

Epolene

P O L Y M E R S

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EASTMAN

Contents

Introduction	1
Applications	2
Properties	4
Emulsifiable Polymers	6
Nonemulsifiable Polymers	8
Packaging	10
Typical Properties of <i>Epolene</i> Polymers	11
FDA Food Additive Regulation Status of <i>Epolene</i> Polymers	12

Eastman Chemical Company offers a series of medium to low molecular weight polyethylene or polypropylene polymers under the *Epolene* trade name.

They are useful in the plastics industry as lubricants for PVC, processing aids, mold release agents, dispersion aids, and coupling agents. They are also widely used as base polymers for hot-melt adhesives and pavement-stripping compounds as well as petroleum wax modifiers for use in candles, investment casting, cable filling, and various paperboard coatings. Numerous types of *Epolene* polymers are available, and properties can be selected to fit various processing operations. Many of these polymers meet U.S. FDA food additive regulations for various applications.

Applications

Candles

Using 1%–5% *Epolene* N-11, N-34, C-10, and C-15 polymers is common to improve shrinkage, mold-release properties, gloss, sheen, opacity, and color dispersion in petroleum wax based candles. These additives are virtually odorless and smokeless when the correct wick size, candle shape, and additive concentration are used, plus with excellent melt and color stability, they can produce brighter, more reproducible colors when compared to stearic acid. *Epolene* N-11 and N-34 are suggested when very low melt viscosities are preferred.

Coatings

Epolene polymers are useful as:

- Hot-melt or emulsion coatings on paper, providing high gloss and excellent barrier properties.
- High-gloss emulsion coatings for citrus fruits to maintain freshness and flavor of the fruit by reducing moisture loss and shrinkage.
- Coatings/laminations of paper for packaging materials used in manufacturing spiral-wound fiber drums.
- Components in hot melts for improved durability as compared with paint for marking highway surfaces.
- Temporary protective coatings for metal surfaces.
- Scuff-resistant emulsion coatings for glass bottles.
- Flatting agents for lacquers and enamel paints.
- Ingredients in sprayable herbicide and insecticide formulations for improved wetting and spreading characteristics.



Coupling Agents

Epolene maleated polyolefins are useful as coupling agents and adhesion promoters for filled/reinforced polyolefins. *Epolene* polymers attract various materials such as inorganic fillers, metal surfaces, cellulosic surfaces, and nylon polymers to nonpolar polyolefins.

Hot-Melt Adhesives

Epolene C polymers are useful as base polymers for hot-melt adhesives, producing bonds with low color, low density for excellent mileage, high char resistance, relatively high elevated

temperature resistance, and excellent compatibility with various tackifying resins. Because of its relatively low viscosity and high softening point, *Epolene* N-21 polymer can be useful as an additive for improving set speed.

Inks

Dispersions and emulsions of *Epolene* polymers are added to solvent and waterborne inks to improve resistance to rub-off, increase slip to the printed surface, and reduce offset. The emulsions are compatible with many acrylic polymers used in formulating inks for the water-based market.

Natural/Wood Fiber Composites

Epolene maleated polyolefins strengthen wood plastic composites and natural fiber reinforced polyolefins. The maleic functionality wets out and bonds natural fibers into the base polymer to substantially increase tensile strength, and other physical properties. *Epolene* polymers are especially useful for strengthening highly filled composites with 50–60% wood fiber loadings.

Paper

As a lubricant for clay coatings applied to paper, *Epolene* E polymers tend to outperform many calcium stearate dispersions by providing increased lubricity during calendaring. *Epolene* polymer dispersions in clay coatings allow for higher processing speeds, less dusting, and higher gloss.

Personal Care Products

By improving elevated-temperature resistance, chemical resistance, and inertness, *Epolene* polymers find use in a number of cosmetics and personal care products.

Petroleum Wax Blends

As a paraffin wax modifier in candles and crayons, *Epolene* polymers provide desirable gloss, sheen, opacity, and good mold release properties.

Petroleum wax coating formulations can be modified with *Epolene* polymers to provide gloss retention, scuff resistance, improved hold-out and, in certain formulations, heat sealability. Specific applications include coatings for corrugated kraftboard, folding cartons, carbon paper, and a variety of other paper products.

Plastic Additives

As dispersion aids, *Epolene* polymers have unique wetting and dispersion characteristics for highly filled compositions and color concentrates. The maleic-anhydride modified *Epolene* polymers function as coupling agents for many filled or reinforced plastics to improve processability and surface characteristics. These functionalized polymers are also useful as compatibilizers for various polymer alloy systems.

Epolene polymers can be used as external lubricants for rigid and flexible PVC (polyvinyl chloride), including the extrusion of rigid PVC pipe for potable water.

As a processing aid for linear-low-density polyethylene (LLDPE), *Epolene* N-34 polymer has been found to increase the throughput of LLDPE with conventional extrusion equipment.

Polishes

Epolene E polymers are used in a number of polish applications:

- Emulsions based on *Epolene* E polymers may be used in industrial or household liquid floor polishes to improve slip resistance, hardness, scuff resistance, durability, gloss, water resistance, leveling, buffability, and color.
- Small additions of *Epolene* E polymers have been found to impart excellent gloss and film hardness in creamy automobile polishes that are used in a single application to clean and wax weathered automobile finishes.
- *Epolene* E polymers are used in spray-and-wipe furniture polishes as typically applied using manual, pump-type dispensers to impart excellent luster and serve as a good dusting aid.

Processing Aids

The addition of small amounts of *Epolene* polymers can substantially improve the processability of many plastics.

Rubber

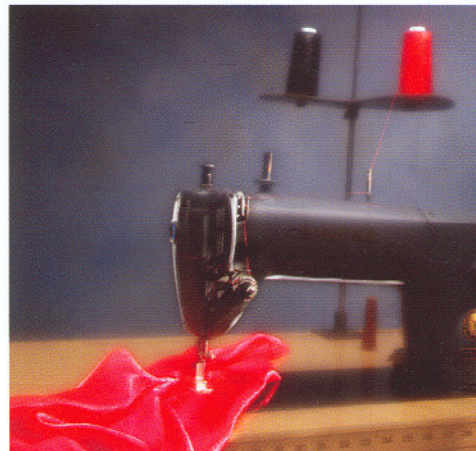
As a processing aid for nitrile, butyl, SBR, EPDM, and neoprene rubber, *Epolene* polymers improve mixing of recipe ingredients, help reduce shrinkage, and reduce tackiness during processing.

Textiles

Emulsions based on *Epolene* E polymers are effective as softeners and lubricants for natural and synthetic fibers, improving abrasion resistance, tear resistance, and hand and sewing lubricity.

Wire and Cable

Epolene N-21 and N-22 wax can be used in gelled mineral oil formulations to improve high-temperature properties such as slump and sag resistance. It is also useful in the modification of amorphous polyolefin and polybutene polymer-type cable flooding compounds. *Epolene* C waxes can be used to upgrade the properties of petrolatum in both filling and flooding compounds.



Properties

Abrasion Resistance

Epolene polymers' outstanding toughness and low coefficient of friction enable them to be excellent additives for improvement of abrasion resistance in a wide variety of formulated coating materials.

Additive Dispersion

Low melt viscosity and good compatibility with a variety of materials enable *Epolene* polymers to improve the dispersion properties of pigments, fillers, and other additives in a variety of plastics and rubber formulations.

Antiblocking Action

Epolene polymers are added to a variety of coating formulations to prevent parts that are coated with the formula from sticking together.

Barrier Properties

Based on polyolefins, *Epolene* polymers are resistant to water, grease, and many chemicals. They can be used in hot melts and aqueous emulsions and/or as solution/solvent dispersions.

Color

Most *Epolene* polymers have very low color (Gardner color scale values in the 1 to 2 range).

Compatibility

Epolene polymers are compatible with many polymers, resins, and natural and synthetic waxes.

Hardness

Penetration hardness values for *Epolene* polymers range from 0.1 to 7.0 tenths of a mm at 25°C. *Epolene* polymers

tend to retain more hardness at elevated temperatures than most natural and paraffin waxes.

Lubricity

Because of their low coefficient of friction and range of compatibility, *Epolene* polymers are often added to formulated or compounded materials

to improve surface lubricity, slip, and release properties. *Epolene* E polymers are frequently used as external lubricants in the extrusion of rigid PVC for such applications as pipe, siding, and profiles. *Epolene* C and N polymers can be used as external lubricants for flexible PVC.



Melt Viscosity

Epolene polymers are available in a broad selection of low, medium, and high viscosities. Each product is manufactured under a narrow viscosity range.

Moisture and Grease Resistance

Epolene waxes are insoluble in water, which results in high moisture resistance. They are also quite resistant to grease and many other chemicals.

Softening Point

Epolene polymers are available with a wide range of softening points ranging from 100° to 163°C.

Solubility

Epolene polymers tend to have limited solubility in solvents and oils at room temperature, but at elevated temperatures, they are soluble to varying degrees. Using cloud point, it has been found that *Epolene* E emulsifiable polymers tend to be more soluble in aliphatic solvents

than nonemulsifiable *Epolene* C and N polymers, and *Epolene* C polymers tend to be more soluble than *Epolene* N polymers.

