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Performance Additives

A-C® Polyethylene
IN RUBBER PROCESSING

A-C® Polyethylene in Rubber Processing

A-C® polyethylenes are low molecular weight polymers which are proven processing aids for natural rubber and synthetic elastomers.

Their unique combination of low melting point and low viscosity coupled with excellent compatibility and general chemical inertness enables A-C® polyethylenes to provide outstanding lubricating characteristics without sacrificing cure rate or physical properties.

Outlined to the right, are some of the advantages that A-C® polyethylenes have shown in rubber compounding applications. These characteristics have been tested in our laboratory and evaluated in commercial operations where A-C® polyethylenes have performed effectively in solving a number of processing problems.

A-C® Polyethylenes:

- Provide excellent release properties from Banbury, mill, and calender rolls.
- Do not adversely affect scorch, cure rate, or general physical properties (tensile strength, elongation, hardness).
- Do not bloom or bleed in either green or cured stocks.
- Improve filler dispersion, particularly carbon blacks.
- Improve mold flow and mold release.
- Increase extrusion rates and improve surface finish.
- Are compatible with all elastomers.
- Have excellent chemical and oxidation resistance.
- Have excellent electrical properties.
- Disperse readily in the temperature range of 75°-95°C (170°-200°F) and above.

Most of the grades of A-C® polyethylenes and copolymers are suitable for use in rubber processing. However, from a practical standpoint (both physical and economic), the homopolymer grades are usually selected.

The most widely used grades for rubber processing are A-C® 617A, 617, 6, 6A, and 1702. A-C® 617A is generally preferred because of its combination of low melt point and low viscosity. It is in powder form and provides ease of dispersion with lubrication properties unmatched with the other solid grades.

The lowest molecular weight homopolymer, A-C® 1702, is specifically recommended for mill mixing or temperatures below 94°C (200°F). The grease-like consistency of A-C® 1702 provides excellent dispersion, even at low mixing temperatures, and the overall performance properties are fully comparable to A-C® 617A.

A-C® Polyethylene as a Rubber Mixing Aid

A-C® polyethylenes have long been known as effective processing aids in rubber compounds to improve release, reduce viscosity and increase extrusion rates. A laboratory study evaluating the performance of several grades of A-C® polyethylene in a SBR-NR mechanical goods compound demonstrated the superiority of these materials in rubber processing. This study showed that significant improvements were achieved in Banbury mixing and mill handling with the smooth release of the stock by the incorporation of A-C® polyethylene.

A-C® 6, 617A and 629 polyethylenes were added to the compound during the Banbury mixing cycle. The compounds, including a control, were mixed four minutes at 120 rpm and 0.41 MPa (60 psi) ram pressure. The test sheets were cured 7 minutes at 160°C (320°F).

Base Formulation	
SBR 1815	112.5
No.1 Smoked Sheets	50.5
MT Black	20.0
Zinc Oxide	3.0
Stearic Acid	1.0
Thermoflex A[1]	1.5
Santocure[2]	1.0
TMTMS[3]	0.4
Sulfur	2.0
A-C® Polyethylene	0 or 3.5 as indicated

[1] Antioxidant, E.I. du Pont de Nemours & Co.
[2] Accelerator, Monsanto Co.
[3] Tetramethylthiuram Monosulfide, Accelerator, R.T. Vanderbilt Co.

