fatty acids and mixtures of aromatic and aliphatic resins called homogenisers. These substances also improve homogeneity and increase the repeatability of the properties of rubber compounds. Moreover, zinc salts may be applied as physical peptising agents. The influence of these substances on energy consumption during mixing, processing properties, vulcanisation kinetics and vulcanisate properties of rubber compounds is examined. 11 refs.

EASTERN EUROPE; POLAND

Accession no.657648

*Item 321***Rubber Technology International**

1997, p.49-51

AUTOMATING COMPOUNDING PROCESS

Raeven J

Thona International

Established in 1991, Thona set out to redefine rubber compounding. By focusing exclusively on compounding, and not moulding or extruding finished products, the company was able to take a fresh approach. It introduced a high degree of automation, which was complemented by mixing lines customisation. Thona originally focused on producing high-quality natural rubber and polyisoprene compounds for the construction industry, but success enabled expansion into new markets and the company now also produces a wide range of synthetic compounds for the automotive and domestic appliance industries. Today Thona is one of the world's leading EPDM compounders for the automotive industry. The Thona site in Eupen was strategically chosen because it is close to the major industrial regions of Western Europe, with Germany and the Netherlands both within easy reach. The natural geography of the site in Eupen also presented the opportunity to design a two-level plant, tailored to the specific needs of the mixing and compounding process. By using the latest processing equipment in combination with the company's own plant design and integration skills, a highly efficient rubber compounding plant has been created. Details are given.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

Accession no.657640

*Item 322***Kautchuk und Gummi Kunststoffe**

50, No.10, Oct.1997, p.728/35

**FLOW VISUALISATION IN INTERNAL MIXER
USING NEW EXPERIMENTAL ROTORS
INCLUDING DIFFERENT ROTOR SPEED RATIOS**

Cho J W; White J L; Pomini L

Flow visualisation studies of two new experimental rotor designs for internal mixers are described. The capabilities of these rotors with traditional two wing and four wing rotors are compared. The experiments described involve flow visualisation of homogenising bales of initially different colours, measured torques, determining dump temperatures, and flow visualisation of carbon black incorporation into rubber. 22 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

Accession no.656335

*Item 323***China Synthetic Rubber Industry**

20, No.4, 1997, p.207-9

Chinese

**STUDY OF SYNCHRONOUS AND SAME
DIRECTION-ROTATING ROTOR INTERNAL
MIXER**
Bing J; Haiming H; Chuansheng W; Qian D; Jiashu Z
Qingdao, Institute of Chemical Technology

The mixing principle of a synchronous and same direction-rotating rotor internal mixer is analysed and the physical properties of synchronous and same direction-rotating and synchronous and counter-rotating rotor internal mixers are compared. The results show that, as compared with the latter, the mixed compounds with the former increased modulus at 300% 16.6%, tensile strength 3.4% , permanent set 13.8%, decreased elongation at break 7.1% , and has better black dispersion than the latter. The optimum operating conditions for the XM-1.7L synchronous and same direction-rotating rotor internal mixer are: filling factor 0.6, rotor speed 160 r/min, cooling water temperature 30-40 deg.C.

CHINA

Accession no.651602

*Item 324***Polymers and Polymer Composites**

5, No.3, 1997, p.223-31

**EFFECTS OF MIXING REGIMES ON
FRACTURE TOUGHNESS OF POLYURETHANE
RUBBER-TOUGHENED UNSATURATED
POLYESTER RESINS**
Miller N A; Langford V S M; Howell O T; Finch G R
Industrial Research Ltd.

The effects of different mixing regimes on the fracture toughness of PU rubber-toughened polyester resins is investigated. Variables studied included stirring action, temperature of mixing and rubber content. Two PU rubbers, one hydroxyl terminated and one isocyanate terminated, are studied. It is found that mixing at 60 deg.C and stirring with a laboratory mixer gives the most consistent results in terms of improvement in fracture toughness of the base resin. The optimum rubber content for the hydroxyl

terminated rubber is found to be 2.5% w/w, while for the isocyanate terminated rubber the optimum rubber content lies between 5% and 7.5%. Both rubber additions produce a decrease in flexural modulus and tensile strength of the base resin, with the hydroxyl terminated rubber giving the greatest decrease. 12 refs.