Furthermore, the lower-density products tend to be more soluble than the higher-density products, and the lower molecular weight products tend to be more soluble than the higher molecular weight products. Solubility tends to be best in nonpolar solvents such as toluene, xylene, mineral spirits, and naphtha. They tend to be insoluble in such solvents as n-butyl alcohol, n-propyl acetate, and ethyl alcohol.

Surface Appearance

The addition of *Epolene* polymers to formulated or compounded plastics can improve gloss and surface appearance of finished products.

Toughness

Epolene polymers are tougher than most natural and many synthetic waxes.

Viscosity Modification

A broad range of *Epolene* polymers exist with low, medium, and high viscosities, making them excellent viscosity modifiers for plastics, adhesives, elastomers, and natural and synthetic waxes.



Emulsifiable Polymers

Epolene E-10

An oxidized polyethylene developed for water-emulsion floor polishes, *Epolene E-10* polymer imparts excellent slip resistance, outstanding toughness, and good durability to polish films. These properties are often apparent at low polymer concentrations, but they are best observed where E-10 comprises 20% or more of the total solids in the polish. It can be used in both atmospheric polymeric wax-to-water and pressure emulsification methods.

Emulsions of E-10 are also used as finishing agents for cotton and synthetic fabrics and as textile softeners in conjunction with wash-and-wear finishing waxes. They are also used as lubricants in clay coatings on paper to reduce dusting during calendering.

Epolene E-14 and E-15

Epolene E-14 and *E-15* are oxidized polyethylenes that have lower densities and softening points than E-10. Such properties contribute to their versatility and ease of emulsification in both wax-to-water and pressure emulsification methods.

E-14 has a lower molecular weight than E-10, which allows for more forgiveness in atmospheric emulsification. E-14 is commonly used to impart excellent slip resistance to floor polish films. The best results tend to occur when used in concentrations of 20% or less solids or in polishes containing both natural and synthetic waxes. E-14 in powdered form (*Epolene E-14P*) is useful as a lubricant in processing

rigid and flexible polyvinyl chloride and as a pigment dispersing aid in color concentrates.

E-15 has the lowest density and is the softest of the emulsifiable *Epolene* polymers and is generally used at low concentrations in mixed-wax emulsions and high-polymer floor polishes to improve slip resistance.

Along with E-10 and E-20 polymers, E-14 and E-15 are lawful for use (21 CFR 175.125) in formulating pressure-sensitive adhesives for use in food-contact surfaces of tapes and labels used in dry food and processed, frozen, dried, or partially dehydrated fruits and vegetables.



They can also be lawful for use in manufacturing food-contact articles as defined under regulation 21 CFR 177.1620 and as adjuvant substances on textiles and textile fibers intended for use in contact with food in amounts not exceeding those required to achieve their intended effect (21 CFR 177.2800). Other applications for these four polymers include use as coatings or as a component of coatings for various fruits and vegetables as noted under 21 CFR 172.260.

Epolene E-16 and E-17

Epolene E-16 is a low-density, oxidized polyethylene polymer having properties between those of E-10 and E-14. E-17 is similar to E-16, but it has a higher acid number than the other low-density *Epolene E* polymers. Both are commonly used to provide stable, low-color emulsions by both atmospheric and pressure emulsification methods for such end uses as textiles, floor polishes, inks, and paint rheological additives.

Epolene E-20

Epolene E-20 is a low molecular weight, medium-density oxidized polyethylene with exceptional hardness and low color. It has a low softening point and low viscosity that help it provide the desirable emulsification properties of a low-density polymeric wax. *Epolene E-20P* is commonly used as a lubricant for bottle molding PVC and in pipe extrusion of rigid PVC and HDPE.

E-20 is an excellent performer in high-speed, buffable floor polish, textile lubricant/softener, and fruit-coating applications. In powder form, it is used as an extrusion lubricant for clear, rigid PVC compounds. Its higher density and softening point make it particularly attractive for use in citrus fruit coating emulsions. These properties contribute to the hardness, short drying time, and excellent gloss of the coatings.

Epolene E-25 and E-43

Epolene E-43 is a relatively low molecular weight, maleic anhydride modified polypropylene polymer with the greatest hardness and highest softening point of all the *Epolene E* emulsifiable polymers. It is commonly used to impart outstanding slip resistance to floor polishes. Because of its high melting point, pressure equipment is required for emulsification.

Because of its polarity and available anhydride functionality, E-43 is also useful as a compatibilizer in many plastic alloy systems. It can also be used as a coupling additive for filled polypropylene to increase tensile, modulus, and heat-deflection temperature of molded parts when fillers such as glass, mica, talc, CaCO₃, and wood flour are used with polypropylene. For the same reasons, E-43 also acts as an excellent pigment dispersant and processing aid for single plastic systems such as ABS.

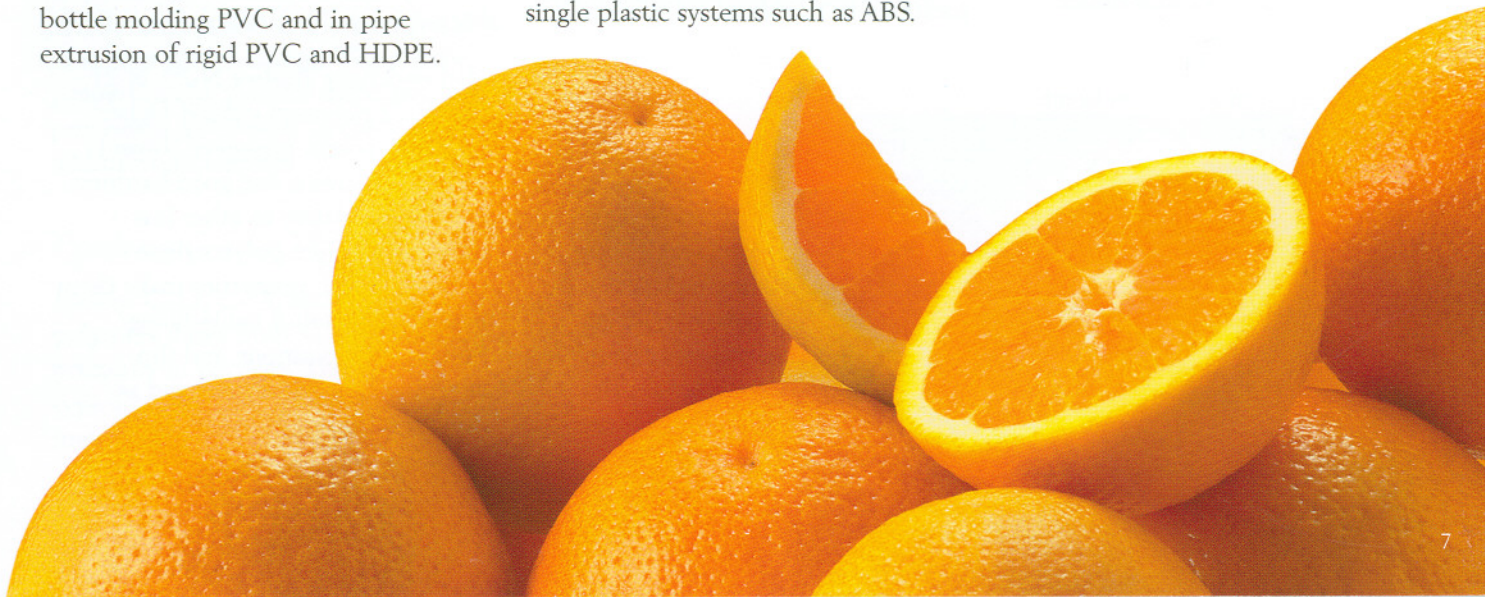
Maleic anhydride modified polymers are especially effective in dispersing polyamide-based fluorescent pigments in polyolefins.

Epolene E-25 is a lower acid number, lower color material than *Epolene E-43* for use in those applications where color needs to be minimized.

Epolene G-3003 and G-3015

As with E-43, *Epolene G-3003* and *G-3015* are maleic anhydride modified polypropylene polymers. They differ primarily in acid number, color, and molecular weight. Their optimum functionality and molecular weights enable them to couple various fillers in polypropylene and in nylon/polypropylene composites. Small additions of as low as 1%–1.5% can result in a significant increase in most fiberglass-reinforced polypropylene and polypropylene/nylon composite physical properties. They also function well as compatibilizers in nylon/polypropylene alloys. *G-3003* and *G-3015* are commonly used as coupling agents when using fillers such as glass, mica, and wood flour with polypropylene.

Epolene G-3003 and *G-3015* should be added to natural fiber composites at approximately 3% to achieve optimum physical properties in highly filled composites.