Compound Number	A	B	C	D
A-C® Polyethylene Grade	None	A-C® 6	A-C® 617A	A-C® 629
Mooney Viscosity				
ML @ 100°C (212°F)	34	33	35	34
Oscillating Disk Rheometer @ 160°C (320°F) (ASTM D-1646-72) Minutes to:				
1 Point Rise	3.9	4.0	4.0	3.8
Optimum Cure	5.9	5.9	5.8	6.0
Torque				
Maximum Newton-Metre	7.7	7.2	7.3	7.7
Pound-Inch	67.8	63.7	64.3	67.8
Stress-Strain Properties Cured 7 minutes @ 160°C (320°F)				
Durometer, Shore, "A"	57	56	57	58
Modulus 300% , MPa (psi)	10.3 (1500)	9.7 (1410)	9.4 (1370)	10.4 (1510)
Tensile Strength, MPa (psi)	16.1 (2330)	17.4 (2520)	16.1 (2340)	17.2 (2500)
Ultimate Elongation, %	410	450	430	420
Specific Gravity	1.13	1.12	1.12	1.12
Peak power and temperature readings as well as release prop with the following results:				
Banbury Mixing				
Peak Power, amps	45	42	41	42
Final Temperature, °C (°F)	127 (260)	124 (255)	121 (250)	121 (250)
Release from Banbury	Fair	Good	Good+	Excellent
Stock Appearance	Fair+	Good	Good	Good
Mill Handling @ 65°C (150°F)				
Release	Fair	Good+	Good+	Excellent
Smoothness	Fair	Good	Good	Good
Tack	Good	Good	Good	Good

Rubber Processing With A-C® Polyethylene

Rubber compound processibility and product uniformity are greatly improved with the use of A-C® polyethylenes. Because of their low softening points and viscosities, A-C® polyethylenes provide better wetting and lubrication. Significant improvements are also realized in extrusion rates, extrudate and shrinkage, and surface smoothness. Effective release from calender rolls and mills as well as from molds is obtained with A-C® polyethylenes. Mold flow is also markedly enhanced.

With the use of A-C® polyethylenes, power reductions as well as an increase in productivity are possible. These result in the all-important cost economies.

A-C® polyethylenes are relatively inert materials and, thus, will not affect scorch. In some instances, the A-C® polyethylenes will improve mechanical properties because of their ability to effectively disperse reinforcing fillers.

A study to determine the effect of A-C® polyethylenes on processing variables was made on an SBR-NR mechanical goods compound. Extrusion appearance and characteristics were determined with a Garvey die. Mold flow and release were also observed.

The study used the same base formulation as is shown on Page 2.

A-C® polyethylenes, long standards in the industry as processing aids, are supplied as prills and in powder form. The powder is generally recommended for rubber processing

Compound Number	A	B	C	D
A-C® Polyethylene Grade	None	A-C® 6	A-C® 617A	A-C® 629
Compound Processing Properties				
Mooney Scorch @ 100°C (212°F)				
1 1/2 minutes	38	37	39	38
4 minutes	34	33	35	34
Torque, Newton-Metre (in./lb.)				
Minimum	2.35 (20.8)	2.45 (21.7)	2.51 (22.2)	2.61 (23.1)
Maximum	7.66 (67.8)	7.20 (63.7)	7.26 (64.3)	7.66 (67.8)
Extrusion and Molding Properties				
Extrusion (Garvey Die)				
Rate (grams/minute)	7.07	7.46	7.65	7.70
Relative	100	106	108	109
Shrinkage (cm/gm)	0.742	0.800	0.805	0.808
Shrinkage (in./gm)	0.292	0.315	0.317	0.318
Relative (%)	5.0	0.9	0.3	0
Appearance				
Mold Release @ 160°C (320°F)	Fair	Good+	Good+	Excellent
Mold Shrinkage, %	2.4	2.4	2.4	2.4

because of its better dispersibility; however, if mixing temperatures exceed the softening points of A-C® wax being used, prills are recommended.

Where lower processing temperatures (less than 90°C 194°F) are required, A-C® 1702, which is supplied in a grease form, is recommended.

Processing Neoprene® Compounds

A-C® 617A makes compounding Neoprene not only easier, but the benefits of its addition will be readily recognized on a two-roll mill or in the kneader. In addition, processors who extrude this elastomer to make cable jackets, for example, will appreciate the smoothness of extrusion, with optimal surface and minimal distortion.

- The electrical properties are better when using A-C® 617A.
- Where replacing 4 parts of the rubber with 4 parts of A-C® 617A, tensile can be expected to go down by about 5%, and elongation decrease will be minimal.
- Air oven aging affects neoprene compounds with A-C® 617A less than compounds without it.
- There is no noticeable difference in the 18-hour oil immersion test at 121°C between Neoprene with A-C® 617A and Neoprene without A-C® 617A.

