INEOS Oligomers

Indopol® Polybutene | Product Bulletin

indopol
polybutenes

Indopol polybutenes | table of contents

Indopol® polybutenes are synthetic hydrocarbon polymers made by polymerization of C4 olefins (primarily isobutene), and are available in a wide range of viscosities. All Indopol grades are colorless, practically non-toxic, and exhibit little or no odor. They are non-drying and do not leave residues when volatilized or thermally decomposed. They are hydrophobic, can easily be emulsified, and are resistant to oxidation by light and moderate heat. The higher viscosity grades are also tacky. This combination of physical properties and uniquely wide range of products makes Indopol polybutenes extremely versatile – rest assured, there's a grade that's just right for your application requirements.

Indopol polybutenes possess an olefinic double bond at the end of each molecule that makes them amenable to many chemical derivatisation reactions. This allows yet more applications, such as fuel and oil additives and emulsion stabilizers. Alternatively, if high chemical stability and very low odor and taste are essential (as in personal care applications) then Panalane® is the ideal choice. Panalane is Indopol polybutene that has been hydrogenated to remove the double bonds – otherwise the properties are similar to those of the parent polymer.

This brochure describes the physical properties and some of the many applications of Indopol polybutenes. Samples of Indopol and Panalane, and more detailed literature on specific applications are available via our website at www.indopolpib.com or from INEOS Oligomers Sales and technical service centers, addresses for which can be found at the end of this brochure.

Indopol polybutenes are uniquely versatile liquid polymers. They are ideal for a wide range of applications - from oil additives to sealants, from lubricants to cling film, from coatings to adhesives. Global availability, comprehensive grade range, high product quality and world-class customer service and technical support – these are all reasons why Indopol polybutenes are the polymers of choice for your application.

Indopol polybutenes | characteristics

INEOS Oligomers is a leading merchant supplier of polybutenes, with world-scale plants on two continents. This ensures global availability and reliable sourcing, as well as the high product quality and excellent service that customers expect from INEOS Oligomers. Expert technical support is readily available in the Americas, Europe, and Asia to help customers worldwide make the most cost effective use of Indopol and Panalane in their products.

The driving force behind our polybutene business is to meet customers' needs and provide value by producing and selling the broadest product range to allow customers, whatever their application, to find the polybutene that meets their needs. INEOS Oligomers offer is also differentiated with a number of commercial and logistics services such as the capability to accept customer orders 24 hours a day 7 days a week through Orders Online. For larger customers the benefits from vendor inventory management may be available in some areas.

Indopol polybutenes have many useful properties. For instance, they are:

- Permanently non-drying
- Colorless (water white) and non-staining
- Soluble in a wide range of organic solvents
- Compatible with a wide range of organic materials
- Completely hydrophobic
- Tacky
- Emulsifiable
- Excellent electrical insulators
- Good lubricants
- Non-corrosive
- Practically non-toxic and non-ecotoxic
- Stable to light and air (i.e. oxidatively stable) under ambient conditions
- Reactive by virtue of their olefinic end-group

Indopol polybutenes also exhibit:

- Very low moisture transmission rates
- Low to negligible evaporation loss at ambient temperature
- High viscosity indices
- Low pour points
- Complete depolymerization at elevated temperature leaving no residues

Many of these properties are discussed in more detail in later sections of this brochure.

Indopol polybutenes | applications

Indopol polybutenes are produced at manufacturing sites at Whiting, Indiana, and Lavera France. The company has a very long association with the manufacture and use of polybutenes which has resulted in considerable knowledge and experience being accumulated in a wide range of applications. This knowledge is used by our Technical Service group to assist our customers to make the most cost effective use of Indopol polybutene.

Indopol polybutenes | lubricants

Traditionally, polybutenes have been used to improve the performance of automotive and industrial oils by virtue of their good thickening power and excellent shear stability. As health, safety and other environmental aspects of lubricants become increasingly important, polybutenes are a particularly good choice, since they exhibit very low deposit formation and low toxicity. Unlike conventional lubricants, polybutenes depolymerize cleanly when heated above about 200°C leaving little or no residue. (The thermal degradation properties are discussed in detail in the Physical Properties section of this brochure.) Applications that can take advantage of these properties include low smoke/clean burning two-stroke oils, non-staining metal working lubricants, bearing lubricants, specialist compressor lubricants, and low toxicity/energy efficient gear oils and greases.

Two-stroke fuels and lubricants

Indopol polybutenes have been shown to be a cost-effective way of achieving low smoke performance in two-stroke engines, as well as bringing other significant benefits including clean burning, reduced corrosion and scoring, and the elimination of engine deposits. Consequently manufacturers of two-stroke engines are increasingly specifying formulations containing polybutene, especially as concern about air pollution continues to grow in countries with large motorcycle populations.

Polybutenes are now an integral component of two-stroke oils formulated to meet JASO and global performance specifications. These performance specifications seek to assure the modern image of the two-stroke engine and address the growing environmental pressure to reduce smoke emission from exhaust systems. They also aim to standardize the quality of lubricant available for use in engines, world-wide. The specifications cover oils used in motorcycles, scooters, chainsaws, snowmobiles and agricultural equipment.

Gear and hydraulic oils

The excellent shear stability, friction reduction (as evidenced by 4-ball wear tests) and high viscosity index of the higher molecular weight grades of Indopol are of particular benefit in the formulation of high quality, energy efficient gear and hydraulic oils. Unlike many high molecular weight polymers, Indopol polybutene is not degraded by high shear – indeed tests have shown that Indopol grades from L-14 to H-18000 are as shear stable as any lubricant of comparable molecular weight.

Indopol polybutenes can be dissolved in oil (mineral oil, polyalphaolefin) for use as viscosity index improvers and for multigrade gear oils. Please contact us for more information on these products.

Indopol polybutenes are inherently good lubricants and have physical properties that make them highly suitable for a large variety of lubricant applications. The extensive range of Indopol grades, with viscosities from solvent-like to semi-solid at room temperature, gives the formulator considerable scope to devise and optimize lubricant formulations.

Indopol polybutenes | lubricants

Metalworking lubricants

Polybutenes are widely used as lubricants for metalworking, including can making, automotive applications (cutting, stamping, etc.), hot or cold rolling, drawing and brazing, tube extrusion and rust prevention. The ability of polybutene to depolymerize at high temperature and the absence of sulfur and nitrogen containing species, helps to obtain a clean and unblemished surface finish to the metal. Unlike conventional oils degreasing is not necessary prior to annealing, thereby helping to reduce processing costs.

Emulsions of Indopol polybutene (and Panalane hydrogenated polybutene) are also effective lubricants for non-ferrous metals. Typically, emulsions are preferred where large quantities of frictional heat must be removed. Polybutene emulsions do not need solvents for cleaning and therefore can help reduce VOC emissions. They can be formulated with biocides, corrosion inhibitors, coupling agents and demulsifiers to obtain the required performance characteristics. The inherent extreme pressure (EP) properties of polybutene emulsions make them particularly beneficial for working with aluminium. Since water and surfactants present in some emulsions may cause stains, individual applications may require evaluation of special surfactants if staining is a concern. For information on formulating polybutene emulsions contact us via our website at www.indopolpib.com.

Lubricants containing Indopol polybutene (or polybutene emulsions) are used in several applications where incidental food contact can result, such as the production of aluminium and steel foils and cans. The chemical stability of Panalane hydrogenated polybutene makes it an ideal choice for applications that require a clean, non-oxidizing lubricant with low odor and no taste, such as food and beverage cans. More details about Panalane can be found later in this brochure.

Soap-based gels/greases

Indopol polybutenes can be converted to a gel by incorporating a metal soap such as aluminum stearate. Greases can be made using Indopol with calcium, lithium or aluminum soaps in a heated grease mixer, for use in plain and anti-friction bearings. Polybutenes control the consistency of the grease and, more importantly, provide protection against water wash-off. This is especially important in greases for heavy-duty construction equipment, chain drives and other applications requiring a grease that clings to metal and resists spin-off.

Compressor oils

Indopol polybutenes are widely used either alone or in combination with other oils, as lubricants for the barrels of the compressors that are used to generate the high pressures of ethylene gas required in the manufacture of LDPE. Polybutenes help provide the necessary high pressure sealing, continuous film forming and oxidation resistance properties needed. They have limited volatility, and will fully meet typical requirements regarding high purity, low moisture content, low deposit formation and inertness, which are important parameters for these lubricants.

Indopol polybutenes | oil and fuel additives

In engine oils, chemical derivatives of Indopol polybutenes are widely used as dispersants to control deposits and prevent oil thickening and sludge formation. These dispersant additives have environmental benefits, since they allow longer oil drain intervals and can improve fuel economy. They are amphiphilic molecules, wherein the hydrophobic polybutene "tail" is attached chemically to a hydrophilic "head group". An example of such a dispersant is polybutenyl succinimide. This is made by reacting polybutene with maleic anhydride to give polybutenyl succinic anhydride (PIBSA), which is then reacted with a polyamine to make the succinimide. PIBSA derivatives are also used as stabilizers in emulsion explosives for mining.

Polybutene-based fuel additives such as polybutenyl amines are widely used in gasoline engines to reduce deposit formation and to remove deposits already present in carburetors, fuel injectors and intake system, and on valves and pistons. They are also used in diesel fuel to help clean fuel injectors and hence improve fuel economy.

Indopol polybutenes | adhesives

Indopol polybutenes are vital ingredients in many pressure-sensitive adhesives (PSAs) and hot-melt adhesives (HMAs). They are very useful for modifying properties such as the tack, softness, bond strength, cohesive strength and water resistance of adhesives.