Nonemulsifiable Polymers

Epolene N-10

As a nonemulsifiable, medium-density, relatively low melting point polyethylene homopolymer, *Epolene N-10* polymer can easily be melt-blended with natural or synthetic waxes to improve tensile strength, abrasion resistance, and adhesion to fibrous substrates. For paper coating applications such as folding cartons, N-10 can be used to improve paraffin wax mileage and provide a glossy, scuff-resistant finish. It is also commonly used in printing inks to improve resistance to scuffing and rub-off. Its low coefficient of friction characteristics and good wetting properties enable N-10 to act as a processing aid and pigment dispersant for polyolefin color concentrates.

Epolene N-11, N-14, N-30, N-34, and N-35

Epolene N-11, N-14, N-30, N-34, and N-35 polymers are lower in molecular weight and density than N-10 and differ primarily in viscosity. They are used in many of the same applications as N-10 but offer advantages where lower viscosities are desired. They are also useful as mold release additives and lubricants in rubber processing and as extrusion and calendering aids for vinyl. In powder form, they are used as pigment-dispersing aids for color concentrates used in various plastic applications.

N-14 is used as a mold release agent for solvent systems with urethane and HDPE.

N-34 is commonly used as a processing aid for blown-film extrusion of LLDPE, LDPE, and HDPE polymers. It can also be useful as a pigment dispersion aid or color-flushing medium when preparing color concentrates with polyethylene and polypropylene. N-35 is slightly higher in viscosity and lower in melt

point than N-34. N-30 is significantly harder and higher in viscosity and melting point relative to N-34 and N-35. N-30 is commonly used as a paraffin wax modifier.

Epolene N-15

Epolene N-15 is a low-density, low viscosity polypropylene homopolymer. It has a relatively high softening point and exhibits great hardness. These features make it desirable as a paraffin wax modifier to improve blocking, scuff, and abrasion resistance. N-15 is also used in color concentrates and reprographic toner compounds. Its compatibility with plastic-grade

polypropylene provides improved pigment dispersing properties, especially for polypropylene fiber applications.

Epolene N-20, N-21, and N-22

Higher-density *Epolene N-20, N-21, and N-22* polymers exhibit higher softening points, improved solvent and oil resistance, and good hardness properties relative to other low molecular weight polyethylene polymers. Such properties make them useful in cosmetics, cable-filling/flooding compositions, and slip additives for printing inks and as modifiers for hot-melt highway marking.



N-20 is especially useful for improving production rates with extruded fractional melt, high-density polyethylene. Rates have been increased by as much as 31% without adversely affecting the physical properties of fabricated parts.

Because of its relatively high softening point and relatively low viscosity, N-21 is used as an additive to improve set speed in hot-melt adhesives. The higher density of N-21 makes it an excellent pigment dispersing aid for color concentrates used in HDPE.

Epolene N-22 has properties intermediate of N-20 and N-21. It is particularly useful in cable filling compositions.

***Epolene* C-10 and C-15**

Epolene C-10 and C-15 are low-density, highly branched, medium molecular weight polyethylene polymers that are particularly useful as base polymers in hot-melt adhesives and coatings for various paper and packaging materials. They differ primarily in their viscosity. Coatings produced using these products exhibit high gloss, low moisture vapor transmission rates, and good heat-sealing properties. Both can also be useful as paraffin wax modifiers in slush molding, cast molding, candles, oil-based inks, and investment castings.

The low-density, low softening point and good lubrication properties of C-10 and C-15 allow them to be widely used as low-cost processing aids in rubber compounding. These same properties also provide dispersing and processing advantages in color and additive concentrates.

***Epolene* C-13, C-14, and C-17**

Epolene C-13, C-14, and C-17 polymers differ from C-10 and C-15 primarily in viscosity. They are typically used with paraffin wax and lower molecular weight polymers as

viscosity modifiers. Increased viscosity can be of importance for controlling penetration of the coatings into paper substrates and to improve cohesive strength in hot-melt adhesives.

Blending these *Epolene* polymers with paraffin wax offers improved grease resistance, higher blocking temperatures, better scuff resistance, and improved gloss. They can also be used as additives for inks and as base polymers for color concentrates. For example, *Epolene* C-17 polymer commonly replaces granular, linear low-density polyethylene (LLDPE) as the base polymer in many color concentrates because it's easier to process and has higher output rates.

C-14 and C-17 are lawful for use [21 CFR 177.1520(c)(2.1)] in all noncooking, food-contact applications including films, bottles, and coatings. The finished food-contact surfaces are subject to extractability limitations imposed by other regulations pertaining to specific uses. They are also lawful for use in manufacturing ion-exchange membranes intended for use in the production of grapefruit juice where the finish membranes must be manufactured as set forth by the regulations and limitations in regulation 21 CFR 173.20.

***Epolene* C-16 and C-18**

Epolene C-16 and C-18 polymers are maleic anhydride-modified polymers of low molecular weight polyethylene.

They differ primarily in their viscosity. When used as hot-melt coatings for paper, they provide a good glossy barrier coating that may be readily heat-sealed to many paper products, metal foils, and polyolefin films.

In paraffin wax coating formulations, C-16 and C-18 provide good gloss retention, scuff resistance, improved blocking resistance, superior wet corrugated crush strength and, in certain formulations, good heat sealability. Because of their functionality, these modified polyethylene polymers provide good wetting and dispersing properties for highly filled compositions. Both are also useful as dispersion aids for aluminum pigment concentrates with polyethylene and polypropylene. C-18 has also been very useful as an additive in basecoat/clearcoat automotive paints to impart improved metal flake orientation.

Because of their maleic anhydride functionality, C-16 and C-18 have a strong affinity for nylon, allowing them to be excellent dispersing aids for amide-based fluorescent pigments used in polyolefin color concentrates. In hot-melt adhesive formulations, their increased functionality allows for improved adhesion, greater filler tolerance, broader compatibilities, and improved aging properties. Unlike conventional polyethylene, these modified polyethylene polymers are compatible with most polyamides used in hot-melt formulations.



Packaging

Epolene polymers are supplied as free-flowing pellets, packaged in multiwall paper bags with a polyethylene-coated inner liner [22.67 kg (50 lb) net weight]. The bags are palletized and stretch-wrapped to prevent contamination during storage and shipment. Many *Epolene* polymers are also shipped in a variety of bulk containers.

Epolene E-14, E-20, E-43, C-10, C-13, C-16, C-17, and most *Epolene* N polymers are available in powder form.

For specific information on bulk shipments or availability of powder forms, contact your Eastman representative.



Typical Properties of *Epolene* Polymers^a

Product	Polymer Type	Ring & Ball Softening Point, °C	Mettler Drop Point, °C ASTM D3954-94	Penetration Hardness, dmm ASTM D5 ^b	Density @ 25°C, g/cm ³	Acid No.	Brookfield Thermosel Viscosity, cP				Melt Index 190°C	Gardner Color (Molten)	Yellowness Index	Molecular Weight		Cloud Point, °C ^c
							125°C (257°F)	140°C (284°F)	150°C (302°F)	190°C (374°F)				M _w	M _n	
Coating Grade—Highly Branched Medium Molecular Weight																
C-10	PE	102	103	3	0.906	<0.05	18,600	16,650	8,200	3,550	2,250	1	—	35,000	7,700	77
C-13	PE	110	137	3	0.913	<0.05	—	—	—	—	190	1	—	76,000	12,000	81
C-14	PE	>133	>133	2	0.918	<0.05	— ^d	—	—	—	1.6	1	—	143,000	18,000	84
C-15	PE	101	101	4	0.906	<0.05	8,950	6,100	4,200	1,800	4,200	1	—	17,000	6,700	75
C-16	Ma-PE	102	103	3	0.908	2	16,650	10,000	8,100	2,850	1,700	1	—	26,000	5,600	78
C-17	PE	133	>133	2	0.917	<0.05	— ^d	—	—	—	19	1	—	100,000	14,000	81
C-18	Ma-PE	101	101	4	0.905	2	7,750	5,000	4,100	1,550	4,200	1	—	15,000	5,700	71
Nonemulsifiable—Low Molecular Weight																
N-10	PE	108	110	2	0.925	<0.05	1,500	1,100	—	—	—	1	—	10,000	3,200	82
N-11	PE	107	111	2	0.921	<0.05	350	250	—	—	—	1	—	6,000	2,000	80
N-14	PE	108	108	3	0.920	<0.05	150	100	—	—	—	1	—	4,000	1,700	80
N-15	PP	163	164	<1	0.902	<0.05	— ^d	— ^d	— ^d	600	—	1	—	12,000	5,000	104
N-20	PE	119	119	<1	0.930	<0.05	7,000	4,300	3,725	—	—	1	—	15,000	5,500	86
N-21	PE	120	121	<1	0.950	<0.05	600	400	350	—	—	1	—	6,500	2,800	87
N-22	PE	118	118	<1	0.943	<0.05	580	410	380	—	—	1	—	6,500	2,700	—
N-30	PE	110	110	2	0.924	<0.05	1,050	700	—	—	—	1	—	9,200	2,600	—
N-34	PE	103	104	5	0.910	<0.05	450	300	—	—	—	1	—	6,200	2,200	76
N-35	PE	103	104	3	0.913	<0.05	700	—	—	—	—	1	—	7,580	2,580	—
Emulsifiable—Oxidized Low Molecular Weight																
E-10	PE	106	105	2	0.942	17	800	525	—	—	—	1	—	6,100	1,700	—
E-14	PE	104	104	4	0.939	17	225	160	—	—	—	1	—	3,600	1,300	—
E-15	PE	100	100	7	0.925	17	350	200	—	—	—	1	—	4,200	1,400	—
E-16	PE	102	105	4	0.943	17	700	500	—	—	—	1	—	5,500	1,450	—
E-17	PE	100	104	4	0.941	24	500	—	—	—	—	1	—	4,200	1,050	—
E-20	PE	111	112	<1	0.960	17	1,500	900	—	—	—	1	—	7,500	1,600	—
Chemically Modified PP																
E-25	Ma-PP	157 ^e	160	<1	0.921	25	— ^d	— ^d	— ^d	300	—	4	36	12,000	4,000	—
E-43	Ma-PP	157 ^e	160	<1	0.934	45	— ^d	— ^d	— ^d	300	—	8	51	9,100	3,900	—
G-3003	Ma-PP	158 ^e	174	<1	0.912	9	— ^d	— ^d	— ^d	60,000	—	—	25	52,000	27,200	—
G-3015	Ma-PP	156 ^e	170	<1	0.913	15	— ^d	— ^d	— ^d	25,000	—	—	40	47,000	24,800	—