Processing EPDM Compounds

Like many other elastomers, EPDM stocks can present processing problems unless properly compounded. Many of these problems can be alleviated by the addition of A-C® polyethylene. Mooney viscosity and mill tackiness are reduced; mold release and building tack are improved, and there is more uniform extrudate surface.

A-C® 617A does not affect cure rate and has very slight influence on physicals. Addition of 8 parts of A-C® 617A to 100 parts of rubber will decrease its tensile by only 5%; elongation increases and modulus decreases. After oven aging, physicals of EPDM with A-C® 617A are equivalent to those of EPDM with no A-C® 617A.

Processing VITON®

Processing properties of VITON® compounds can be significantly improved by the addition of small quantities of A-C® polyethylene.

Better mold flow and mold release characteristics are obtained — with no change in cure rate. Surface qualities of both extruded and molded VITON® parts are also greatly enhanced. Neither original nor aging properties are impaired, and, due to the non-blooming characteristics of A-C® polyethylene, green tack and adhesion properties are not affected.

Addition or substitution of 3 phr of A-C® polyethylene, for example, has no effect on original properties and causes only minor changes in heat and oil-aging data. However, it can bring an important reduction in compound cost.

Processing HYPALON® Compounds

Traditionally, A-C® polyethylene has been used with HYPALON® compounds to provide improved processing properties. A-C® polyethylene shortens mixing cycles, decreases viscosity, reduces shrinkage, improves mold flow and mold release, and provides excellent handling characteristics during mill and calendar operations.

Studies conducted with HYPALON® shoe sole formulations have shown that additional benefits, in the form of improved physical properties, can also be achieved with the use of A-C® polyethylene. These evaluations have shown that 5 phr of A-C® 617 improves abrasion resistance by 20% and decreases crack growth by about 2/3.

Processing Nitrile Elastomer Compounds

A-C® polyethylene is a very effective processing aid for nitrile rubber compounds. Milled stocks sheet faster and smoother, viscosities are lowered, and scorch sensitivity is decreased. Nerve and shrinkage are reduced, contributing to better calendering and extrusion properties, while mold flow and mold release are also improved.

The addition of up to 5 phr of A-C® 617A to a nitrile formulation provides all the benefits of easier processing with little or no adverse effect on the vulcanizate's physical properties. Influence on tensile strength or elongation can barely be detected, whereas a certain decrease in modulus can be anticipated.

Processing SBR Compounds

The general improvement in processing properties is also valid in SBR compounds.

Addition of 5-10 parts of A-C® 617A to SBR markedly increased its abrasion resistance, also lowering the modulus of the compound. Tensile, tear resistance and compression set lowered only as much as would be expected when diluting a rubber with 5 to 10 parts of a low molecular weight additive.

A-C® Polyethylene In Tire Applications

A-C® polyethylenes have been found to be particularly effective in the following areas:

- For chlorobutyl Innerliners, A-C® polyethylenes provide calender release and improvement of the surface smoothness of the finished sheet, while not interfering with building tack or other physical properties.
- For the tread, A-C® polyethylene help carbon black filler dispersion and provide excellent mold flow and mold release, which is particularly important in very intricate tread design.

Because of the lubricating action of A-C® polyethylenes, the mixing temperatures will be lower, resulting in better scorch safety.

Effect of A-C® Polyethylene On Carbon Black Dispersion

Laboratory and plant studies have shown that the addition of A-C® polyethylene to a rubber formulation can improve filler dispersion, notably carbon black, and provide improved properties to the compound.

A comparative test was conducted, whereby 1 phr stearic acid was present in the two carbon black filled SBR compounds. In one of the compounds, 5 parts of mineral oil were exchanged by 5 parts of A-C® 617A.

After compounding, it was very noticeable that the compound with A-C® 617A enjoyed much better carbon black dispersion than the compound with mineral oil, resulting in a more than 10% improvement in tensile strength.