The advantages offered by polybutenes when compared to mineral oils include: low color and excellent color stability, good resistance to oxidation, practically no toxicity, and a wide range of viscosities. More significant, however, is the ability of the highly tacky grades (e.g. Indopol H-300 and H-1900) to partially or totally replace relatively expensive tackifier resins, thereby reducing formulation costs. Polybutenes are used to modify a variety of polymers and rubbers in adhesive formulations, exhibiting excellent compatibility with the non-polar types. Polybutenes can also be used in polar rubbers such as nitrile and polychloroprene, but the addition of natural rubber may be necessary to improve the compatibility.

Pressure-sensitive adhesives

In laboratory studies of PSAs, polybutene improved the quick stick and peel strength of elastomers such as polyisobutene, styrene-isoprene-styrene block copolymers, and styrene-butadiene rubber. Polybutene also improved the tack of styrene-butadiene-styrene block copolymer, natural rubber and synthetic rubber. Raw material costs can be lowered as polybutene partially replaces tackifiers used in pressure sensitive adhesives formulations. On top of this, Indopol polybutenes are pure, clear, practically non-toxic polymers and can be used in special pressure sensitive applications for the pharmaceutical industry. Examples of these adhesives which can be improved with polybutene include: adhesives for paper laminates, masking and friction tapes; surgical tapes; transdermal drug patches; labels & tapes, colorless adhesives; cements for leather; paper, foil and fiber lamination; and industrial tapes.

Polybutene emulsions made using nonionic surfactants decrease the organic vapor emissions in water-based PSAs. These emulsions offer enhanced adhesion and temperature stability and can lower adhesive costs for packaging, labels, and product assembly.

Hot-melt adhesives

When incorporated into hot melts, polybutene acts as a polymer extender, plasticizer, tackifier and wetting agent. Polybutene decreases the melt index and increases the cold temperature flexibility. Compatible adhesive resins include butyl rubber, styrene-isoprene-styrene copolymers, ethylene vinyl acetate, polyurethane, and low density polyethylene. The major applications for these HMAs include packaging, disposable soft goods, book binding, carton sealing, carpet, shoes, and furniture.

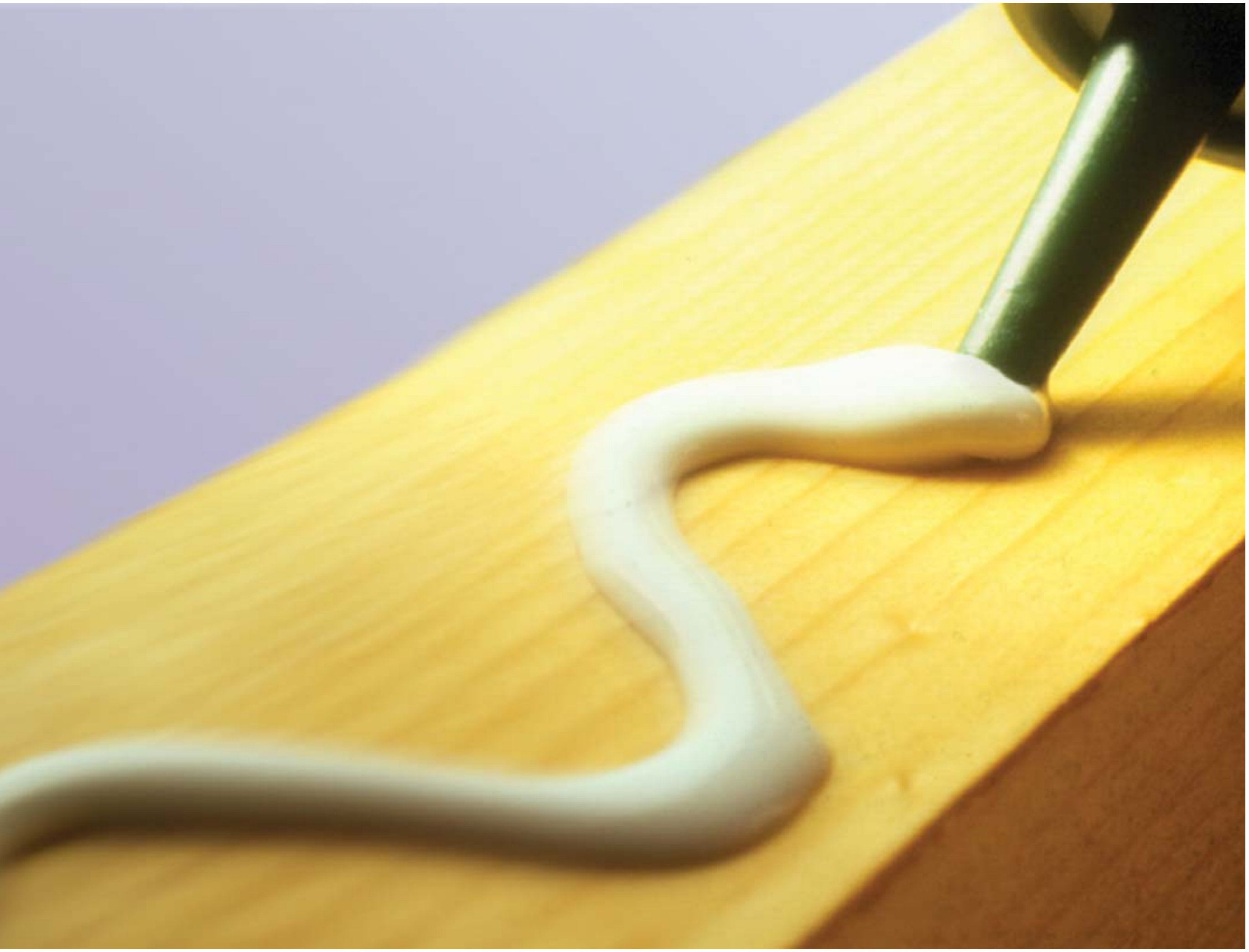
In multi-layer food packaging applications, a barrier resin bonds to a substrate which can be rigid or flexible. Co-extrusion of the adhesive tie layer, barrier resin, and substrate bonds the dissimilar resins during processing. Polybutene improves the tack and adhesion of the tie layer and can reduce formulation costs. Food packaging applications using a hot melt extrudable adhesive include cups, trays, plates, bags, and lid films.

Hot-melt pressure-sensitive adhesives

Indopol polybutene plasticizes many elastomers used in hot melt pressure sensitive adhesives. Examples include natural rubber, styrene-butadiene rubber, alpha olefin, and butyl rubber.

Polybutene enhances the tack and quick-sticking properties of thermoplastic elastomers which exhibit negligible inherent tack. Adjusting the relative concentration of polybutene can tailor hot melt PSAs for a variety of end uses.

Indopol polybutenes | sealants and putties



Indopol polybutenes plasticize and add tack to elastomer-based sealants. Incorporation of polybutene results in a softer, more easily extruded sealant. Such sealants can be applied from an application gun without using large proportions of solvents, or extruded into tape form supported on removable backing paper. The reduction in solvent content of the sealants minimizes the shrinkage of the product after application.

Indopol polybutenes are widely used as partial replacements for drying oils in sealant and putty formulations. Their incorporation can give permanence, improved adhesion and cohesion and ageing, less shrinkage and lower oil to filler ratios.

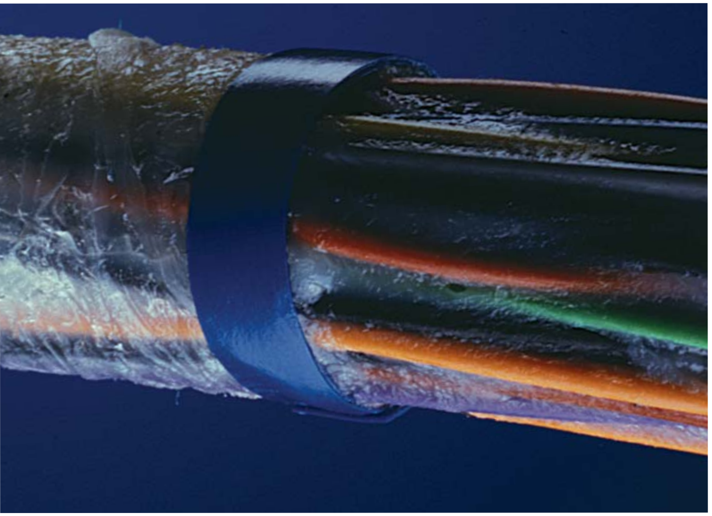
Combinations of butyl rubber and Indopol H-6000/H-18000 are used in sealants for double glazed window systems, and other applications where low moisture vapor transmission is important. They are suitable for use as both primary and secondary sealants in typical window glazing units. Sealants based on thermoplastic elastomers are another area where Indopol polybutene can offer advantages.

In high performance silicone sealants low molecular weight polybutenes such as Indopol L-8 can be employed as a partial replacement/extender for silicone oil, which can result in cost savings without detracting from the properties of the sealant. Clear sealants based on polybutene have outstanding peel adhesion and good ageing characteristics, and are also more translucent than commercial silicone, acrylic or thermoplastic elastomer sealants.

Indopol polybutenes | electrical and fiber-optic cables

Indopol polybutenes have significant advantages over mineral oils in electrical applications. The composition and quality of mineral oils varies with the origin of the crude oil from which they are derived. In contrast, polybutenes are synthetic products and therefore have properties within a very narrow specification range.

Impregnant for dielectrics
Indopol polybutenes are used as paper and fabric impregnants for wire insulation. The insulation may be applied in tape form, with glass or quartz fibers embedded in the solid polybutene.



Cable oils
Pipe oils in extremely high voltage conductors can be made from polybutene. An Indopol polybutene was selected as the primary pipe oil for the first commercial under-ground 345kV transmission line because of its low chloride content and power factor stability on ageing.