NEW ZEALAND

Accession no.650806

Item 325

Rubber Chemistry and Technology

70, No.1, March/April 1997, p.15-24

EFFECT OF PROCESSING ADDITIVES ON CARBON BLACK DISPERSION AND GRIP PROPERTY OF HIGH-PERFORMANCE TYRE TREAD COMPOUND

Takino H; Iwama S; Yamada Y; Kohjiya S

Toyo Tire & Rubber Co.Ltd.; Kyoto,University

The influence of a processing additive on carbon black incorporation and dispersion behaviour in rubber mixing were investigated by inspecting Banbury power curves. The dry grip properties of a tyre was estimated from the temperature dependence of dynamic viscoelastic properties of rubber compounds with improved carbon black dispersion due to the processing additive. 18 refs.

JAPAN

Accession no.649658

Item 326

Journal of Elastomers and Plastics

29, No.3, July 1997, p.239-61

EFFECT OF MIXING TIME ON FILLER-MATRIX INTERACTIONS IN POLYACRYLIC ACID, EPOXIDISED NATURAL RUBBER AND CARBON BLACK COMPOSITES

Mallick A; Gupta B R

Indian Institute of Technology

It is known that increased mixing times help carbon black disperse better in a polymer matrix. An experimental study is conducted to investigate the effect of mixing time on self-crosslinkable polyacrylic acid (PAA) and epoxidised NR (ENR) blend, filled with HAF carbon black. The constituents are mixed at 180 deg.C in a Brabender Plasticorder. Preliminary investigations show that there exists a critical mixing time, which varies with the filler loading as well as mixer rotor speed. The best dynamic mechanical and physical properties of the composites are obtained at the critical mixing time. These are explained on the basis of maximum interaction between the filler particles and the rubber matrix at the critical mixing time due to increase in surface area of filler with increase in dispersion and enhancement of carbon black promoted chemical interaction between PAA and ENR. Further mixing beyond the critical mixing time results in poorer properties of the composites, possibly because of mechanochemical degradation of ENR chains. 40 refs.

INDIA

Accession no.648074

Item 327

International Polymer Science and Technology

24, No.3, 1997, p.T/38-43

ASSESSMENT OF STABILITY OF COMPOSITION OF RUBBER MIXES PREPARED IN SINGLE STAGE AND OF RUBBER MASTERBATCHES

Litvin-Sedoi Y Z

An approach has previously been suggested towards assessment of the stability of the composition of rubber mixes of known homogeneity, prepared in several stages in production lines with known equipment. The approach is based on the construction of a precision diagram corresponding to the basic flow sheet. On the precision diagram, it is possible to show graphically any changes in the mass fractions of components and the characteristics of errors with which they are introduced into the mix, and also the characteristics of errors of the content of components in mix samples as the mix passes through a particular unit of equipment in the rubber mix preparation line. On account of this it becomes possible to carry out precision analysis of the operation of different rubber mix preparation lines and to compare them. Three cases are examined, taking into account of specific proportioning systems and batch internal mixer charging procedures for mix preparation plants of the tyre industry, on the basis of the concept adopted in metrology of precision assessment of weighing devices and proportioners. These three cases are statistical independent weighing/proportioning of all components, the general case of charge formation and the formation of a batch of rubber in whole briquettes taken in a certain cycle (without weighing). 6 refs.