^aTypical properties are reported for information only. These figures are average values for typical production material and should not be construed as specifications.

^bNeedle under 100-g load for 5 s @ 25°C, tenths of mm

^c2% in 54°C (130°F) paraffin

^dSolid at this temperature

^eDSC T_m, °C

<i>Epolene N Polymer</i>							<i>Epolene E Polymer</i>							<i>Epolene G Polymer</i>	
	N-20	N-21	N-22	N-30	N-34	N-35	E-10	E-14	E-15	E-17	E-20	E-25	E-43	G-3003	G-3015
to Direct Food Contact															
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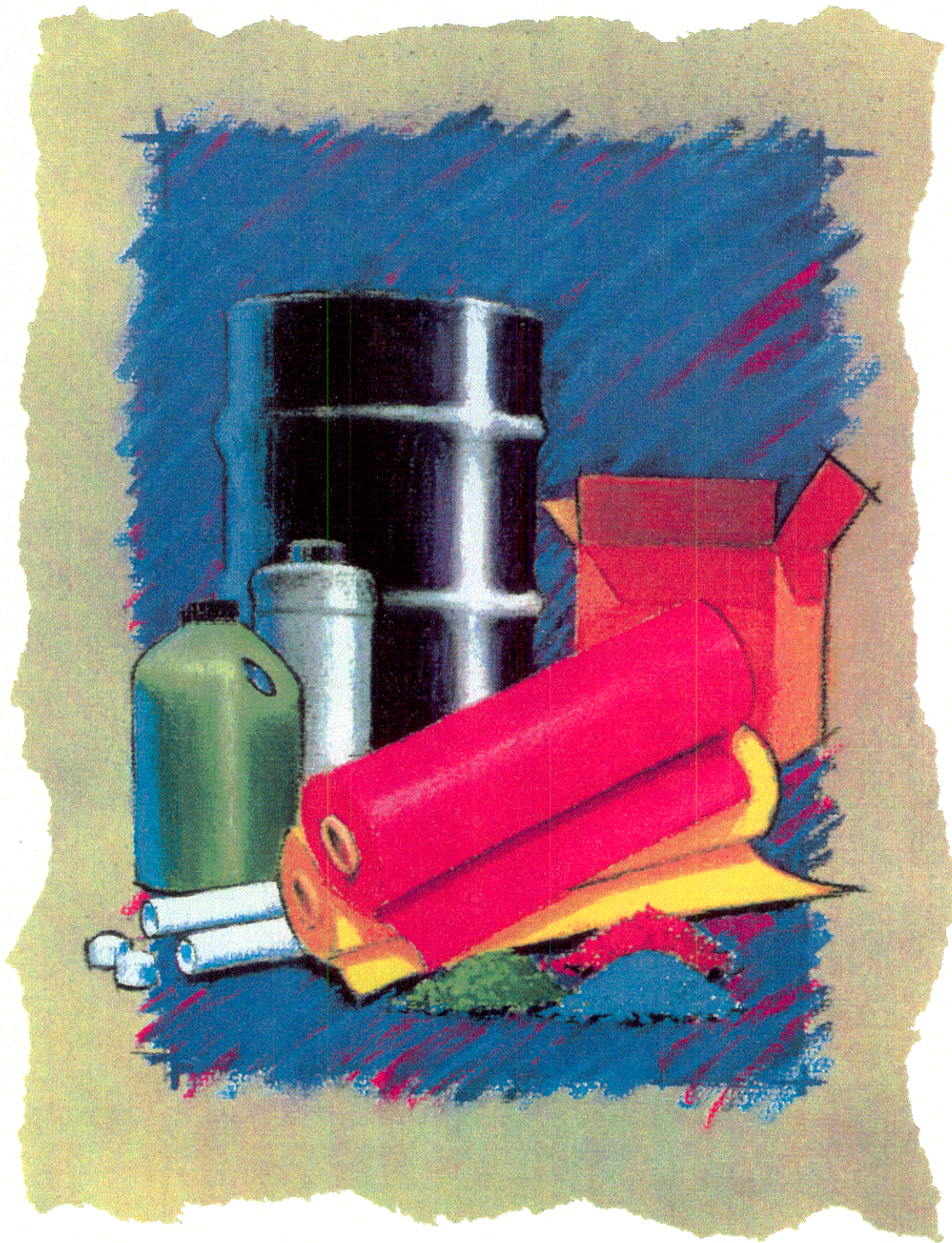
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Epolene Waxes



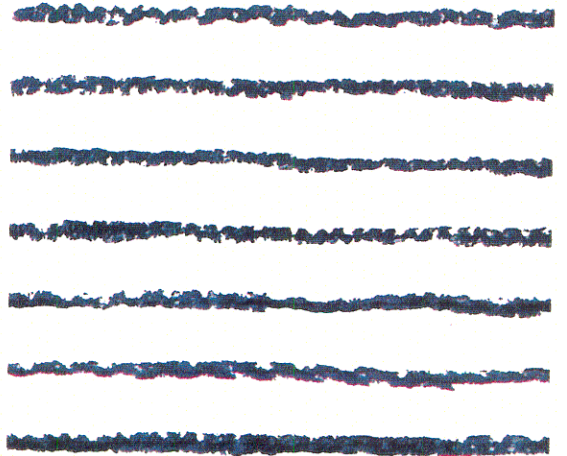
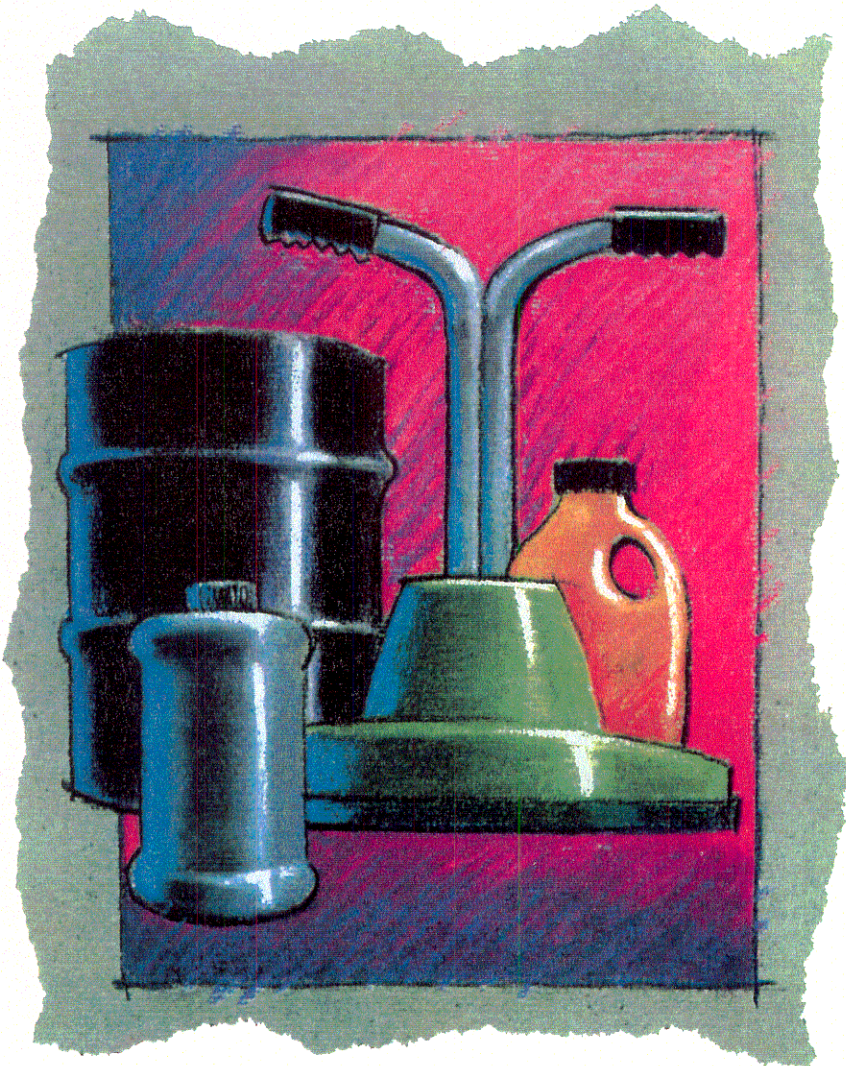
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EASTMAN



Epolene Waxes

Low-Molecular-Weight
Polyolefin Resins
for
Industrial Applications



Emulsifiable Waxes

- **Epolene E-10**

An oxidized homopolymer developed for water-emulsion floor polishes, *Epolene E-10* imparts excellent slip resistance, outstanding toughness, and good durability to polish films. These properties are often apparent at low wax concentrations; however, they are best observed where *Epolene E-10* wax represents 20% or more of the total solids in the polish.