Cable gels and potting compounds
Blends of polybutene and polyolefin waxes produce semi-solid gels which can be used as potting compounds and flooding and filling compounds for copper and fiber-optic cables. The gels act as a moisture barrier and corrosion inhibitor when used to flood the area between the layers of composite metal-plastic sheath in telecommunication cables, or to fill the interstitial space in the cable core. The adhesive quality contributed by the polybutene helps to prevent slippage between layers of the cable sheaths.

Cable insulation
When combined with a halogenated flame retardant, butyl rubber plasticized with polybutene can be used as an electrical insulator. Foamable polyethylene plasticized with polybutene can also be used as an insulator. Polytetrafluoroethylene (PTFE) films or fabrics of glass or other inorganic fabric treated with PTFE can be coated on one side with a pressure-sensitive adhesive based on polybutene. These fabrics can be used to form anti-corrosive, anti-stick insulations.

Indopol polybutenes are non-conductive and hydrophobic, and thus are ideally suited for a variety of electrical insulation applications. Their chemical structure and low chloride content, as well as low levels of impurities, make them highly resistant to oxidation and gas evolution under electrical stress.

Indopol polybutenes | tackified polyethylene films

Polybutenes are ideally suited as tackifiers of linear low density polyethylene (LLDPE). They can be employed in the production of LLDPE/polybutene masterbatches for subsequent conversion to film, or more typically added directly to the LLDPE during the film extrusion process. The major areas of application for tackified LLDPE are pallet stretch wrap, bale silage wrap, and hand wrap. The films exhibit good clarity, durability and cling properties. Owing to their very low toxicity, some grades of Indopol polybutene can also be employed as a tackifier for domestic cling films (food wraps).

The Indopol technical service team can advise our customers on direct addition of polybutene to extruders, and on cling film evaluation - contact us via our website at www.indopolpib.com.

In film processing operations, polybutene can improve resin melt flow, and improve film properties such as elongation, tear resistance, haze, impact strength and low temperature flexibility.

Indopol polybutenes | agriculture

Indopol polybutenes are used in the continuing fight against pests which threaten agricultural crops. Low viscosity grades are used as pesticide and insecticide carriers where the slight tackiness of the polybutene increases the effectiveness of the active ingredient. Higher viscosity grades of polybutene find application as adjuvants for improving the rainfastness of water-soluble herbicides and pesticides. Polybutenes are preferred to other carrier oils because they are free from any aromatic hydrocarbons, and have the consistent quality necessary for formulating ultra low volume sprays.

Polybutenes can be used to enhance the effectiveness of insecticide-coated granules. The polybutene is used to provide an adhesive coating to the pre-formed limestone granule which acts as a sticker for the powdered insecticide. The hydrophobic property of the polybutene maintains the integrity of the granule over a period of time when in use, providing a slow release mechanism for the active ingredient.

Sticky blends of polybutenes with waxes, resins and/or rubbers are used to physically trap pests such as small insects. For example, yellow cards coated with sticky blends are commonly used to trap insects in greenhouses. When polybutene is mixed with low molecular weight polyethylene, a tacky gel is formed which can be used for tree banding to trap tree climbing pests.

Indopol polybutenes | asphalt, polymer and rubber modifications

Asphalt modification

The incorporation of polybutenes into asphalt improves weathering, flexibility, and adhesion in a number of uses such as roofing felts and shingles as well as foundation coatings. Asphalts modified with polybutene can also be used in road construction to give improved low temperature flexibility and better aggregate/binder adhesion.

Automotive undercoatings that deaden sound and protect against corrosion are sometimes based on asphaltic compounds. The addition of certain grades of polybutene improves low temperature flexibility and adhesion. The undercoat must be applied to a clean, dry surface to ensure good adhesion.

Asphalt emulsions with TPE rubber latex can be plasticized with polybutene emulsions. These materials are quick drying and have good cold crack resistance.

Polymer modification

The impact strength, flexibility, and melt flow rate of many thermoplastic resins can be increased with Indopol polybutenes. Polybutenes plasticize polypropylene, polystyrene, ethylene-vinyl acetate copolymer resins, ester gums, and polyterpene.

In crystal polystyrene, polybutenes improve melt flow better than mineral oil while maintaining higher strength and heat deflection temperature. The environmental stress crack resistance (ESCR) of high impact polystyrene (HIPS) to fats and oils can be improved by addition of polybutene. Since most Indopol grades have food contact approval, this is particularly advantageous for applications of HIPS in food packaging and serving containers. Polybutenes also improve the ESCR of polyphenylene ether/HIPS alloys to gasoline and hydrocarbon solvents, while increasing impact strength and maintaining a high level of heat deflection temperature. These properties are important in automotive applications of these alloys.

Polypropylene random and impact copolymers modified with polybutenes have higher melt flow rates, greater elongation, and improved impact strengths. In filled and reinforced polypropylene, polybutene can be used to “wet” the fillers and aid processing. In polypropylene homopolymer film applications, polybutene improves tear resistance, flexibility, clarity and gloss properties. Tear strength can be improved by 100% or more by incorporation of polybutenes.

Polybutenes can significantly increase the izod impact strength of acrylonitrile-butadiene-sytrene (ABS) resins, while maintaining heat deflection temperature and increasing melt flow rate. Polybutenes have also been used in ethylene-propylene diene monomer (EPDM)/polypropylene compounds to increase impact strength. These materials are useful as roofing compounds.

Rubber modification

Indopol polybutenes are used as extenders and plasticizers for a variety of vulcanized elastomers including natural rubber, butyl rubber, polyisoprene, polybutadiene, ethylene-alpha olefin rubber and styrene-butadiene rubber (SBR). Unlike mineral oil, polybutenes cannot be easily extracted from vulcanized elastomers by solvents, and are resistant to exudation by heat ageing. Hence polybutenes impart their properties permanently to the rubber.

Roofing and pipe wrap compounds made from butyl rubber or EPDM modified butyl rubber can be plasticized with Indopol polybutenes. These compounds show excellent tensile strength, elongation, low temperature flexibility and color/UV stability.

In addition, polybutenes are compatible with the elastomeric portion of thermoplastic block copolymers such as butylene-ethylene-styrene block copolymer. In low concentrations, polybutenes soften and plasticize such elastomers. At higher levels, polybutenes contribute tack and adhesion.

Indopol polybutenes | coatings

Indopol polybutenes are used as a component in many special purpose paints and coatings. Their advantages in such applications include water resistance, low color, plasticization of the final film, excellent adhesion, and ability to replace volatile solvents.

Polybutenes are employed in hot applied thermoplastic road marking paints where they improve low temperature performance and skid resistance, and give excellent color stability. They have also been used in masonry paints as an alternative to chlorinated plasticizer and can give a number of performance benefits such as improved whiteness, excellent durability and ageing, improved brushability and excellent rust and corrosion resistance.

When applied to porous substrates such as wood or concrete, both solvent-based formulations and water-based emulsions of Indopol polybutene provide waterproofing protection. They can reduce swelling, shrinkage and splitting of wood, and protect against the effects of freeze-thaw cracking, salts and chemicals on brick and concrete.

Polybutene emulsion formulations can lower manufacturing costs and improve water repellency relative to commercial acrylic-based systems. Low VOC polybutene emulsion starting formulations for wood and concrete sealers have been demonstrated in our laboratory. These formulations provide water repellency comparable to commercial low VOC systems. Optimization of these formulations could result in improved performance at lower costs than current commercial products.

Indopol polybutenes | personal care and emulsions

Personal care

Indopol polybutenes are pure, clear and practically non-toxic polymers, and most grades have regulatory approval for cosmetics applications. They are formulated into personal care products such as lip gloss and roll-on deodorants.

If very high chemical and oxidative stability, and very low odor and taste are essential then Panalane hydrogenated polybutene is the polymer of choice. Panalane is made via hydrogenation of Indopol polybutene to remove all the double bonds. Two grades of Panalane are offered:L-14E and H-300E. Apart from the absence of unsaturation (as evidenced by the very low bromine number) the physical properties of Panalane are similar to Indopol polybutenes, and they can be easily emulsified.

Panalanes are used to formulate many personal care products, where their very high purity makes them candidates to replace squalane, fatty esters, and other expensive oils. Panalanes are bright, clear, viscous liquids with outstanding feel, waterproofing properties and moisturizing ability. This makes them ideal for use in cosmetics, sunscreens, lip preparations, eye shadow, stick and roll-on deodorants, creams and lotions. Panalanes' economical price allows them to be used to upgrade the quality of personal care products currently formulated with mineral oils.

Laboratory tests show that Panalane is non-irritating to eyes and skin, non-comedogenic, and non-toxic when ingested.

Polybutene emulsions

All grades of Indopol polybutene can be emulsified to produce both water-in-oil (invert) and oil-in-water emulsions using a variety of anionic, cationic and non-ionic surfactants. Oil-in-water emulsions in particular provide an easy and cost-effective method of using polybutenes in a wide variety of applications, including lubricant, paper, textile, agricultural, wood sealer and adhesive products. This range of applications continues to expand as environmental and cost considerations drive the trend towards replacement of hydrocarbon solvents with water.

Polybutene emulsions are generally prepared by blending the surfactant with polybutene in a high shear mixer, then slowly adding water. Heavier grades of polybutene must be heated to enable efficient mixing. Details of emulsion preparation methods and example formulations are available upon request by contacting our technical experts via our website at www.indopolpib.com.

Indopol polybutenes | miscellaneous applications

The versatility of Indopol polybutenes
Indopol polybutenes have a unique combination of properties that makes them ideally suited for a huge range of different applications, some more of which are described below.

In the construction industry, very light grades of polybutene are used as concrete mold release agents where, as well as giving much improved non-staining performance, they also confer benefits compared with traditional mineral oils.

Polybutenes are used in the construction board industry for controlling dust in the forming process as well as giving additional water resistance properties. Other examples where polybutenes are used as a dust suppressant include land-fill coverings and synthetic tracks for horse racing.