RUSSIA

Accession no.647869

Item 328

International Polymer Science and Technology

24, No.1, 1997, p.T/24-8

INFLUENCE OF THE RADIUS OF THE WORKING SURFACE OF THE ROTOR BLADE OF A BATCH INTERNAL MIXER ON THE EFFICIENCY OF FORMATION AND QUALITY OF THE MIXES

Shikhirev N I; Raskazov A N; Trofimov A P; Ugretsova O V; Skok V I

Investigations were carried out on an experimental single-rotor unit during the formation of a model rubber mix consisting of 68 wt% SKMS-30ARKM-27 and 32 wt% P245 carbon black under specified conditions. The nature of the changes occurring during formation of the mix were assessed visually, and also from the amount of carbon black introduced into the polymer and the change in the torque. The quality of the mixes was assessed from the degree of dispersion and the uniformity of distribution of carbon black in the polymer in the testing of 15 specimens. Uniformity of distribution was characterised by the coefficient of variation of mix density. Kinetics of change

in the rheological properties was studied on a Mooney viscometer at 120 C and a Monsanto SRPT relaxometer at 100 C. 6 refs. Translation of Kauch i Rezina, No.3, 1996, p.19

RUSSIA

Accession no.639431

Item 329

Plastics World

54, No.3, March 1996, p.14-6

MIXER ADDS DIMENSION TO SINGLE-SCREW CAPABILITY

Miller B

DMX has developed an in-line mixing unit, the Dynamic Melt Mixer. The rotating-vane device is being proposed as means for making polymer blends and alloys with single-screws. The retrofittable dynamic mixer is also said to greatly enhance the efficiency of single-screws for compounding colourants, lubricants and other additives. The basic idea behind the Dynamic Melt Mixer is to let the extruder concentrate on melting and shift the mixing function to a device designed specifically for intensive mixing.

DMX INC.

USA

Accession no.637578

Item 330

Rubber World

215, No.6, March 1997, p.21/62

MIXERS WITH VARIABLE INTERMESHING CLEARANCE

Sheehan E; Pomini L

Pomini Inc.

A variable intermeshing clearance style mixer is an internal mixer with intermeshing rotors that provides technologists and compounders with the ability to control and adjust the variation of the clearance between the rotors. By adjusting the gap between the rotors, it is possible to optimise the amount of energy to be transferred to the compound in accordance to its actual viscosity. The results on mixed compounds presented in this article are based on tests run with industrial sized machines directly at the customer's production facility. 8 refs.

USA

Accession no.636320

Item 331

Tire Technology International

1997, p.184/90

TEMPERATURE CONTROL SYSTEMS FOR INTERNAL MIXERS

Grundy A

Carter UK

This comprehensive article describes the developments that have taken place with the internal mixer since

World War Two, highlighting the improvements in rotor design, better knowledge of mixing techniques, and the increase in throughput rates for all types of compounds. The article focuses on the necessity of ensuring that temperature control systems have kept pace with these developments.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.636147

Item 332

Rubber Chemistry and Technology

69, No.5, Nov-Dec.1996, p.742-51

EVALUATION OF CHAIN SCISSION DURING MIXING OF FILLED COMPOUNDS

Asahiro Ahagon

Yokohama Rubber Co.Ltd.

The question of whether chain scission takes place during mixing of black-filled compounds is unresolved and originates from the material system which contains gel. A direct way to evaluate scission is to quantify the change in the number of chain ends. This, however, requires determination of an average molecular weight of the linear components which constitute the gel-containing system. Although the Charlesby-Pinner theory used in crosslinking studies, which defines the degree of polymerisation, appears to be a promising approach to this problem, the theory cannot be directly applied for black-filled compounds because the composite structure in the compounds does not allow one to satisfy the assumptions made in the theory, i.e. an equal chance of crosslinking for every reactive site. In this work, a new technique, involving the use of an additional crosslinking agent, is developed which allows the sol-gel analysis to be carried out even with black-filled compounds. NR and SBR formulations mixed using various mixing specifications were used; the results clearly indicate that chain scission takes place during mixing of both NR and SBR compounds. 11 refs.

JAPAN

Accession no.633313

Item 333

Polymer Plastics Technology and Engineering

36, No.2, 1997, p.231-40

MECHANOCHEMICAL DEGRADATION OF EVA-EPDM BLENDS

Mishra S; Naik J B

North Maharashtra,University

The internal mixing mastication of EVA-EPDM blends was studied in the temp. range 80-230C. The extent of degradation was determined by torque measurement in a Haake Rheocord 90 torque rheometer. The breakdown of EVA and EPDM in the mixer was shown to be minimum in the temp. range 110-120C and 150-160C, respectively. Cold mastication and hot mastication occurred below and above the given temp. ranges, respectively. The processing

temp. (flow activation energy) of blends varied with variation in the amount of EVA and EPDM. 7 refs.