Emulsions of *Epolene E-10* wax may be used as finishing agents for cotton and synthetic fabrics, and as textile softeners in conjunction with wash-and-wear finishing waxes.

Emulsions prepared with *Epolene E-10* may be used as lubricants in clay coatings for paper to reduce dusting during calendering.

- **Epolene E-14 and Epolene E-15**

These are oxidized homopolymers with lower densities and softening points than *Epolene E-10* wax. These properties contribute greatly to their versatility and ease of emulsification by the wax-to-water or pressure emulsification methods.

Epolene E-14 wax imparts excellent slip resistance to floor polish films. Best results are obtained when *Epolene E-14* is used in concentrations of 20% or less, or in polishes containing natural and synthetic waxes.

Epolene E-14 in powdered form (*Epolene E-14P*) is also useful as a lubricant in processing rigid and flexible polyvinyl chloride and as a processing aid for preparing color concentrates.

Epolene E-15 is the softest of the *Epolene* emulsifiable waxes and is used at low concentrations in mixed-wax emulsions and high-polymer floor polishes to improve slip resistance.

- **Epolene E-20**

Epolene E-20 wax is a low-molecular-weight, medium-density, oxidized polyethylene wax with exceptional hardness and low color. This product has a low softening point and low viscosity that give it the desirable emulsification properties of a low-density wax.

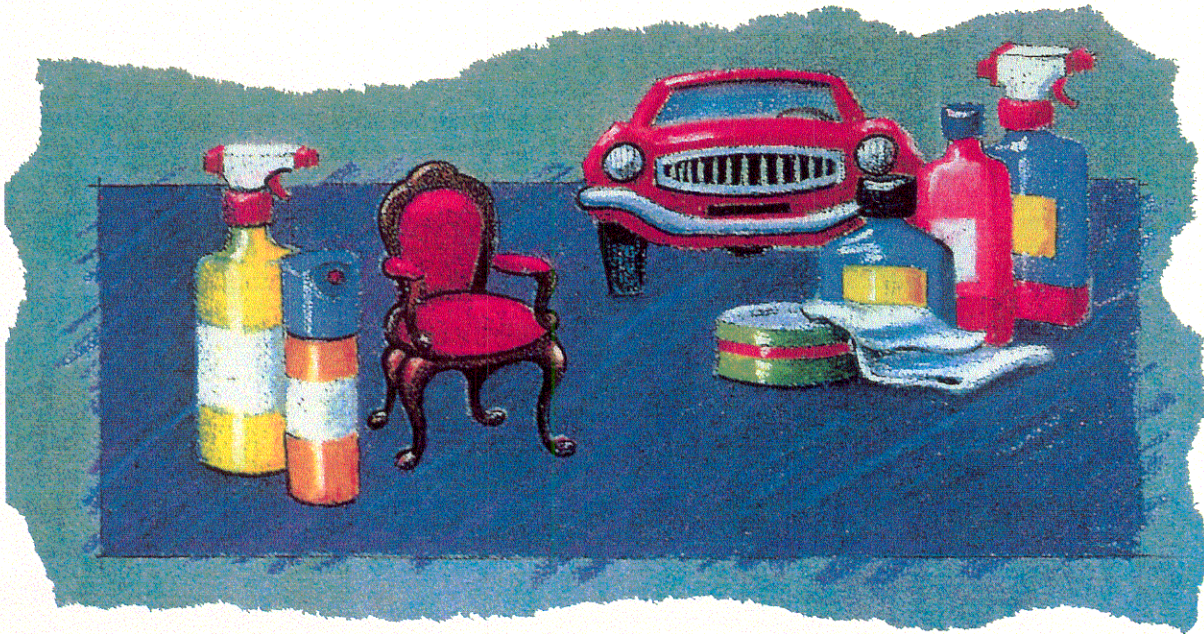
Epolene E-20 wax is an excellent performer in high-speed, buffable floor polish, textile lubricant/softener, and fruit coating applications. In powder form, it is also useful as an extrusion lubricant for clear, rigid PVC compounds.

The higher density and softening point of *Epolene E-20* wax make it particularly attractive for use in emulsions for coating citrus fruit. These properties contribute to the hardness, short drying time, and excellent gloss of the coatings.

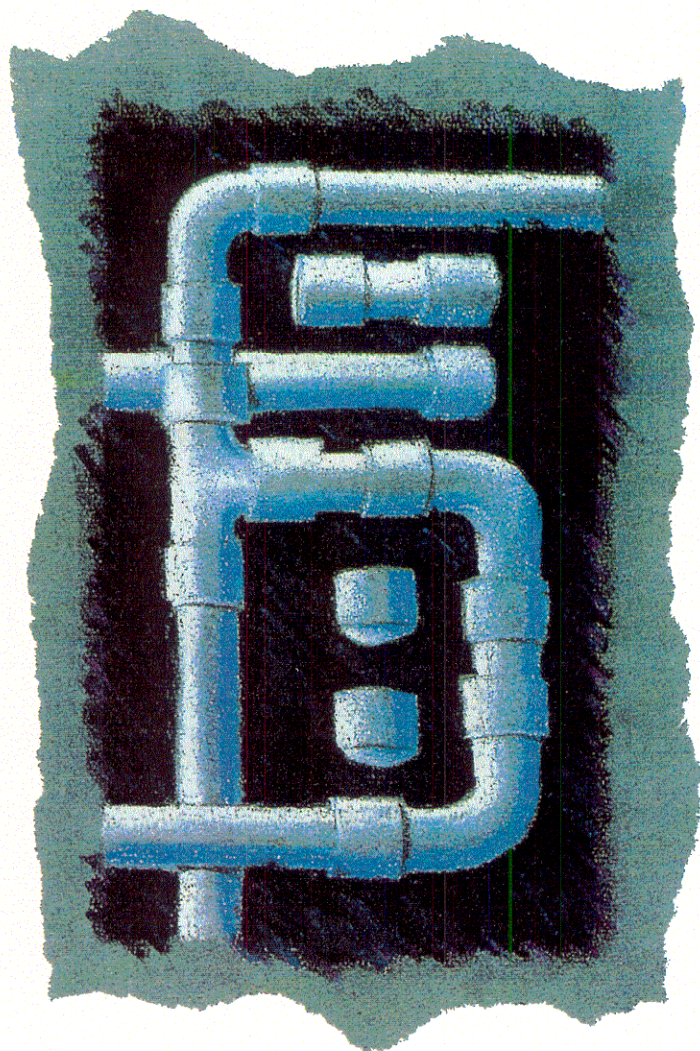
- **Epolene E-43**

Epolene E-43, a chemically modified polypropylene with the greatest hardness and highest softening point of all the emulsifiable *Epolene* waxes, imparts outstanding slip resistance to floor polishes.

Epolene E-43 is also used as a coupling additive for filled polypropylene to increase tensile, modulus, and heat deflection temperature of molded parts. Because of its polarity and available anhydride functionality, *Epolene E-43* is useful as a compatibilizer in many plastic alloy systems. For the same reasons, *Epolene E-43* acts as a pigment dispersant and processing aid for single plastic systems, such as ABS.



Epolene waxes are important ingredients in various polishes.



Epolene waxes are effective internal and external lubricants for PVC pipe extrusion, including pipe meeting National Sanitary Foundation requirements.

Nonemulsifiable Waxes

- ***Epolene N-10***

A nonemulsifiable, medium-density, relatively low melting point homopolymer, *Epolene N-10* wax is easily melt-blended with natural or synthetic waxes to improve tensile strength, abrasion resistance, and adhesion to fibrous substrates.

For paper coating applications such as folding cartons, *Epolene N-10* increases paraffin wax mileage and provides a glossy, scuff-resistant finish. *Epolene N-10* is also used in printing inks to improve resistance to scuffing and rub-off. The low coefficient of friction characteristics and good wetting properties enable *Epolene N-10* to act as a processing aid and pigment dispersant for polyolefin color concentrates.