Polybutenes are used to control the rheological properties of inks, resulting in improved processing and print image. They also offer an alternative to the naphthenic oil carriers traditionally used in printing inks, and have been used to improve the image quality and feel of carbon papers.

Paper can be made moisture and vapor resistant by treating with emulsions of Indopol polybutene in combination with a variety of materials such as latex, alkyd-coumarone indene and rosin ester dispersion, asphalt emulsions, and acrylic and methacrylate polymer and copolymer emulsions. These treated papers are flexible and offer excellent physical and optical properties. Waxes used for paper coatings can be toughened and plasticized by blending with polybutene.

Leather shoe soles impregnated with combinations of polybutene and resins have increased resistance to water and wear, and improved flexibility. Leather impregnated with polybutene is a popular material for sports grips for golf clubs, tennis racquets and gear shift knobs. The permanent inherent tackiness of polybutene provides significant performance advantages for these applications.

Just a few of the many and varied applications for Indopol polybutenes have been described above. There are many other quite specialized end uses where polybutenes provide the product formulator with the unique properties needed to meet demanding performance requirements. Our world-class technical service experts are available to advise customers on the development of new applications.

For more information or samples contact us via our website at www.indopolpib.com.

Indopol polybutenes | physical properties

Table 1: Specifications and typical properties

Indopol grade			L-2	L-3	L-6	L-8	L-14	L-50	H-7	H-8	H-15	H-25	H-35	H-50
Specifications properties	Method	ASTM number (if applicable)												
Viscosity (cSt):	Kinematic	D 445												
Min			3.0	3.9	5.8	13.5	24.0	94.0	11.0	14.5	27.5	48.5	70.0	100
Max			3.7	5.0	7.2	16.5	30.0	100.0	14.0	16.0	33.5	55.5	78.0	115
Temp (°C)			20	20	40	40	40	40	100	100	100	100	100	100
Color (Hazen), max	Pt-Co Scale	mod. D 1209	50	50	50	50	50	50	50	50	50	50	50	50
Flash Point (°C), min	Pensky-Martens Closed cup	D 93	65	65	82	82	115	115	115	115	115	125	125	135
Water (ppm), max	Coulimetric Karl-Fischer	E 1064	40	40	40	40	40	40	40	40	40	40	40	40
Appearance (clear & bright)	Visual	n/a	C&B	C&B	C&B	C&B	C&B	C&B	C&B	C&B	C&B	C&B	C&B	C&B
Typical properties														
Molecular weight (M_n)	Gel permeation chromatography	mod. D 3536	180	220	280	320	370	430	440	490	570	635	700	800
Polydispersity index (M_w/M_n)	Gel permeation chromatography	mod. D 3536	-	-	1.10	1.65	1.30	1.70	1.80	1.85	1.85	2.10	1.85	1.60
Flash point (°C)	Cleveland Open Cup	D 92	-	-	-	-	>138	>138	>145	>141	>141	>150	>154	>190
	Luchaire Closed Cup	NFT 60103	>40	>60	>60	>60	-	-	-	-	-	-	-	-
Turbidity (NTU)	Nephelometric	D 5180	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Acid number (mg KOH/g)	Titrimetric	D 974	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromine number (g Br_2/100g)	Titrimetric	IP 129/87	87	83	64	57	52	45	40	38	29	27	24	20
Bromine index (mg Br_2/100g)	Titrimetric	D 2710	-	-	-	-	-	-	-	-	-	-	-	-
Chlorine (ppm)	X-Ray fluorescence	n/a	80	70	90	80	60	60	60	50	50	50	50	50
Metals (ppm):	Inductively coupled plasma spec.	n/a												
Na			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
K			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fe			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Specific gravity (at 15.5 °C)		D 1298	0.788	0.803	0.824	0.835	0.839	0.850	0.850	0.857	0.865	0.869	0.879	0.884
Glass transition temperature, T_g (°C)	Differential scanning calorimetry	n/a	-	-	-	-	-90.5	-	-	-	-	-	-	-
Pour point (°C)		D 97	< -60	< -60	< -60	< -60	-51	-40	-36	-35	-35	-23	-15	-13
Viscosity index		D 2270	-	-	-	-	60	-	90	-	90	-	90	-
Viscosity (SUS)	Kinematic	D 2161	36.9	40.6	47.1	76.5	136.5	450	67.8	80	142	241	341	500
Temp (°C)			20	20	40	40	40	40	100	100	100	100	100	100
Refractive index		D 1218	1.445	1.452	1.461	1.467	1.470	1.475	1.474	1.478	1.485	1.486	1.487	1.490
Total sulfur (ppm)	X-Ray Fluorescence	n/a	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

Summary of physical properties

The physical properties of all the Indopol and Panalane grades of polybutene are summarized in Table 1.

For non-specification properties the values quoted were obtained from samples of production materials, and are provided for guidance only.

Table 1: Specifications and typical properties

Indopol grade			H-100	H-300	H-1200	H-1500	H-1900	H-2100	H-6000	H-18000	Panalane L-14E	Panalane H-300E
Specifications properties	Method	ASTM number (if applicable)										
Viscosity (cSt):	Kinematic	D 445										
Min			**200**	**605**	**2300**	**2900**	**3900**	**3900**	**11100**	**36000**	**27**	**635**
Max			235	655	2700	3200	4200	4600	13300	45000	37	690
Temp (°C)			**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**38**	**99**
Color (Hazen), max	Pt-Co Scale	mod. D 1209	50	50	50	50	50	50	100	100	10	20
Flash Point (°C), min	**Pensky-Martens Closed cup**	**D 93**	**155**	**160**	**165**	**170**	**170**	**170**	**175**	**180**	**115***	**160***
Water (ppm), max	Coulimetric Karl-Fischer	E 1064	40	40	40	40	40	40	40	40	40*	40*
Appearance (clear & bright)	**Visual**	**n/a**	**C&B**	**C&B**	**C&B**	**C&B**	**C&B**	**C&B**	**C&B**	**C&B**	**C&B***	**C&B***
Typical properties												
Molecular weight (M_n)	Gel permeation chromatography	mod. D 3536	910	1300	2100	2200	2500	2500	4200	6000	370	1300
Polydispersity index (M_w/M_n)	**Gel permeation chromatography**	**mod. D 353**	**1.60**	**1.65**	**1.80**	**1.75**	**1.80**	**1.85**	**1.80**	**1.70**	**1.30**	**1.65**
Flash point (°C)	Cleveland Open Cup	D 92	>210	>240	>250	>250	>270	>270	>275	>280	>138	>235
	Luchaire Closed Cup	**NFT 60103**	-	-	-	-	-	-	-	-	-	-
Turbidity (NTU)	Nephelometric	D 5180	<4	<4	<4	<4	<4	<4	<4	<4	<2	<3
Acid number (mg KOH/g)	**Titrimetric**	**D 974**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	**<0.1**	**<0.1**
Bromine number (g Br_2/100g)	Titrimetric	IP 129/87	16.5	12	9	8	6.5	6.5	4	3	-	-
Bromine index (mg Br_2/100g)	**Titrimetric**	**D 2710**	-	-	-	-	-	-	-	-	**1000****	**1000****
Chlorine (ppm)	X-Ray fluorescence	n/a	40	60	130	100	100	-	-	-	<1	<1
Metals (ppm):	**Inductively coupled plasma spec.**	**n/a**										
Na			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
K			**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**
Fe			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Specific gravity (at 15.5 °C)		**D 1298**	**0.893**	**0.904**	**0.906**	**0.908**	**0.912**	**0.912**	**0.918**	**0.921**	**0.825**	**0.885**
Glass transition temperature, T_g (°C)	Differential scanning calorimetry	n/a	-69.6	-66.9	-	-64.6	-	-	-	-	-	-
Pour point (°C)		**D 97**	**-7**	**3**	**15**	**18**	**21**	**21**	**35**	**50**	**-51**	**2**
Viscosity index		D 2270	125	173	242	250	267	267	306	378	-	170
Viscosity (SUS)	**Kinematic**	**D 2161**	**1025**	**2950**	**11650**	**14230**	**18850**	**19800**	**56800**	**188500**	**138**	**2930**
Temp (°C)			100	100	100	100	100	100	100	100	40	100
Refractive index		**D 1218**	**1.494**	**1.497**	**1.502**	**1.502**	**1.504**	**1.504**	**1.505**	**1.508**	**1.464**	**1.498**
Total sulfur (ppm)	X-Ray Fluorescence	n/a	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5

* = not specification properties for Panalane

** = specification property for Panalane

Indopol polybutenes | viscosity

Viscosity

Indopol polybutenes are available in a wide range of viscosities to meet the needs of many applications.

The variation of polybutene viscosity with temperature is shown in Figure 1.