INDIA

Accession no.632814

Item 334

Kautchuk und Gummi Kunststoffe

50, No.3, 1997, p.226-31

ROTOR CLEARANCE VARIATION

Pomini L; Testa E L; Schoenefeld G

A rubber compound has been used to test three simple models on the operation point transfer from a VIC 125 production mixer to a VIC 1.9 laboratory mixer (scale-down). In a second step, the model which gave the best conformity in the rheological and mechanical properties of compounds and vulcanised specimen has been used for the operation point transfer tests from a VIC 1.9 laboratory mixer to a VIC 125 production mixer (scale-up). Using this model, the rheological and mechanical properties of the rubber compounds corresponded very well. The rotor clearance variation of the internal mixers proved to be a primary condition to allow this simple scale-up/down model to be successfully applied. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; WESTERN EUROPE

Accession no.631939

Item 335

Indian Rubber Journal

Vol.24, Feb.1997, p.107-12

CORRECT ONE STEP MIXING

Schiesser W

Tips to achieving correct one-stage rubber mixing are presented. The objectives are improvement in quality, better dispersion, high uniformity and perfect reproducibility.

INDIA

Accession no.629006

Item 336

Rubber Chemistry and Technology

69, No. 4, Sept.-Oct.1996, p.686-95

SIMULATION OF FLOW IN AN INTERMESHING INTERNAL MIXER AND COMPARISON OF ROTOR DESIGNS

Kim P S; White J L

Akron,University,Inst.of Polym.Engineering

This paper describes a simulation of flow in various intermeshing rotor internal mixer designs. The rotor designs studied were obtained from the patent literature and presentations of the major intermeshing rotor machinery mixer manufacturers. The results of the simulation are compared to those for rotors of commercial separated rotor mixers. Intermeshing and separated rotor mixers are compared by contrasting estimated rates of mixing per unit total mixing chamber volume. Intermeshing rotors

are generally predicted to perform better. This indicates that they will mix more material despite smaller available internal mixer volume. Rotor designs discussed include; Cooke, Wiedmann and Schmid, Johnson et al, Tanaka and Yamada, double flighted, four flighted, Banbury and Sata et al. 27 refs.

USA

Accession no.628831

Item 337

China Rubber Industry

44, No.2, 1997, p.90-4

Chinese

APPLICATION OF PRODUCTION DATA DIRECTLY TO OPTIMIZATION OF PROCESSING PARAMETERS IN RUBBER MIXING

He Dehua; Wang Guoqiang; Zhang Hai; Wu Guangchao; Ma Tiejun; Cai Dayang; Zou Mingqing
South China,University of Science & Technology;
Guangzhou Zhujiang Tire Co.

A study was conducted of the application of the production data obtained with a microcomputerised monitor of MGKJ internal mixer directly to optimise the processing parameters in rubber mixing by using these parameters as factors and the intervals as levels of these factors. B4 compound and 902 compound were taken as examples to illustrate the whole process of the optimisation and good values of the parameters were obtained. 3 refs.

CHINA

Accession no.626119

Item 338

Advances in Polymer Technology

16, No.1, 1997, p.45-68

MODELLING THE TRANSIENT FLOW OF RUBBER COMPOUNDS IN THE DISPERSIVE SECTION OF AN INTERNAL MIXER WITH SLIP-STICK BOUNDARY CONDITIONS

Ghoreishy M H R; Nassehi V

Loughborough,University

Using finite element techniques, a mathematical model was developed for the two-dimensional analysis of non-isothermal and transient flow and mixing of a generalised Newtonian fluid with an inert filler. The model could incorporate no-slip, partial-slip or perfect-slip wall conditions using a universally applicable numerical technique. The model was used to simulate the convection of carbon black with flowing rubber in the dispersive section of a tangential rotor (Banbury) mixer. The Carreau equation was used to model the rheological behaviour of the fluid in this example. 31 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.626067

Item 339

Rubber News

36, No.3, Dec.1996, p.29-38

BANBURY MIXING

Majumdar S

Exxon Chemical Eastern Inc.