- ***Epolene N-11, Epolene N-14, and Epolene N-34***

These *Epolene N* waxes are lower in molecular weight and density than *Epolene N-10*. Their applications are similar to those for *Epolene N-10* wax, but they offer advantages where wax modifiers with lower viscosities and cloud points are needed.

Epolene N-11, N-14, and N-34 waxes are also used as mold release additives and lubricants in rubber processing and as extrusion and calendaring aids for vinyl. Powder forms are used as dispersing aids for color concentrates going into plastic applications.

- ***Epolene N-15***

Epolene N-15 is a low-density, low-viscosity polypropylene homopolymer. This wax has a high softening point and exhibits great hardness. These features make it useful as a modifier for paraffin waxes to increase resistance to blocking, scuff, and abrasion, and as a component for hot-melt adhesives.

Epolene N-15 is also used in color concentrates and reprographic toner compounds. Its good compatibility with plastic-grade polypropylene provides improved pigment dispersing properties, especially for polypropylene fiber applications.

- ***Epolene N-20 and Epolene N-21***

These higher-density *Epolene N* waxes exhibit higher softening points, improved resistance to solvents and oils, and good hardness. Such properties make them useful in cosmetics, hot-melt adhesives, dispersing aids for color concentrates, cable filling compositions, slip additives for printing inks, and modifiers for hot-melt highway marking.



Nonemulsifiable Waxes

- ***Epolene C-10 and Epolene C-15***

These low-density waxes were developed for use in hot-melt coatings for paper and packaging materials. Coatings produced with *Epolene C-10/C-15* waxes or blends containing these waxes exhibit high gloss, low moisture vapor transmission rates, good grease resistance, and good heat sealability. *Epolene C-10* or *C-15* can also be used as a paraffin modifier in slush molding, cast molding, candles, oil-based inks, hot-melt adhesives, and investment castings.

The low density, low softening point, and good lubricating properties allow *Epolene C-10* and *C-15* waxes to be widely used as low-cost processing aids for rubber compounding. These same properties also provide dispersing and processing advantages in color concentrates.

- ***Epolene C-13, Epolene C-14, and Epolene C-17***

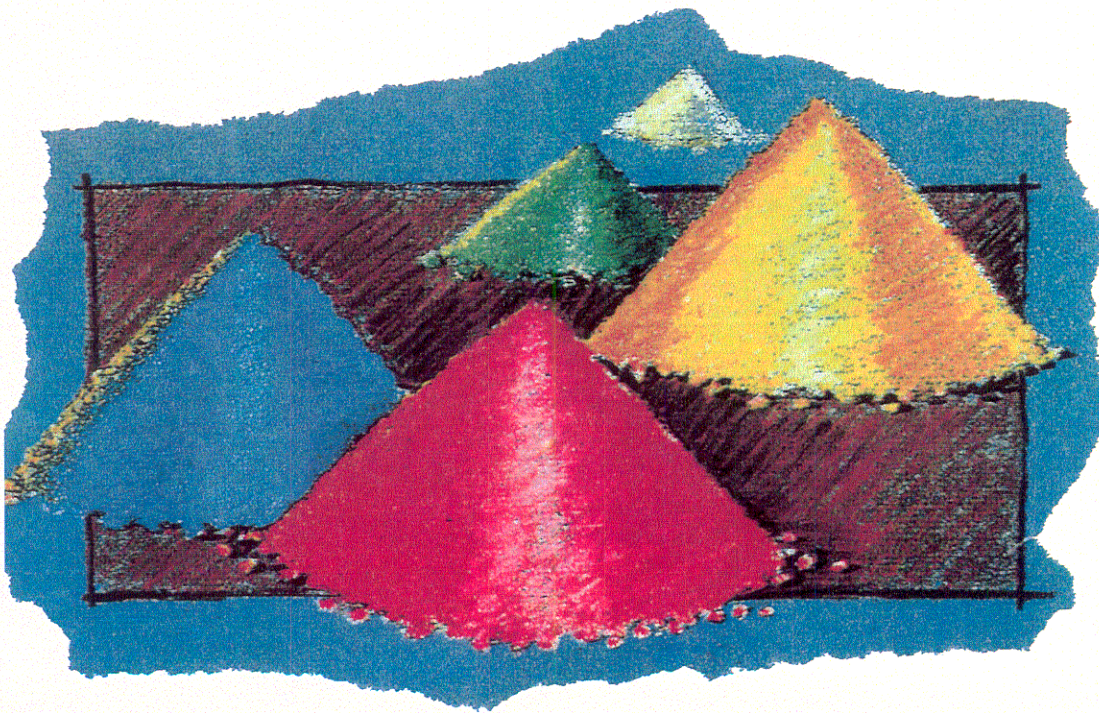
These waxes were developed for use in combination with the other *Epolene* waxes or in blends containing lower-molecular-weight materials. As paraffin wax modifiers, these three *Epolene* waxes increase blend viscosity, which is important for controlling penetration of the coating into paper substrates.

Blends of these *Epolene* waxes with paraffin wax offer improved grease resistance, higher blocking temperatures, better scuff resistance, and improved gloss. Other uses are as additives for inks and ingredients in hot-melt adhesives. These medium-to-high-molecular-weight, low-density polyethylenes are used extensively as base polymers for color concentrates. In fact, *Epolene C-17P* has replaced granular linear-low-density polyethylene (LLDPE) as the base polymer in many color concentrates because of easier processing and higher output rates.

- ***Epolene C-16 and Epolene C-18***

Epolene C-16 and *C-18* waxes are graft polymers of polyethylene and maleic anhydride with a low amount of functionality. As a hot-melt coating for paper, *Epolene C-16* and *C-18* waxes provide a glossy barrier coating that may be readily heat-sealed to most paper products, metal foils, and polyolefin films.

In paraffin wax coating formulations, *Epolene C-16* and *C-18* provide good gloss retention, scuff resistance, and in certain formulations, heat sealability. As an additive in paraffin-copolymer coatings, *Epolene C-16* and *C-18* can provide increased hot tack, scuff resistance, and gloss stabilization. Because of their functionality, these waxes provide good wetting and dispersing properties for highly filled compositions. *Epolene C-18* is also useful as an additive in basecoat/clearcoat automotive paints to impart improved metal flake orientation.



Epolene waxes are widely used in preparing color concentrates and additive master batches. A wide range of grades functions as dispersing aids, lubricants, and base resins in various polymer systems.



Wax blends containing Epolene waxes are used to coat paper plates, paper cups, drinking straws, and florist paper.

Better Processes and Products With *Epolene* Waxes

- **Viscosity Modification**

Epolene waxes include a broad range of products with a low, medium, or high melt viscosity. This makes them excellent viscosity modifiers for plastics, adhesives, elastomers, and natural or synthetic wax blending.

- **Barrier Properties**

Epolene waxes are insoluble in water and resistant to greases and many chemicals. They can be used in hot melts, aqueous emulsions, and/or as solution/solvent dispersions.

- **Surface Appearance**

Addition of selected *Epolene* waxes to formulated or compounded plastics improves gloss and surface appearance of the finished products.

- **Antiblocking Action**

Epolene waxes are added to a variety of coating formulations to prevent parts that are coated with the formula from sticking together.

- **Lubricity Improvement**

Because of a low coefficient of friction and a wide range of compatibility, *Epolene* waxes are often added to formulated or compounded materials to improve surface lubricity, slip, and release properties.

- **Abrasion Resistance**

Outstanding toughness and the low coefficient of friction of *Epolene* waxes make them excellent additives to improve abrasion resistance for a wide variety of formulated coating materials.

- **Additive Dispersion**

Low melt viscosity and good compatibility of *Epolene* waxes improve dispersion of pigments, fillers, and other additives in plastics and rubber formulations.

- **Solvent and Oil Gelation**

Epolene waxes offer excellent gelling and solvent retention properties with a wide variety of fats, oils, waxes, and solvents.

- **Coatings**

In coatings *Epolene* waxes are useful as:

Hot-melt coatings or emulsion coatings on paper, providing high gloss and excellent barrier properties.

High-gloss emulsion coatings for citrus fruits to maintain freshness and flavor of the fruit by reducing moisture loss and shrinkage.

Coatings/laminations of paper for packaging materials to include winding of fiber drums.

Components in hot-melt coatings that are more durable than paint for marking highway surfaces.

Temporary protective coatings for metal parts.

Scuff-resistant emulsion coatings for glass bottles.

Flattening agents for lacquers and enamel paints.

Ingredients in sprayable herbicide and insecticide formulations used on foliage; emulsions of *Epolene* wax improve the wetting and spreading characteristics.

- **Hot-Melt Adhesives**

Base polymers for hot-melt adhesives, C-type *Epolene* waxes produce bonds with excellent high and low temperature resistance. The adhesives may be formulated to exhibit excellent machinability properties with most hot-melt adhesive application systems and to have excellent bond-peel strength properties.