Figure 1: Viscosity of Indopol polybutenes in centistokes

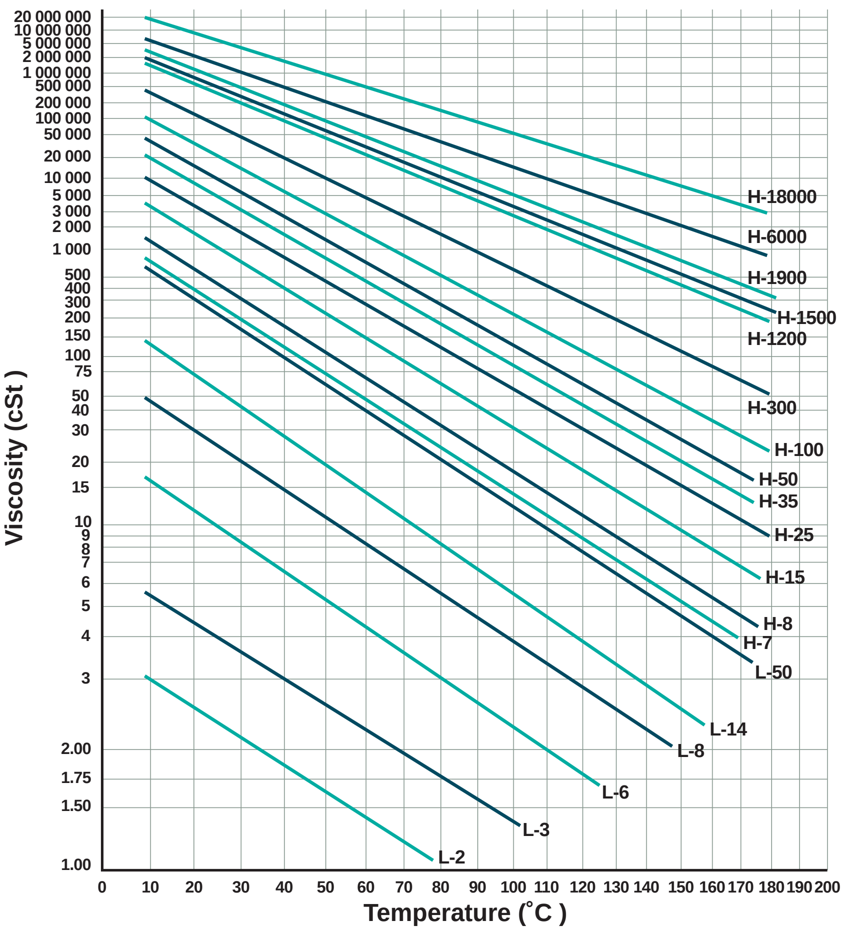
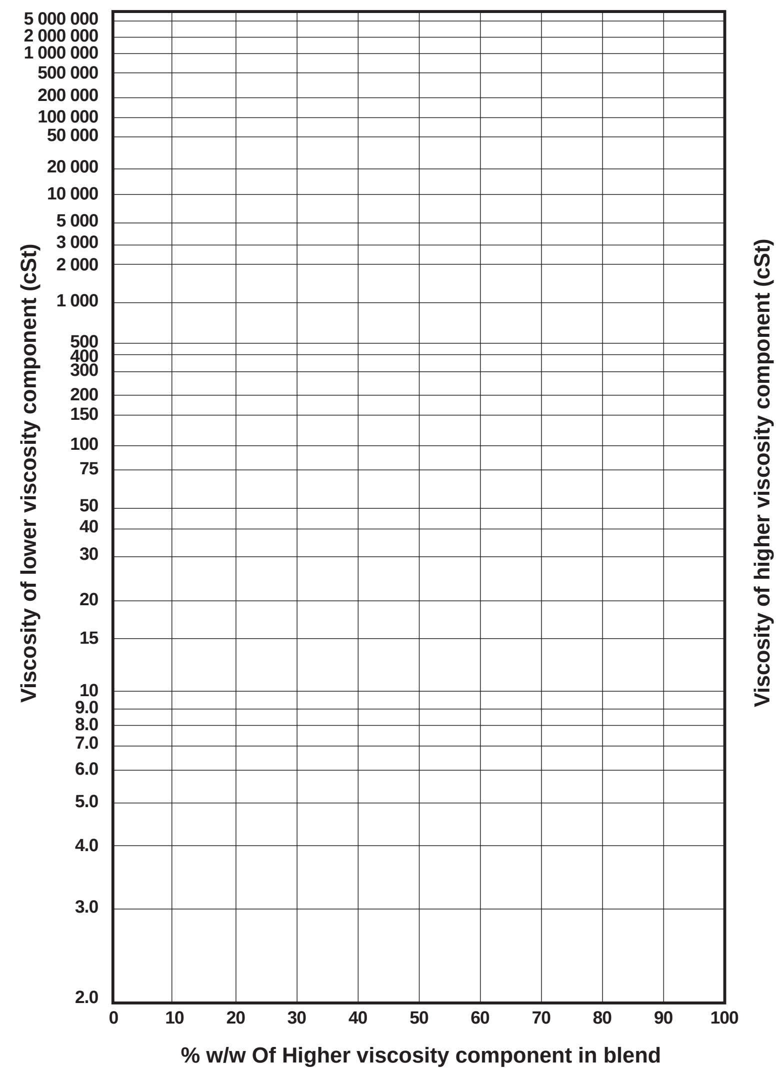


Figure 2: Viscosity blending chart



To determine the viscosity of a two component blend, plot the viscosity (in cSt at 100°C) values for the two components on the axes. A straight line joining the two points will provide the viscosity of any blend composition (again in cSt at 100°C)

To convert from centistokes (cSt) to centipoise (cP) multiply the viscosity in cSt by the density at the temperature under consideration:

$$cP = cSt \times density\ (kg/L)_T$$

To convert accurately from cSt to Saybolt Universal Seconds (SUS) is less straightforward. For viscosities of 100cSt and above at 100°C the relationship is:

$$SUS = cSt \times 4.653$$

At other temperatures and lower viscosities conversion charts should be used. Typical viscosities of Indopol polybutenes in SUS at 40°C or 100°C are shown in Table 1.

A blending chart to enable estimation of the viscosity (in cSt) of a two component blend is provided in Figure 2.

Molecular weight

Typical number average molecular weights (Mn) and dispersion indexes (Mw/Mn) of Indopol polybutenes are shown in Table 1. These data were generated using a gel permeation chromatograph calibrated using polybutene standards.

Density

Typical densities at 15°C are shown in Table 1. Density increases with molecular weight, and decreases with temperature. The latter effect is illustrated in Figure 3.

Surface tension

The surface tension of polybutenes are in the range of 26-34 dyne cm^{-1} at 25°C. Surface tension increases with viscosity.

Thermal properties

Due to the viscous nature of the higher molecular weight polybutenes it is typical to heat them during storage and transfer for ease of handling. Hence the thermal properties such as heat capacity and thermal conductivity are important in determining the most effective form of heating.

The specific heat capacity of polybutene increases with temperature and decreases with molecular weight and viscosity, as illustrated for selected Indopol grades in Table 2.

The thermal conductivity of polybutene tends to increase as the molecular weight and viscosity increases, as illustrated for selected Indopol grades in Table 3.

Table 2: Specific heat capacity of Indopol polybutenes ($kJ.kg^{-1}.K^{-1}$)

Indopol grade	L-14	H-100	H-300	H-1200	H-1900	H-18000
Temp. (°C)						
40	2.30	2.05	2.01	1.97	1.95	1.84
60	2.34	2.11	2.09	1.99	1.99	1.87
80	2.40	2.16	2.13	2.05	2.04	1.93
100	2.43	2.24	2.21	2.12	2.11	2.00
120	2.46	2.37	2.33	2.26	2.26	2.16
150	2.51	2.53	2.49	2.43	2.43	2.38

(Note: 1 $kJ.kg^{-1}.K^{-1}$ = 0.239 $Btu.lb^{-1}.°F^{-1}$)

Table 3: Thermal conductivity of Indopol polybutenes ($W.m^{-1}.K^{-1}$)

Indopol grade	L-14	H-100	H-300	H-1200	H-1900	H-18000
Temp. (°C)						
40	0.114	0.112	0.112	0.114	0.113	0.118
80	0.111	0.111	0.111	0.113	0.113	0.119
150	0.112	0.123	0.119	0.131	-	-

(Note: 1 $W.m^{-1}.K^{-1}$ = 0.578 $Btu.hr^{-1}.ft^{-1}.°F^{-1}$)

Tackiness

In general the tackiness of polybutene increases as molecular weight increases. The tackiness of formulations containing polybutene depends upon the polybutene grade and concentration, and also upon the compatibility of polybutene with the other components of the mixture. Specific data about the tackiness of adhesives, rubbers and polyethylene films formulated with polybutene are available upon request by contacting our technical experts via our website at www.indopolpib.com.

Thermal decomposition, volatility and evaporation

Indopol polybutenes are stable at room temperature but decompose at high temperature. The rate of decomposition for the higher molecular weight grades becomes significant at about 200°C and is rapid above 250°C. Thermal decomposition yields lower molecular weight polybutene fragments, but at sufficiently high temperatures the major products are butene monomers. Since each grade contains a range of molecular weight components, it is not easy to distinguish between true evaporation (i.e. volatilization of whole molecules) and decomposition/depolymerization. However, since depolymerization proceeds slowly at temperatures below 200°C, it is safe to assume that losses measured at lower temperatures are mainly due to evaporation.

Low molecular weight, low flash point materials such as butenes are generated when polybutenes are stored hot for an extended period. Under these circumstances storage under an inert gas atmosphere is recommended in order to prevent the formation of explosive mixtures. Refer to Handling Precautions on page 30 and consult the appropriate MSDS.

The depolymerization of polybutenes is a very valuable property, since it confers on the higher molecular weight grades the ability to volatilize before rapid combustion takes place. This volatilization occurs cleanly and without the formation of carbonaceous and tarry matter found when other materials (e.g. mineral oils) are heated strongly. This property is a particular advantage in non-staining metal working applications, and in two-stroke lubricants. The low level of deposits formed during the decomposition of polybutene has been demonstrated by the Conradson carbon residue test (ASTM D 189), the results of which are shown in Figure 4.

Thermogravimetric analysis (TGA) has been used to quantify the volatile loss of polybutenes versus temperature. Here a thin film of polybutene is steadily heated in a controlled flow of gas and the weight loss of the sample is monitored. This method serves as an approximate guide to the volatilization behavior of polybutenes under heating, but the circumstances of the heating and the sample (including the presence of other materials) must also be considered when assessing the suitability of polybutene for a particular application. TGA results for several Indopol grades are shown in Figure 5.