This article explains Banbury mixing (internal mixing) in detail. The following subject headings are included: internal mixer, principle of mixing, milling, kneading, longitudinal cut-back, lateral overlap, rotor wing, ram thrust, mixing chamber, Banbury batch weight and volume, discharge door, hopper, dust seals, and energy mixing. 10 refs.

INDIA

Accession no.618508

Item 340

International Polymer Science and Technology

23, No.7, 1996, p.T/10-4

CONTINUOUS PRODUCTION OF RUBBER MIXTURES ON TWIN-SCREW EXTRUDERS

Capelle G

Berstorff Maschinenbau GmbH

Twin-screw extruder systems have opened up new prospects in continuous production of rubber compounds. In 1995, production in Western Europe alone exceeded 3 million tonnes, almost half of which was used for the production of industrial rubber goods and tyres. The installation of continuous systems on a small scale as replacement investments would result in considerable savings. The procedure is described, together with test results and economic considerations. Translation of Gummi Fasern Kunststoffe, No.6, 1996, p.470

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

Accession no.614548

Item 341

Tire Technology International

1996, p.256-60

DEVELOPMENT IN TANGENTIAL MIXERS

Grundy A

Carter Bros.

Through extensive experience in the repair and overhauling of mixers, Carter Brothers is reported to have observed a number of ways in which the design of tangential rotor mixers could be enhanced. This has led to the introduction of a wider tip rotor which the company builds into its own mixer units or which can be supplied as part of a retrofit package. Customer experience indicates highly favourable results with benefits, including low power consumption and better mixing characteristics. The concept behind the wider tip rotor is reviewed and other ways in which Carter has improved mixers for tyre industry applications are examined. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.614242

Item 342

150th ACS Rubber Division Meeting. Fall 1996.

Conference Preprints.

Louisville, Ky., 8th-11th Oct.1996, Paper 48, pp.43. 012

INTENSIVE MIXER PREVENTATIVE MAINTENANCE PROGRAMME

McNabb R W; Smith T

Skinner Engine Co.

(ACS,Rubber Div.)

Guidelines are presented for the maintenance of mixers used in the rubber industry. A troubleshooting guide lists typical operational problems, their causes and solutions. USA

Accession no.611809

Item 343

International Seminar on Elastomers. Applied Polymer Symposium proceedings.

Akron, Oh., 14th-16th July 1993, p.203-17. 012

DUAL MIXER: FLEXIBLE TOOL TO MANAGE MIXING QUALITY

Pomini L

Pomini SpA

Edited by: White J L; Inoue T

Applied Polymer Symposium 53

A mixing cycle is controlled by different parameters and some are more important than others, in terms of how they will affect the quality of the processed compound. For that reason the total number of the cycle parameters can be divided into two separate ranges. Range A parameters deeply affecting the quality of the compound: filling factor, raw material loading sequence and cycle time. Range B parameters are: rotors speed, WTS, clearance between the rotors (intermeshing mixers only) and ram pressure. The technologist should pay the closest possible attention to the fine-tuning and checking of the first listed parameters range, a task which can be carried out using any internal mixer. On the other hand, the fine-tuning and checking of the second parameters range requires the use of more sophisticated mixers, equipped with accurate data-collecting devices. Currently, it is no longer enough studying and controlling only the first three parameters (filling factor, loading sequence, cycle time), because while being determinant, they will not be able on their own to ensure that the compound achieves the expected quality level. Modern mixing rooms specifications already include rotor speed variations, and changes in the ram pressure. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.611260

Item 344

International Seminar on Elastomers. Applied Polymer Symposium proceedings.