Typical Properties of A-C® Polyethylenes and Copolymers					
	Mettler Drop Point (ASTM D-3954)	Hardness, dmm (ASTM D-5)	Density, g/cc (ASTM D-1505)	Viscosity, cps @ 140°C (Brookfield)	Acid Number, mg KOH/g (ASTM D-1386)
Polyethylene Homopolymers					
A-C 820A[1]	126°C 259°F	1.0	0.97	80	Nil
A-C 1810A[1]	121°C 250°F	2.0	0.95	20	Nil
A-C 9	115°C 239°F	0.5	0.93	450	Nil
A-C 8	113°C 235°F	1.0	0.93	450	Nil
A-C 3A[1]	112°C 234°F	2.0	0.92	450	Nil
A-C 7	109°C 228°F	2.5	0.92	450	Nil
A-C 6	106°C 223°F	4.0	0.92	375	Nil
A-C 16[8]	102°C 216°F	5.5	0.91	525	Nil
A-C 617	101°C 214°F	7.0	0.91	180	Nil
A-C 1702[2]	90°C 194°F	98[3]	0.88	30	Nil
Oxidized Polyethylene Homopolymers					
A-C 623P	110°C 230°F	<1.0	0.95	400	17
A-C 680	108°C 226°F	1.5	0.93	250	16
A-C 629	101°C 214°F	5.5	0.93	200	15
A-C 656	98°C 208°F	9.0	0.92	185	15
A-C 6702[5]	88°C 190°F	90[3]	0.85	35	15
High-Density Oxidized Polyethylene Homopolymers					
A-C 307	140°C 284°F	<0.5	0.98	85,000 @150°C	7
A-C 316	140°C 284°F	<0.5	0.98	8,500 @150°C	16
A-C 325	136°C 277°F	<0.5	0.99	4,500 @150°C	25
A-C 392	138°C 280°F	<0.5	0.99	4,500 @150°C	30
A-C 330	137°C 279°F	<0.5	0.99	3,600 @150°C	30
A-C 395	137°C 279°F	<0.5	1.00	2,500 @150°C	41
Polypropylene Homopolymers					
	Softening Point				
A-C 1754[1]	167°C 333°F	<0.5	0.89	775 @190°C	Nil
A-C 1660[1]	150°C 302°F	<0.5	0.89	60 @190°C	Nil
A-C 1089[1]	146°C 295°F	<0.5	0.91	45 @190°C	Nil
Ethylene-Acrylic Acid Copolymers					
A-C 540	105°C 221°F	2.0	0.93	575	40
A-C 580	95°C 203°F	4.0	0.93	650	75
A-C 5120[6]	92°C 198°F	8.0	0.93	600	120
Ethylene-Vinyl Acetate Copolymers					
A-C 405T	102°C 216°F	4.0	0.92	600	6% Vinyl Acetate
A-C 405M	100°C 212°F	5.0	0.92	600	8.5% Vinyl Acetate
A-C 405S	94°C 201°F	7.0	0.92	600	10.5% Vinyl Acetate
A-C 400	92°C 198°F	9.5	0.92	595	13% Vinyl Acetate
A-C 415	89°C 192°F	12.5	0.92	1,300	15% Vinyl Acetate
A-C 430[8]	75°C 167°F	70[7]	0.93	600	26% Vinyl Acetate
Oxidized Ethylene-Vinyl Acetate Copolymers					
A-C 645 P	99°C 210°F	5.0	0.94	375	13 (SAP=56)

Notes: Except as noted, product is supplied as prills, pastilles, granules or diced forms. Many products are available as powders

(1) Product only available as a powder

(2) Product only available in fiber drums or slabs

(3) Product has a grease-like consistency, hardness ASTM D-1321

(4) Product only available in steel drums

(5) Product only available in fiber or steel drums

(6) Product only available in fiber drums times may apply

(7) Product is a tacky solid, hardness ASTM D-1321

(8) Minimum order quantities and extended order lead

For additional information or to contact us , please visit:
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