The convergence of the TGA data for the higher molecular weight grades suggest that the main mechanism of volatile loss is depolymerization, whereas for lower grades true evaporation is more evident.

Evaporation rates at constant temperature for several Indopol grades are shown in Figure 6. Here a known weight of sample of fixed surface area was held at a constant temperature for 10 hours, according to ASTM D 972-56.

Vapor pressure data for several Indopol grades over a range of temperatures up to their decomposition temperature are shown in Figure 7.

Figure 3: Effect of temperature on density of a Indopol polybutene

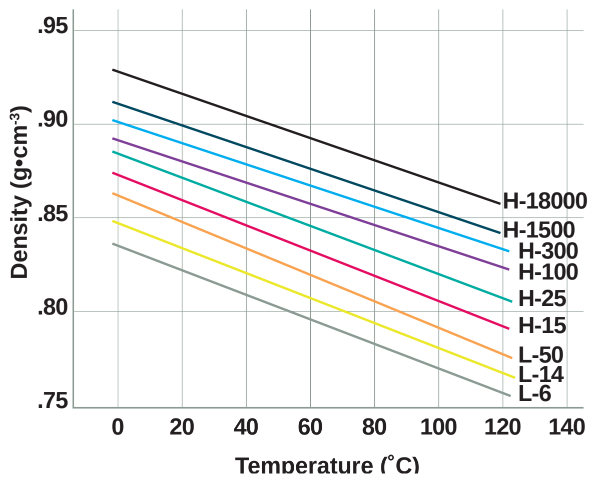


Figure 4: Conradson carbon residue of oils by ASTM D189

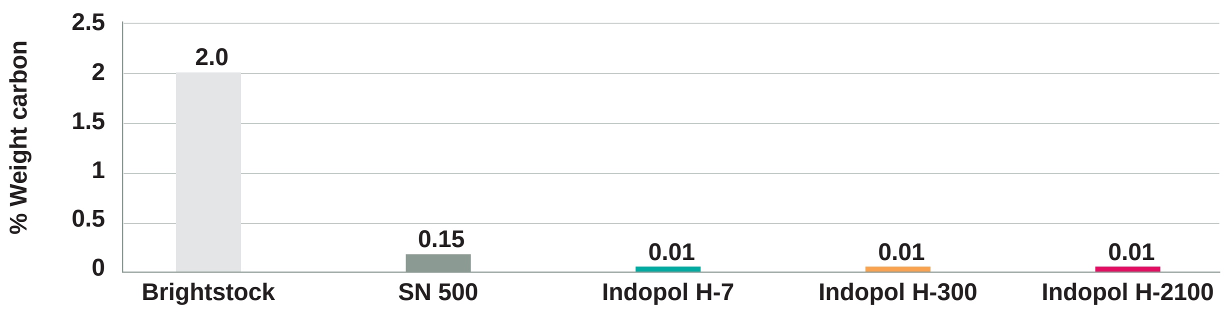


Figure 5: Volatile loss of Indopol polybutenes. Programmed heating at 180°C per hour in dry air at 25ml.min⁻¹

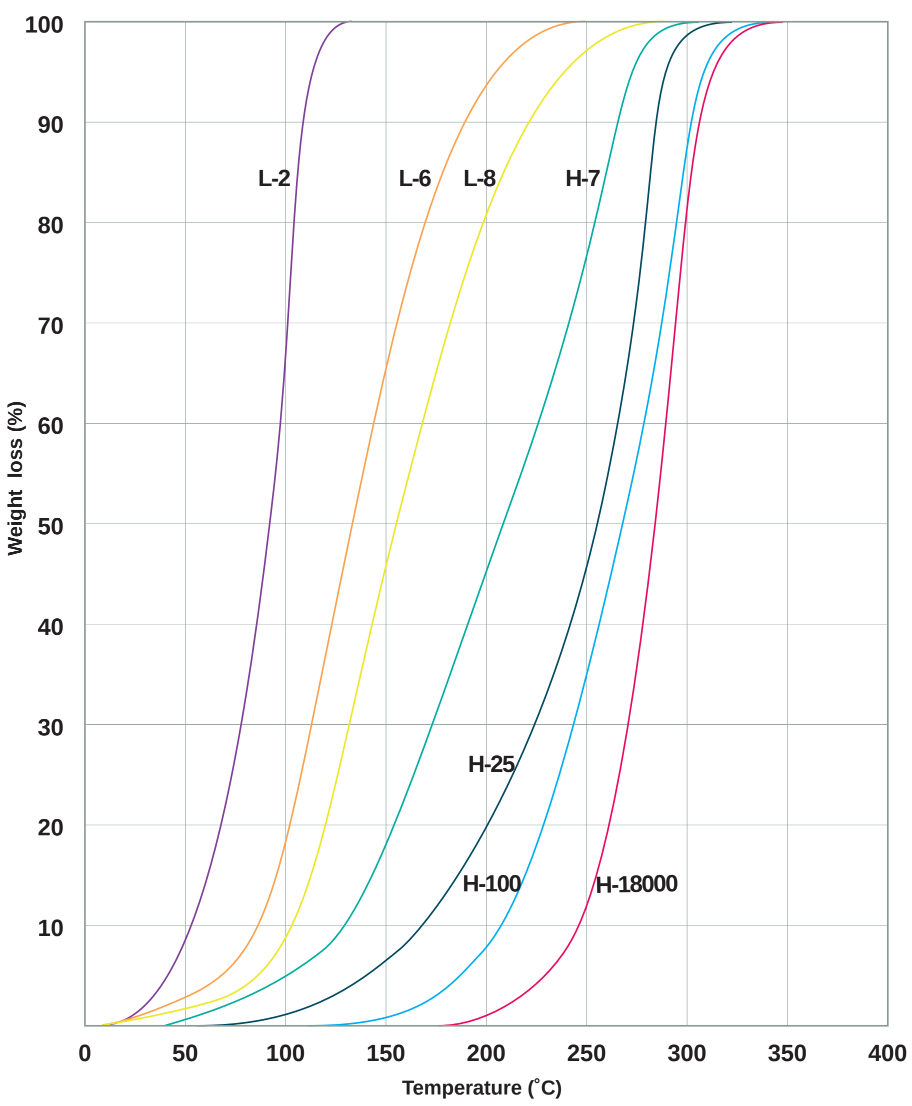


Figure 6. Evaporation loss of Indopol polybutenes by ASTM D972-56. (10 hour test period)

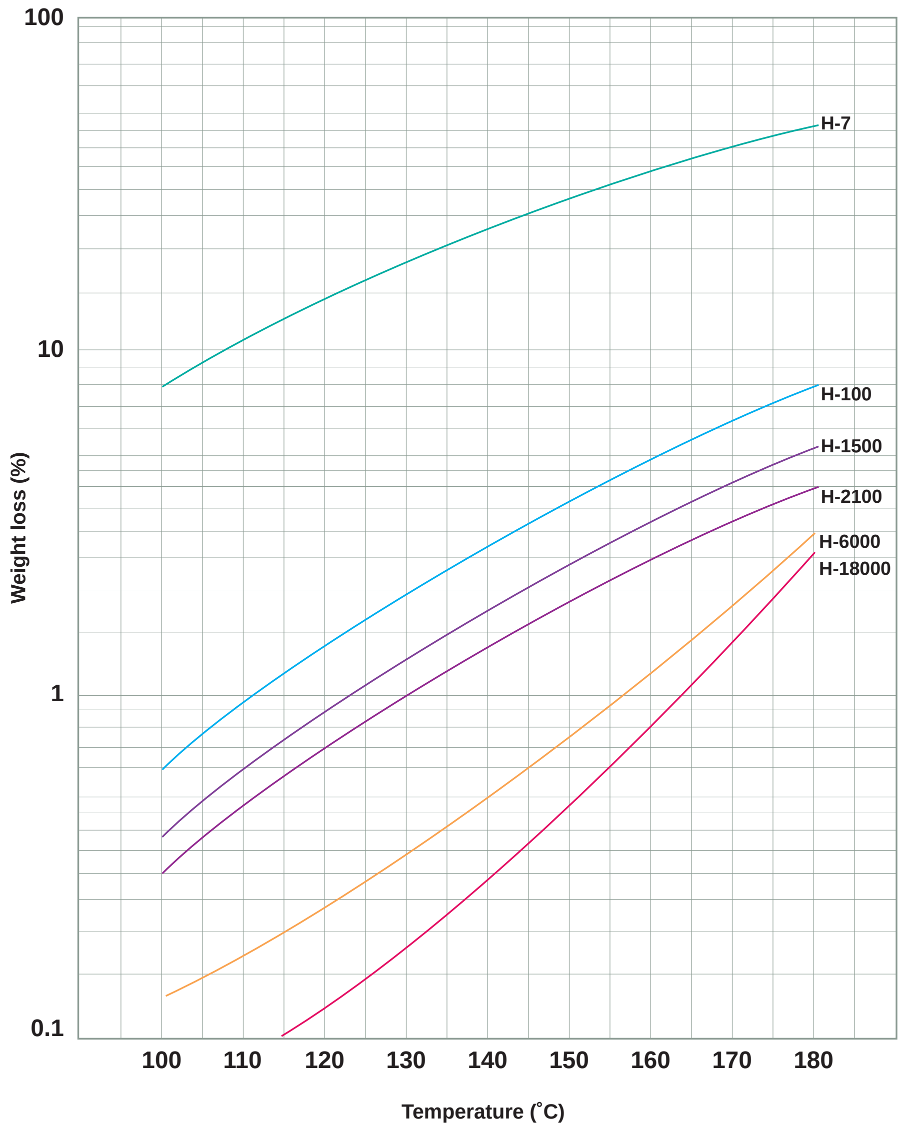
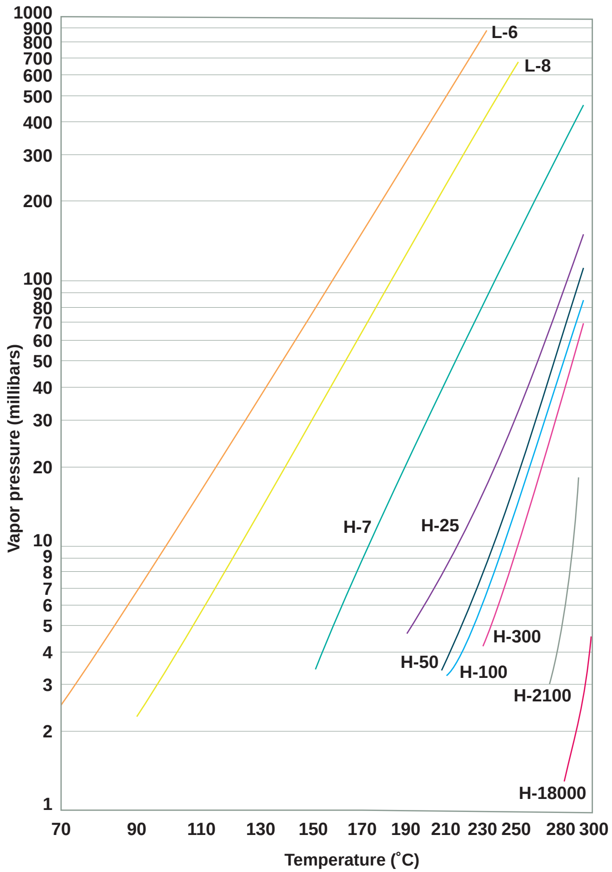