Akron, Oh., 14th-16th July 1993, p.193-202. 012

**MIXING OF EPDM IN INTERNAL MIXERS.
III. COMPARISON OF THE EFFICIENCY OF
MIXERS WITH TANGENTIAL ROTORS VS.
INTERMESHING ROTORS IN RELATION TO
THE MOLECULAR STRUCTURE OF EPDM**

Noordermeer J W M; Wilms M; Post C W

DSM Elastomers BV

Edited by: White J L; Inoue T

Applied Polymer Symposium 53

The influence of EPDM molecular structure, in terms of molecular weight distribution and long chain branching, on mixing behaviour in a three litre internal mixer with tangential rotor configuration has been described. In particular, the rate of dispersion of carbon black throughout the mixing cycle has been studied. The consequences of these differences in mixing behaviour, vulcanisation characteristics and vulcanisate properties of the mixes has been described as a function of the carbon black dispersions obtained. During the mixing of narrow molecular weight distribution (MWD) EPDM types the carbon black dispersion, after an initial increase, tends to stay constant for an extended period of mixing time or energy consumed during the mixing. Mooney viscosity also changes little during this period. During the mixing of broad MWD EPDM types such a period is not observed: the carbon black dispersion steadily increases with time or with the energy consumed. Now that internal mixers with intermeshing rotor configurations are becoming more popular, there are increasing indications gained that the phenomena observed in the tangential rotor mixers do not readily translate to intermeshing type mixers. For that purpose, a similar study is described which compares the mechanisms involved in the process of carbon black dispersion during mixing of EPDM with different MWDs/ long chain branching in both types of mixer. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION;
NETHERLANDS; WESTERN EUROPE

Accession no.611259

Item 345

International Seminar on Elastomers. Applied Polymer Symposium proceedings.

Akron, Oh., 14th-16th July 1993, p.145-92. 012

**CRITIQUE OF INTERMESHING COUNTER-
ROTATING BATCH AND CONTINUOUS MIXERS**

White J L; Kim P-S; Lim S-H

Akron,University

Edited by: White J L; Inoue T

Applied Polymer Symposium 53

Batch and continuous mixing machine technology using intermeshing counter-rotating rotors is summarised. Flow visualisation studies are reported showing the relative mixing capabilities of intermeshing and non-intermeshing rotors in an internal mixer. A study is also presented showing the mixing characteristics of a modular intermeshing counter-rotating twin-screw extruder. This involves removing the modular screws and examining the

development of mixing along the machine axis. The effect of modular designs on mixing is considered. 88 refs.

USA

Accession no.611258

Item 346

International Seminar on Elastomers. Applied Polymer Symposium proceedings.

Akron, Oh., 14th-16th July 1993, p.133-43. 012

**DISPERSION OF CARBON BLACK IN NATURAL
RUBBER**

Coran A Y

Akron,University

Edited by: White J L; Inoue T

Applied Polymer Symposium 53

Carbon black is the most important reinforcing filler for rubbers. The incorporation of carbon black into rubber vulcanisates generally gives improved performance-related properties. In order to exert its beneficial influence on the properties of rubber vulcanisates, the carbon black must be sufficiently dispersed. In addition, large undispersed agglomerates can give rise to poor mechanical properties as they can act as failure-initiating flaws. Thus, it might be expected that agglomerates larger than the inherent flaw size for NR would be responsible for decreases in ultimate mechanical properties. An attempt is made to improve understanding of the carbon black dispersion process, including the understanding of factors which affect the kinetics of dispersion. NR was chosen as a model for study because much background information about it exists, and although agglomerates of NR are readily incorporated into NR, there is a need to improve the rate at which carbon black can be dispersed. Dispersion is defined as the reduction in the amount of carbon black present as undispersed agglomerates of average diameter greater than about 5-10 mn. 12 refs.

USA

Accession no.611257

Item 347

International Seminar on Elastomers. Applied Polymer Symposium proceedings.

Akron, Oh., 14th-16th July 1993, p.121-32. 012

**COMPARISONS OF THE MIXING OF RUBBER
WITH CARBON BLACK IN AN INTERNAL
MIXER AND IN A BICONICAL ROTOR
RHEOMETER**

Freakley P K; Clarke J

Loughborough,University of Technology

Edited by: White J L; Inoue T

Applied Polymer Symposium 53

Mixing in an internal mixer is typified by complex, free-surface flows, in which modes of deformation, strain rates, and temperatures change with time and position. The characterisation of mixing in simple viscometric flows is an essential precursor to modelling the rubber mixing process,

but great care must be taken to ensure that the mechanisms of mixing in such simple flows are representative of those in a practical mixer. The characteristics of mixing in an internal mixer are explored and the results obtained used to design rheometer experiments, with the objective of quantifying the mixing treatment in fundamental units of stress, strain, strain rate, and temperature. The viscosity of the rubber compound is used as a measure of state-of-mix. 10 refs.