- **Inks**

Dispersions and emulsions of *Epolene* wax are added to solvent and waterborne inks to improve resistance to rub-off, increase slip to the printed surface, and reduce offset. The emulsions are compatible with many acrylic polymers used in formulating inks for the water-based market.

- **Plastics Additives**

As dispersion aids, *Epolene* waxes have unique wetting and dispersion characteristics for highly filled compositions and color concentrates.

Chemically modified *Epolene* E-43 wax functions as a coupling agent for many filled or reinforced plastics to improve processability and surface characteristics. This highly functional polymer is also useful as a compatibilizer for various polymer alloy systems.

As a processing aid for linear-low-density polyethylene (LLDPE), *Epolene* N-34 increases throughput of LLDPE with conventional LDPE extrusion equipment.

Epolene waxes function as external and/or internal lubricants for rigid and flexible PVC (polyvinyl chloride) to include the extrusion of rigid PVC pipe for potable water.

- **Paper**

As a lubricant for clay coatings applied to paper, *Epolene* E waxes outperform many calcium stearate dispersions by providing increased lubricity during calendaring. The use of *Epolene* wax dispersions in clay coatings allows for higher processing speeds, less dusting, and higher gloss.

- **Personal Care Products**

By offering high-temperature properties, chemical resistance, water resistance, and inertness, *Epolene* waxes are functional in a variety of cosmetic and personal care products.

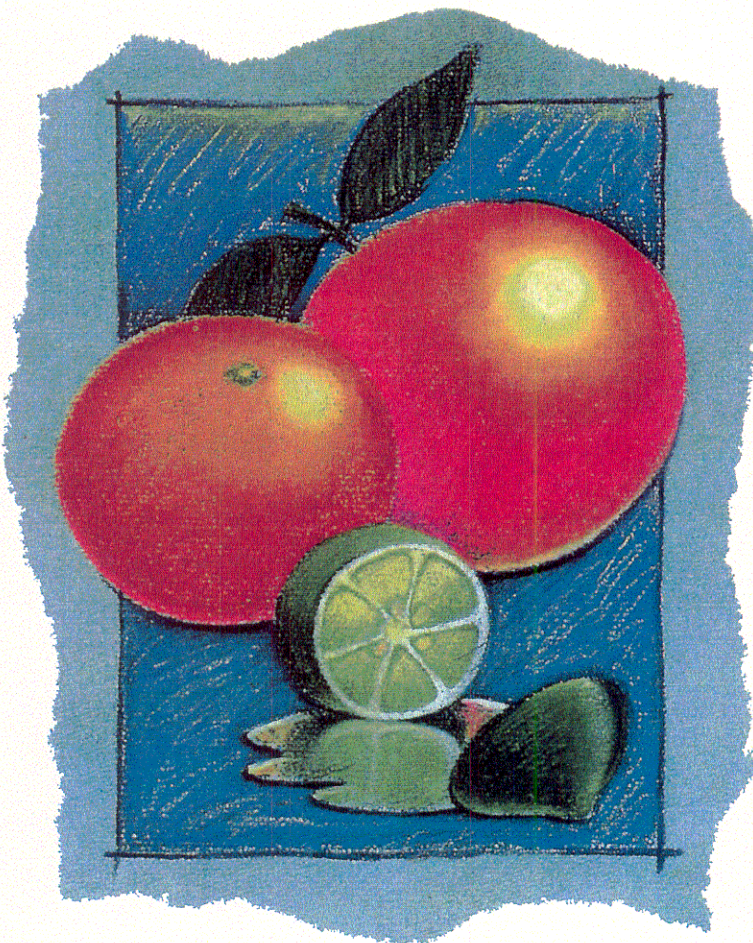
- **Polishes**

Liquid Floor Polish. Emulsions based on *Epolene* E waxes may be used in industrial or household floor polish formulations to selectively improve slip resistance, hardness, scuff resistance, durability, gloss, water resistance, leveling, buffability, and color.

Vinyl Car Top Polish. An emulsion of *Epolene* E wax added to polishes for vinyl car tops gives added luster or sheen and long-lasting protection to the vinyl surface.

Detergent-Resistant Polish for Automobiles. These creamy polishes clean and wax weathered finishes in a single application. Excellent gloss and film hardness are imparted by the addition of a relatively small quantity of *Epolene* E wax.

Spray-and-Wipe Furniture Polish. Developed for use in manually operated, pump-type dispersers, a spray-and-wipe furniture polish based on *Epolene* E wax is easy to apply, imparts excellent luster, and serves as a good dusting aid.



Emulsions of Epolene waxes are effective moisture barriers for citrus fruits.

- **Rubber**

As a processing aid for nitrile, butyl, SBR, EPDM, and neoprene rubber, *Epolene* waxes improve the mixing of recipe ingredients, decrease shrinkage, and reduce tackiness during processing.

- **Textiles**

Emulsions based on *Epolene* E waxes are effective as softeners and lubricants for natural and synthetic fibers and improve abrasion resistance, tear resistance, hand, and sewing lubricity of both resin and nonresin finished fabrics.

- **Wax Blends**

As an additive for candles and crayons, *Epolene* waxes provide gloss, sheen, opacity, and good mold release properties.

Petroleum wax coating formulations may be modified with *Epolene* waxes to provide gloss retention, scuff resistance, improved "hold-out," and in certain formulations, heat sealability. Specific applications include coatings for corrugated board, folding cartons, carbon paper, and a variety of other paper products.

As an ingredient in cable filling formulations, *Epolene* waxes increase the melting point and hardness.

- **High Softening Point**

The wide selection of *Epolene* waxes have softening points ranging from 100° to 163°C.

- **Hardness**

Penetration hardness values range from 0.1 to 7.0 tenths of a mm at 25°C. *Epolene* waxes retain more hardness at elevated temperatures than most natural waxes and paraffin waxes.

- **Melt Viscosity**

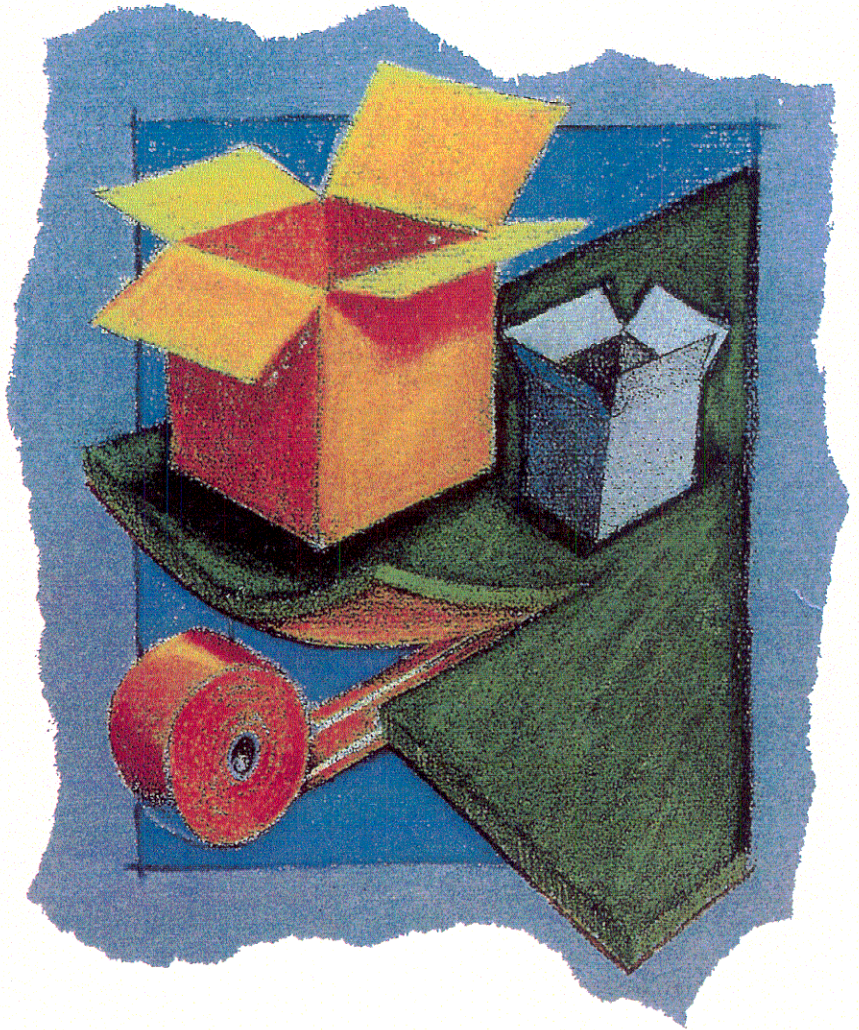
Epolene waxes offer a broad selection of low-, medium-, and high-viscosity. Each product is manufactured under a narrow viscosity range specification.

- **Toughness**

Epolene waxes are tougher than most natural waxes and many synthetic waxes.

- **Compatibility**

Epolene waxes are compatible with many polymers, resins, natural waxes, and synthetic waxes.



Adhesives based on Epolene waxes are used for carton closure and carpet seaming tape.