Figure 7: Vapor pressure vs. temperature of Indopol polybutenes

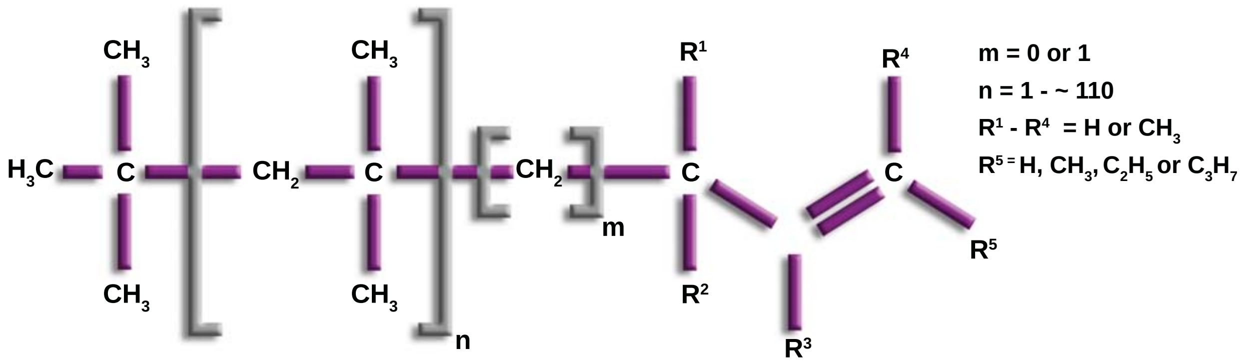


Color

Color is measured spectrophotometrically and reported in Hazen units. Indopol polybutenes are essentially colorless and water white, and exhibit substantial color stability upon prolonged exposure to uv light and moderate heat. They are much more color stable than mineral oils of equivalent Hazen color. Nevertheless, color deterioration can occur via oxidation by atmospheric oxygen under prolonged heating, especially for the lower molecular weight grades. Therefore extended storage of bulk quantities may require precautions such as blanketing with inert gas such as nitrogen. It is also possible to add a small percentage of anti-oxidant such as di-tertiary butyl p-cresol.

Indopol polybutenes | chemical properties

Figure 8: Polybutene chemical structure



Polybutene structure

Indopol polybutenes are synthetic hydrocarbon polymers made via acid catalysed cationic polymerization of an isobutene-rich C4 stream. They approximate to pure polyisobutene (PIB), but also have some n-butene incorporated. Each molecule possesses an olefinic double bond at or near one end. A generic structure for polybutene is shown in Figure 8.

The number average degree of polymerization (DPn) for Indopol polybutenes ranges from about 3 up to about 110, depending upon grade.

Reactivity

The presence of olefinic double bonds makes polybutenes amenable to the same reactions as low molecular weight substituted mono-olefins. Such reactions can be used to impart the properties of polybutenes (e.g. oil solubility, hydrophobicity, viscosity) to the derivative. For instance the reaction of polybutene with maleic anhydride yields polybutenyl succinic anhydride (PIBSA), which is used to make engine oil dispersants and anti-rust additives.

Other reactions which have been successfully performed on polybutene include: epoxidation, oxidation, halogenation, hydrohalogenation, sulphonation, reductive amination, haloboration/oxidation and nitration. Polybutenes can also be used as alkylating agents in electrophilic substitutions of isoalkanes and aromatics.

Oxidative stability

Polybutenes are chemically stable and are not prone to atmospheric oxidation under ambient conditions. Their chemical stability is demonstrated by their retention of viscosity and tackiness, and their failure to harden or to show any deterioration of color on prolonged ageing at ambient temperatures. Indopol polybutenes contain no anti-oxidant, but these can be added by the customer if color and odor requirements are stringent. For further comments on color refer to the section on physical properties.

Metal impurities and corrosion

Indopol polybutenes are essentially free from metal impurities, do not corrode metals and can be stored in carbon/mild steel tanks or drums. ICP analyses have typically shown sodium, potassium, iron, copper and aluminium levels below 1ppm.

Solubility in organic solvents

In general, polybutenes are soluble in non-polar solvents and insoluble in polar solvents. However, polymer molecular weight can influence solubility. For example a light grade such as Indopol L-8 is soluble in some ester and ketone solvents which will not dissolve heavier grades such as Indopol H-300. Note that the solvency of poor or marginal solvents can often be increased by blending with non-polar co-solvents.

The solubility characteristics of polybutenes in a range of common solvents are listed in Table 4.

Table 4: Polybutene solubility in some common solvents

Indopol polybutene grade	L-8	H-100	H-2100
Alcohols and glycols			
Methanol	I	I	I
Ethanol	I	I	I
Isopropanol	C	I	I
n-Butanol	C	I	I
Isobutanol	I	I	I
Ethoxy ethanol	C	I	I
Propylene glycol	I	I	I
2-Ethyl hexanol	S	S	S
Chlorinated hydrocarbons			
Dichloromethane	S	S	S
Carbon tetrachloride	S	S	S
Ethylene dichloride	S	I	I
1,1,1-Trichloroethane	S	S	S
Esters			
Methyl acetate	I	I	I
Ethyl acetate	C	I	I
n-Butyl acetate	S	S	I
Isobutyl acetate	S	S	S
Ethers			
Tetrahydrofuran	S	S	S
Diethyl ether	S	S	S
Diisopropyl ether	S	S	S
Hydrocarbons			
Benzene	S	S	S
Toluene	S	S	S
Xylene	S	S	S
n-Heptane	S	S	S
Cyclohexane	S	S	S
Ketones			
Acetone	I	I	I
Methyl ethyl ketone	S	I	I
Diisobutyl ketone	S	S	S
Cyclohexanone	S	I	I
Miscellaneous			
Dimethyl formamide	I	I	I
Acetonitrile	I	I	I
Nitromethane	I	I	I
m-Cresol	I	I	I

Table 5: Compatibility of Indopol H-100 with resins, polymers and other organic materials

Material type product description	Observations at Indopol H-100 concentration of	
	10%w/w	50%w/w
Bitumens		
Penetration grade 195/210	C	PC
Oxidized grade 85/25	C	PC
Platicizers		
Di-isooctyladipate	C	C
Di-n-heptyl phthalate	C	C
Di-isooctyl phthalate	C	C
Di-butyl phthalate	I	I
Tri-tolyl phosphate	I	I
Process oils		
Highly aromatic, low viscosity oil	C	C
Highly aromatic, medium viscosity oil	C	C
Paraffinic, low viscosity oil	C	C
Naphthenic, low viscosity oil	C	C
Aromatic, low viscosity oil	C	C
Aromatic, medium viscosity oil	C	C
Silicone oil	I	I (see notes)
Polyethylene glycol	I	I
Chlorinated linear paraffin 45% Cl	C	C
Chlorinated linear paraffin 52% Cl	C	I
Rubbers		
Natural rubber	C	PC
Polyisoprene rubber	PC	PC
Polyisobutylene rubber	C	C
Nitrile rubber PC	I	
Styrene – butadiene copolymer rubber	PC	I
Polysulphide rubber	I	I
Chlorinated rubber	I	I

Key: S = soluble; I = insoluble; C = cloudy mixture (no polybutene visible but not a true solution).

Note: Solubility was determined by mixing 10 parts by volume of the polybutene with 100 parts by volume of the solvent at ambient temperature. The description soluble (S) indicates total miscibility, while insoluble (I) indicates solubility too low to be of practical use. Results are shown for three Indopol grades; the behavior of grades not listed can be inferred from their molecular weight relative to those listed.