JAPAN

Accession no.611256

Item 348

Rubber Technology International

1996, p.202-4

FOUR WING ST BANBURY

Rapetski W A

Farrel Corp.

This comprehensive article describes the history, development and advantages of the Farrel Banbury mixer, a concept in use for 80 years, for technical rubber goods compounding. The new generation of Banbury mixer features a new advanced rotor design that delivers enhanced performance with reduced operating costs. Allied to extensive control systems, the machine supplies a cost-effective solution to compounding requirements.

USA

Accession no.610825

Item 349

IRC '96. International Rubber Conference. Conference proceedings.

Manchester, 17th-21st June 1996, poster 5. 012

VIC: INTERNAL MIXERS WITH VARIABLE INTERMESHING CLEARANCE

Pomini L

Pomini SpA

(Institute of Materials)

Internal mixers have been used since the end of the 19th century, but the breakthrough in rubber mixing technology was made by F. Banbury in 1916. Before 1916, internal mixers were simply made by two tangential rotors assembled in a closed mixing chamber in which only one opening was provided for material loading and discharging. Since 1916, substantial improvements have been made to the design of these machines. In 1988, Pomini introduced a new concept of internal mixer to the market: the VIC (Variable Intermeshing Clearance) internal mixer. The VIC is an internal mixer with intermeshing rotors that provides the technologist with an additional variable to work with: the variation of the clearance between the rotors. This is the area where the shear action takes place. By adjusting the gap between the rotors, it is possible to optimise the amount of energy to be transferred to the compound in accordance with its actual viscosity. The intake of the

raw material can also be improved providing you start the mixing cycle with a wide gap between the rotors. The results are better dispersion of the components and a shorter mixing time.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

Accession no.610149

Item 350

IRC '96. International Rubber Conference. Conference proceedings.

Manchester, 17th-21st June 1996, paper 73. 012

DEVELOPMENT OF A VALIDATED, PREDICTIVE MATHEMATICAL MODEL FOR RUBBER MIXING

Nassehi V; Freakley P K; Petera J; Clarke J

Loughborough, University

(Institute of Materials)

It is widely accepted that the mixing of synthetic or natural rubbers with particulate fillers such as carbon black is a crucial stage in determining the properties of rubber compounds. The ability to predict the outcome of a given mixing process is therefore vitally important in the rubber industry. Rubber mixing is usually carried out in batch, and in partially filled internal mixers. Due to the difficulties in predicting the behaviour of the materials involved and the complexity of the mixing operation itself the quantitative analysis of this process is regarded to be a formidable task. The main problems affecting the analysis of rubber mixing stem from transient viscoelastic rheology of the materials and the establishment of a non-isothermal free surface flow regime in geometrically complex mixer chambers. A brief outline is presented of a computer simulation package for rubber mixing which can, to a very large extent, address these difficulties. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.610137

Item 351

The Journal of the Adhesive & Sealant Council. Spring 1996. Conference proceedings.

Rosemont, Ill., 31st March-3rd April 1996, paper 24.

6A1

CLOSED MIXING SYSTEMS FOR THE PRODUCTION OF HIGHLY VISCOUS COMPOUNDS

Fischer J

Voith J.M., AG

(Adhesive & Sealant Council)

A closed, discontinuous mixing system operating within a broad viscosity range from approximately 100,000 to multiples of 10 million mpas is described. Acceptable operating pressures extend from 10 mbar (4 in. WC) vacuum to 140 psi (discharging - 280 psi) pressure.