- **Lubricity**

In a variety of plastics and chemical processes, *Epolene* waxes function as internal and/or external lubricants.

- **Moisture and Grease Resistance**

Epolene waxes are insoluble in water which results in good moisture resistance. They are also resistant to grease and many other chemicals.



Emulsifiable Waxes					
	E-10	E-14	E-15	E-20	E-43
Ring and ball softening point, °C	106	104	100	111	157
Penetration hardness, 100 g/5 sec/ 25°C, tenths of mm	2	4	7	<0.5	<0.5
Density, g/cc @ 25°C	0.942	0.939	0.925	0.960	0.934
Acid number	15	16	16	17	47
Brookfield Thermosel viscosity, ^a cP (mPa·s)					
@ 125°C (257°F)	800	225	350	1,500	— ^b
140°C (284°F)	525	160	—	—	— ^b
150°C (302°F)	—	—	—	800	— ^b
190°C (374°F)	—	—	—	—	400
Color, Gardner scale	2	2	2	2	11
Molecular weight, GPC					
M _w	6,100	3,600	4,200	7,500	9,100
M _n	1,700	1,300	1,400	1,600	3,900

^aConventional Brookfield viscosity = $\approx 1.15 \times$ Brookfield Thermosel viscosity ^bSolid at this temperature

Availability of Powdered Waxes

Epolene E-14, E-20, E-43, C-10, C-13, C-16, C-17 and most N-type *Epolene* waxes are available in powdered form. For specific information about powdered *Epolene* waxes, contact your Eastman representative.

Nonemulsifiable Waxes														
	N-10	N-11	N-14	N-15	N-20	N-21	N-34	C-10	C-13	C-14	C-15	C-16	C-17	C-18
Ring and ball softening point, °C	111	108	106	163	119	120	103	104	110	>133	102	106	133	102
Penetration hardness, 100 g/5 sec/25°C, tenths of mm	2	2	3	0.6	0.1	<0.1	5	3	3	2	4	3	2	4
Density, g/cc @ 25°C	0.925	0.921	0.920	0.902	0.930	0.950	0.910	0.906	0.913	0.918	0.906	0.908	0.917	0.905
Acid number	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	5 ^a	<0.05	5 ^a
Brookfield Thermosel viscosity, ^b cP (mPa·s)														
@ 125°C (257°F)	1,500	350	150	— ^d	—	—	450	—	—	— ^d	—	—	— ^d	—
150°C (302°F)	—	—	—	— ^d	3,725	350	—	7,800	—	—	3,900	8,500	—	4,000
190°C (374°F)	—	—	—	600	—	—	—	—	—	—	—	—	—	—
Melt index (@ 190°C)	—	—	—	—	—	—	—	2,250	200	1.6	4,200	1,700	20	4,200
Color, Gardner scale	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Molecular weight, GPC														
M _w	10,000	6,000	4,000	12,000	15,000	6,500	6,200	35,000	76,000	143,000	17,000	26,000	100,000	15,000
M _n	3,200	2,000	1,700	5,000	5,500	2,800	2,200	7,700	12,000	18,000	6,700	5,600	14,000	5,700
Cloud point, ^c °C	82	80	80	104	86	87	76	77	81	84	75	78	81	71

^aSaponification number ^bConventional Brookfield viscosity = $\approx 1.15 \times$ Brookfield Thermosel viscosity ^c2% in 130°F paraffin ^dSolid at this temperature

Note: Reported for information only. These figures are average values for typical production material and should not be construed as specifications.

Packaging

Epolene waxes are supplied as free-flowing pellets, packaged in multiwall paper bags with a polyethylene-coated inner liner [22.67 kg (50 lb) net weight]. The bags are palletized and stretch-wrapped to prevent contamination during storage and shipment. *Epolene* waxes are also shipped in a variety of bulk containers. Several *Epolene* waxes are offered in powder form.

For specific information about bulk shipments or *Epolene* waxes available in powder form, contact your Eastman representative.

For Additional Information

During the past 3 decades, *Epolene* waxes have received widespread acceptance for use in many applications, as described in this publication. Eastman representatives welcome all opportunities to discuss the use of *Epolene* waxes in these or other potential applications.

For the assistance of an Eastman technical representative or for more information on the use of *Epolene* waxes, please contact Eastman as listed on the back cover of this publication.

The C- and N-type *Epolene* waxes are compatible with many natural and synthetic waxes and resins. These values were obtained from melt-blend studies. The major component of the blend was melted at

149°C (300°F), and the minor component was added slowly with agitation. Incompatibility was evidenced by the formation of a hazy melt or a phase separation on cooling.

Compatibility of *Epolene* Waxes With Various Resins and Waxes

Wax or Resin	Type	Ratio of <i>Epolene</i> N Waxes to Wax or Resin			Ratio of <i>Epolene</i> C Waxes to Wax or Resin			Suppliers
		1:3	1:1	3:1	1:3	1:1	3:1	
<i>Acrawax</i> "C"	Synthetic wax	I ^a	I	C	I	I	C	Glyco Chemicals, Inc.
<i>Acryloid</i> B-72	Polyacrylate	I	I	I	I	I	I	Rohm and Haas Company
<i>Amberol</i> 750	Fortified rosin	I	I	I	I	I	I	Rohm and Haas Company
Bayberry	Vegetable wax	C	C	C	C	C	C	— ^b
Beeswax	Insect wax	C	C	C	C	C	C	— ^b
Candelilla	Vegetable wax	H	H	H	H	H	H	— ^b
<i>Carbowax</i> 6000	Polyethylene glycol	I	I	I	I	I	I	Union Carbide Corp. Chemicals & Plastics
Carnauba	Vegetable wax	C	C	C	C	C	C	— ^b
<i>Cellolyn</i> 104	Pentaerythritol ester of rosin	I	I	I	I	I	I	Hercules, Inc.
<i>Chlorowax</i> 70	Chlorinated paraffin	I	I	C	I	I	C	Diamond Shamrock Corp.
<i>Crown</i> 1035	Microcrystalline wax	C	C	C	C	C	C	Petrolite Corporation
<i>Eastotac</i> H-100	Hydrocarbon resin	C	C	C	C	C	C	Eastman Chemical Company
<i>Eastotac</i> H-115	Hydrocarbon resin	C	C	C	C	C	C	Eastman Chemical Company
<i>Eastotac</i> H-130	Hydrocarbon resin	C	C	C	C	C	C	Eastman Chemical Company
<i>Epolene</i> C	Polyolefin wax	C	C	C	—	—	—	Eastman Chemical Company
<i>Epolene</i> E	Polyolefin wax	C	C	C	C	C	C	Eastman Chemical Company
<i>Epolene</i> N	Polyolefin wax	—	—	—	C	C	C	Eastman Chemical Company
Ester gum 8L	Glycerol ester of rosin	I	I	I	I	I	I	Hercules, Inc.
Japan wax	Vegetable wax	C	C	C	C	C	C	— ^b
<i>Lewisol</i> 33	Maleic alkyd-modified rosin wax	I	I	I	I	I	I	Hercules, Inc.
Mineral oil	Hydrocarbon oil	C	C	C	C	C	C	— ^b
Montan	Mineral wax	C	C	C	C	C	C	— ^b
<i>Neville</i> R-29	Coumarone-indene	C	C	C	C	C	C	Neville Chemical Company
<i>Neville</i> R-52	Styrenated coumarone-indene	I	I	I	I	I	I	Neville Chemical Company
<i>Neville</i> LX-1000	Hydrocarbon	C	C	C	C	C	C	Neville Chemical Company
Oleic acid	Aliphatic acid	C	C	C	C	C	C	— ^b
<i>Oronite</i> 128	Polybutene	H	C	C	H	C	C	Chevron Chemical Company
Ouricury	Vegetable wax	I	I	I	I	I	I	— ^b
Ozokerite	Mineral wax	C	C	C	C	C	C	— ^b
<i>Paracin</i> 1C	Ethylene glycol monomethyl ether ricinoleate	I	I	I	I	I	I	Baker Castor Oil Company
Paraffin	Petroleum wax	C	C	C	C	C	C	— ^b
<i>Piccopale</i> 100	Hydrocarbon	C	C	C	C	C	C	Hercules, Inc.
<i>Pliolite</i> S-5	Styrene-butadiene	I	I	I	I	I	I	Goodyear Tire and Rubber Co., Inc.
Stearic acid	Aliphatic acid	C	C	C	C	C	C	— ^b
<i>Staybelite</i>	Hydrogenated rosin	C	C	C	C	C	C	Hercules, Inc.
Sugar cane	Vegetable wax	C	C	C	C	C	C	— ^b
<i>Uformite</i> F-240	Urea-formaldehyde	I	I	I	I	I	I	Rohm and Haas Company
<i>Uformite</i> MM55	Melamine-formaldehyde	I	I	I	I	I	I	Rohm and Haas Company
<i>Vinsol</i>	Wood rosin fraction	I	I	I	I	I	I	Hercules, Inc.

^aC—clear and homogeneous; H—hazy, some incompatibility; I—incompatible, separates

^bSeveral sources

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