Table 5: Compatibility of Indopol H-100 with resins, polymers and other organic materials (continued)

Material type product description	Observations at Indopol H-100 concentration of	
	10%w/w	50%w/w
Polychloroprene		
(rapid crystallising adhesive grade)	PC	I
Polychloroprene		
(medium fast crystallising grade)	PC	I
Vegetable oils		
Cottonseed oil	C	C
Pine oil	C	C
Soyabean oil (raw)	C	C
Soyabean oil (blown)	PC	C
Coconut oil	C	C
Pitch cottonseed	C	C
Pitch tall oil	C	C
Limed tall oil	PC	I
Linseed oil (raw)	I	PC
Linseed oil (oxidized)	PC	I
Linseed oil (boiled)	PC	I
Castor oil (raw)	PC	I
Castor oil (dehydrated)	PC	I
Tung oil	PC	I
Oiticica oil	I	I
Waxes		
Paraffin wax	C	C
Microcrystalline wax	C	C
Carnauba wax	C	PC
Montan wax	C	C
Palm wax	C	C
White Ceresin wax	C	C
Low molecular weight PE wax	C	C

Table 5: Compatibility of Indopol H-100 with resins, polymers and other organic materials (continued)

Material type product description	Observation at Indopol H-100 concentration of 10%w/w	50%w/w
Alkyds		
Short castor oil pentaerythritol modified non-drying alkyd in n-butanol/xylene	PC	I
Short oil phenolic modified dry alkyd	C	I
Short oil styrenated drying alkyd	I	I
Long oil pentaerythritol modified drying alkyd	C	I
Hydrocarbons		
low density polyethylene	PC	PC
High density polyethylene	PC	PC
Polystyrene	I (see notes)	I
Polypropylene	PC	PC
Aliphatic hydrocarbon resins	C	C
Styrene-methylstyrene resin	PC	I
Natural products		
Congo gum	PC	-
Damar gum	C	-
Manilla gum	C	-
Rosin wood	C	PC
Shellac	I	C
Phenol formaldehyde resins		
Heat reactive phenolic resin drying oil	I	I
Butylated urea formaldehyde resin in n-butanol	I	I
Melamine/formaldehyde resin in n-butanol/xylene	I	I
Non reactive phenol formaldehyde resin	C	C

Table 5: Compatibility of Indopol H-100 with resins, polymers and other organic materials (continued)

Material type product description	Observation at Indopol H-100 concentration of 10%w/w	50%w/w
Miscellaneous products		
PVC suspension polymer (general purpose)	PC	I
Vinyl chloride-vinyl acetate-maleic acid terpolymer	PC	I
Vinylidene chloride-acrylonitrile copolymer	I	I
Poly(vinyl acetate)	I	I
Polyacrylonitrile	I	I
Maleic anhydride and glycerol modified rosin ester	C	PC
Pentaerythritol ester gum	C	C
Coumarone – Indene resin	C	C
Poly(vinyl butyral-acrylic ester) copolymer	I	I
Poly(methyl methacrylate)	PC	I
Liquid epoxy resin	PC	I
Solid epoxy resin	PC	I
Polyisocyanate adduct	I	I
Polyamide resin MPt 110°C	I	I

Notes: The results shown were determined at room temperature, or by heating the mixture and allowing it to cool to room temperature before making observations. In the case of material such as natural rubber, nitrile rubber and polychloroprene, Indopol H-100 was milled into the material at elevated temperatures, with the observations again being carried out at room temperature.

I = Incompatible and is used to describe mixtures where insufficient polybutene is dissolved for it normally to be regarded as of practical interest. However, this may not always be the case. For example, although polybutenes are largely incompatible with polystyrene, at levels of 10% a sufficient amount will dissolve at high temperatures to act as a useful flow promoter by reducing melt viscosity of the polystyrene.

PC = Partially Compatible and is used as an indication that complete compatibility is obtained when a lower percentage than 10% of polybutene is employed. The possibility of using a third component to improve polybutene compatibility should not be overlooked.

C = Compatible and is used to indicate compatibility at the concentration of polybutene used.

Low molecular weight grades of polybutene (e.g. Indopol L-6 and below) are compatible with silicone fluids.

Compatibility with resins, polymers, etc

Polybutenes are generally most compatible with non-polar materials. Compatibility between polybutene and other materials decreases as: 1) the polarity of the other material increases, and 2) the molecular weight difference between polybutene and the other material increases. Nevertheless, incompatibility between polybutene and polar materials can often be overcome by the use of a third compatibilizing component in a mixture, or by the addition of inorganic fillers.

Compatibility tests have been carried out using Indopol H-100 and a range of materials that are of interest in the formulation of sealants, adhesives, coatings, printing inks etc. Results are shown in Table 5. The behavior of other grades can be inferred by taking into account the molecular weight.

Indopol polybutenes | health, safety and enviroment

Product stewardship

INEOS product stewardship encompasses a broad spectrum of services to customers, stakeholders and others who handle our products. A range of specialists is available to provide expert advice on product issues.

Our Product Regulatory Compliance staff is available for discussions on issues related to compliance with industrial chemical control regulations and regulations pertaining to food contact, cosmetic and agricultural uses. With our extensive experience in these areas, we realize that the regulatory compliance requirements are important and we can advise customers on specific issues relating to the use of polybutenes.

Material safety data sheets

Material Safety Data Sheets (MSDSs /SDSs) are available for all INEOS polybutenes and describe the health, safety and environmental characteristics of these products as well as advice on handling precautions and emergency procedures.

MSDSs should be consulted and fully understood before handling, storage or use of INEOS polybutenes. To request a Material Safety Data Sheet for a specific Indopol or Panalane grade, phone +1 866-363-2454 Toll Free –North America, or send an e-mail to: Oligomersmsds@INEOS.com.

Handling precautions

When used for their intended purpose and under normal conditions of industrial handling, Indopol polybutenes do not present any appreciable hazards. Precautions should, however, be taken to prevent entry into the eyes and to avoid prolonged or repeated contact with the skin particularly when the product is handled at elevated temperatures. We recommend the wearing of protective equipment when handling hot polybutene.

Exposure to mist and fumes which may arise from the lower molecular weight products handled at elevated temperatures should be avoided by the provision of adequate ventilation. If ventilation is inadequate, the use of Personal Protective Equipment is recommended.

A high intensity heat source should not be employed when heating the higher molecular weight grades, since their viscous nature prevents rapid convection of heat away from such a source. In addition to mist and fumes, short-chain hydrocarbons with low flash points can be generated rapidly at temperatures above 200°C. Consequently, drums should be vented during the heating operation. For prolonged storage at temperatures of 60°C and above, keep polybutene in rust-free tanks and exclude oxygen by use of a nitrogen blanket. Suitable storage materials are mild steel / carbon steel. Low molecular weight, low flash point materials such as butenes are generated when polybutenes are stored hot for an extended period. Under these circumstances storage under an inert gas atmosphere is recommended in order to prevent the formation of possibly explosive vapour/air mixtures.

Always consult the relevant Material Safety Data Sheet for specific information on recommendations for handling and safety.

Emergency procedures

Fire

Indopol polybutene grades have either open or closed cup flashpoints above 62°C (142°F) and present little fire hazard, but are combustible under most conditions. Depolymerization can occur above 200°C (390°F), producing low flash point hydrocarbons which will exacerbate the hazard in a fire situation.

Spill

Prevent spilled liquid from entering drains, sewers or watercourses. Sand, earth or other absorbent materials can be used to soak up spillages. Disposal should comply with the local regulations for dealing with liquid waste.

Always consult the relevant Material Safety Data Sheet for more detailed and specific information and recommendations for emergency response.

Environmental effects

Polybutenes have been extensively tested and evaluated for potential adverse effects on the environment. The weight of evidence from these tests, comparisons with structurally similar chemicals, and professional judgment indicates that polybutenes are non-hazardous in the environment.

Consult the relevant Material Safety Data Sheet for additional environmental data.

Regulatory status

Indopol and Panalane polybutenes may be used in a wide variety of applications which require regulatory approvals. These applications include food contact, cosmetic and agricultural uses.

For national regulatory compliance status of specific Indopol and Panalane grades, phone +1 866-363-2454 Toll Free - North America, or send an e-mail to: Oligomersmsds@INEOS.com.

Indopol polybutenes | delivering value through versatility

INEOS is a leading petrochemicals company based on a highly integrated product portfolio and strong marketing positions in North America, Europe and the Far East. We operate large-scale chemical manufacturing plants in the United States, United Kingdom, Belgium, France and Germany. We are made up of former Innovene (BP Chemicals) petrochemical businesses, with approximately 40 billion pounds of polymers and chemicals production capacity.

INEOS is a leading global manufacturer of petrochemicals, specialty chemicals, and oil products. It comprises 18 businesses each with a major chemical company heritage. Our production network spans 68 manufacturing facilities in 17 countries throughout the world.

INEOS is a leader in a number of core products including acrylonitrile, polystyrene, alpha-olefins, polypropylene, polyethylene and oxygenated solvents. Our products are used for diverse applications such as pharmaceuticals, cosmetics, detergents, packaging, coatings, adhesives, fuel additives, cable insulation, microfilm, toys and lubricants.

For more information on INEOS and its other products visit: www.INEOS.com.

INEOS is one of the world's largest petrochemicals companies, operating in 100 countries, on six continents, serving 10 million customers every day throughout the world. Our main activities are oil refining, and manufacturing and marketing of petrochemicals. INEOS has well-established operations in Europe, North America and Australasia.

Regulatory information

The products and uses described herein may require global product registrations and notifications for chemical inventory listings or for use in food contact, medical devices, cosmetics or agricultural uses.
For further information, send an e-mail to: Oligomersmsds@INEOS.com.

Health and safety information

The product described herein may require precautions in handling and use because of toxicity, flammability, or other considerations. The available product health safety information for this material is contained in the Material Safety Data Sheet (MSDS) that may be obtained by sending an e-mail to: Oligomersmsds@INEOS.com.

Before using any material a customer is advised to consult the MSDS for the product under consideration for use.

The Material Safety Data Sheet for this product contains shipping descriptions and should be consulted, before transportation, as a reference in determining the proper shipping description of this product. If the material shipped by INEOS is altered or modified, different shipping descriptions may apply and therefore the original material MSDS should not be used.

Further information

Further information on the work reported in this brochure may be obtained from:

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For further information concerning Indopol polybutenes, visit our website at www.indopolpib.com.

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