Operating temperatures lie between cooling and 400 deg. F. As a result of the system's ability to quickly mix and disperse large quantities of fillers, cycle times, in comparison with conventional mixers, can be considerably shortened. Furthermore, mixing cycles can be carried out in a single step and without the need for additional equipment. This means that for a specific production quantity the volume of the described mixing vessel can be smaller than in other mixing systems. For products where every batch must be analysed, this can be a disadvantage. However, the high degree of automation of the plant and the resulting constant reproducibility of the quality parameters generally allows for a statistical quality control procedure. Special features of the mixing system are again the good homogenisation as a result of dispersing under pressure and at low turning speeds. This takes place without a disturbance of the rheology and with good deaeration of the product.

AUSTRIA; WESTERN EUROPE

Accession no.610006

Item 352

Antec '96. Volume II. Conference proceedings.
Indianapolis, 5th-10th May 1996, p.1995-2000. 012

**PREPARATION OF METALLOCENE
PLASTOMER MODIFIED HIGH FLOW
THERMOPLASTIC OLEFINS**

Yu T C

Exxon Chemical Co.
(SPE)

Metallocene plastomers are ethylene-alpha olefin copolymers with a density range from 0.91 to 0.86 and a melt index ranging from less than 1 to 125. The high efficiency single site catalysts provide uniform comonomer insertion, so that at a relatively low comonomer level, the copolymer exhibit both plastics and elastomeric characteristics. Both batch (Banbury) and continuous (extruder) mixing devices were used to melt blend a plastomer into a high flow (35 MFR) homopolymer polypropylene. A mixing device of choice needs to provide both distributive and dispersive mixing as well as adequate mixing time. Examples of good mixing devices are a twin-screw extruder, or a single-screw extruder equipped with a mixing section. 2 refs.

USA

Accession no.607218

Item 353

Polymer International

41, No.1, Sept.1996, p.23-33

**MECHANISM OF MIXING IN INTERNAL
MIXER AND ENERGY-BASED MODELLING**

Nakajima N

Akron,University

Differences between mill mixing and internal mixer operation for mixing of fillers with gum rubbers are

discussed, the experimental results of studies of the energy balance during mixing with an internal mixer are presented, and an energy-based modelling of the mechanism of mixing in the internal mixer is proposed. 29 refs.

USA

Accession no.605758

Item 354

Indian Rubber Journal

Vol.20, July 1996, p.102-8

DEVELOPMENT IN TANGENTIAL MIXERS

Grundy A

Carter Bros.Ltd.

Enhancements to the design of tangential mixers have been made by Carter Bros. The new designs incorporate a wider tip rotor which the company builds into its own mixer units or which can be supplied as part of a retrofit package. Customer experience indicates favourable results with benefits including low power consumption and better mixing characteristics. The concept behind the wider tip rotor is reviewed, together with other ways in which Carter has improved mixers for tyre industry applications.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.605284

Item 355

Shawbury, Rapra Technology, 1996, pp.100. 12ins.

1/9/96. Rapra Review Report No.90, Vol.8, No.6, 1996.

RUBBER MIXING

Wood P R

Edited by: Dolbey R

(Rapra Technology Ltd.)

Rapra Review Report No.90

A review is presented of the current status of mixing in the rubber industry from the point of view of the machinery manufacturer. Following a brief history of the mixing industry, an overview is presented of types of mixing equipment in use today. These include mills, internal mixers and current continuous mixers, together with details of ancillary room equipment. More recent machinery developments discussed include tangential rotors, intermeshing rotors, hydraulically operated rams, hydraulic drives, machine temperature control, variable speed drives, microprocessor control and tandem mixing. Mixing techniques are examined, process development, differences in mixing behaviour with respect to intermeshing versus tangential, and mixing quality problems are also addressed. 429 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

Accession no.603952

Item 356

Rubber Chemistry and Technology

65, No. 3, July/Aug. 1992, p. 527-79

**DEVELOPMENT OF INTERNAL MIXER
TECHNOLOGY FOR THE RUBBER INDUSTRY**

White J L

AKRON, UNIVERSITY

A detailed review is presented of the development of internal mixer technology from its origins in the 19th century to the late 1980s, the emphasis being on the patent literature. 161 refs.

USA

Accession no. 461249

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