Monsanto plasticizers

Monsanto

plasticizers

The most complete selection of liquid ◯ and solid ▢ primary plasticizers, secondary plasticizers and flexibilizing extenders available to the plastics, coatings and adhesives industries

MONS 080627

M. W. Farrar

Largest Selection of Plasticizers From One Source

Monsanto offers you the largest assortment of plasticizers—both in number and variety—in the world. This broad line has unique advantages: you can select from one source the plasticizing system that offers you the optimum in processing and performance; you can obtain impartial technical guidance; you can take advantage of the savings in combined shipments; you can simplify your purchasing procedure.

The need for a selection of plasticizers is readily apparent. In the 1930's—when Monsanto pioneered the technology of plasticization—performance demands were relatively mild. Plasticizing was simple because applications were few and resins fewer. In the intervening years, many new resins were commercialized, countless applications have developed, and today there are rigorous specifications and a variety of needs for ease of processing, speed of cure, and particular performance qualities.

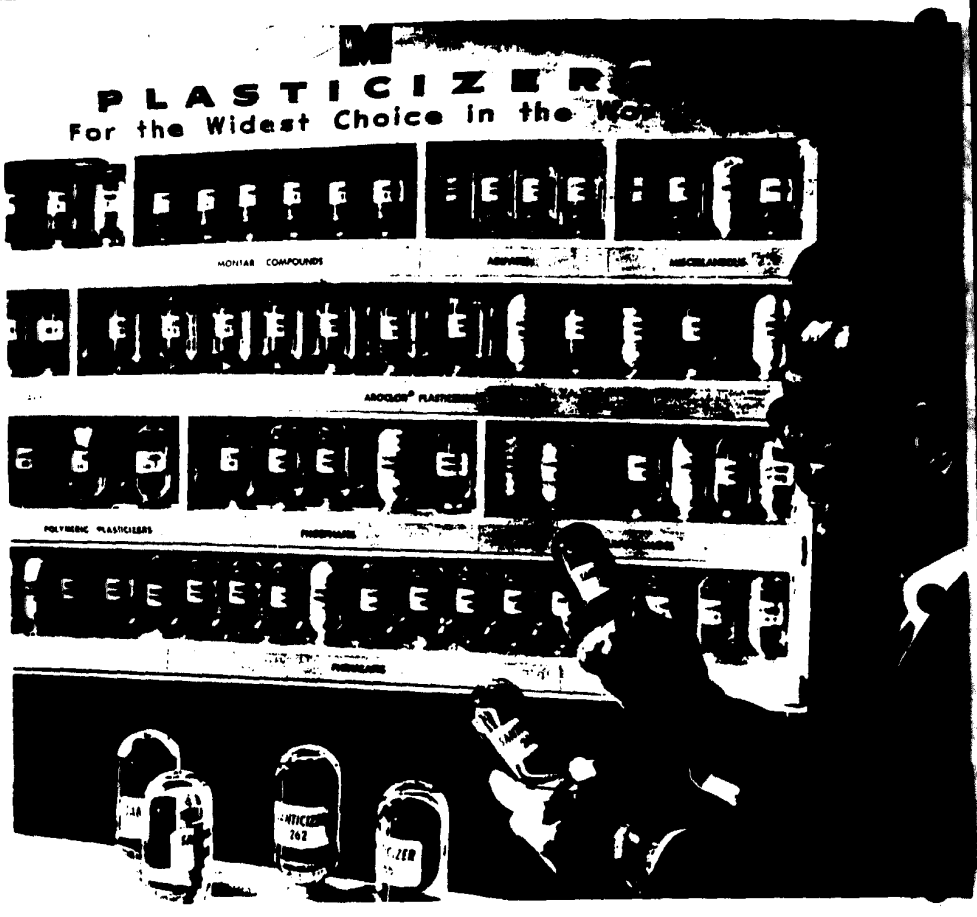
Confronted with the multiplicity of end-use requirements on one hand and a multitude of plasticizer and resin choice on the other—even the most experienced formulator is bewildered by the maze of possibilities of from which to select the one best system for his particular application.

This catalog has been designed to serve as one tool to help you solve the often perplexing problems of what plasticizer to use. It contains complete descriptions of the performance and processing characteristics of each of Monsanto's more than eighty plasticizers. It also includes tabulations of performance data of various plasticizers in several end-use applications and guides to superior plasticizers to develop compounds with special performance.

This catalog is not the final guide to plasticizer selection. It is primarily a guide to performance of types. However, if these data are used as a guide to plasticizer selection, Monsanto technical bulletins on individual plasticizers and on certain end-use applications will provide more complete information.

Specific consultation services are offered by Monsanto's Plasticizer Council. We hope these three sources of information will be helpful to you in your manufacture of plastics products, surface coatings, and adhesives.

MONS 080628



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ON THE FOLLOWING PAGES ...you will find:

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• The "Plasticizer Council"—Monsanto Research and Technical Service—Available to You • Commercial Availability—Production and Distribution	section
• Monsanto Plasticizers, A Description of Each Product and Performance • Monsanto Plasticizers, Summary of Specifications and Typical Properties • Solid Plasticizers • Non toxic Plasticizers • Flame Retardant Plasticizers	section
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Answers to Plasticizing Problems

Although the source of the widest selection of plasticizers in industry, Monsanto provides much more than simply the products: specifically adroit, expert guidance in their use.

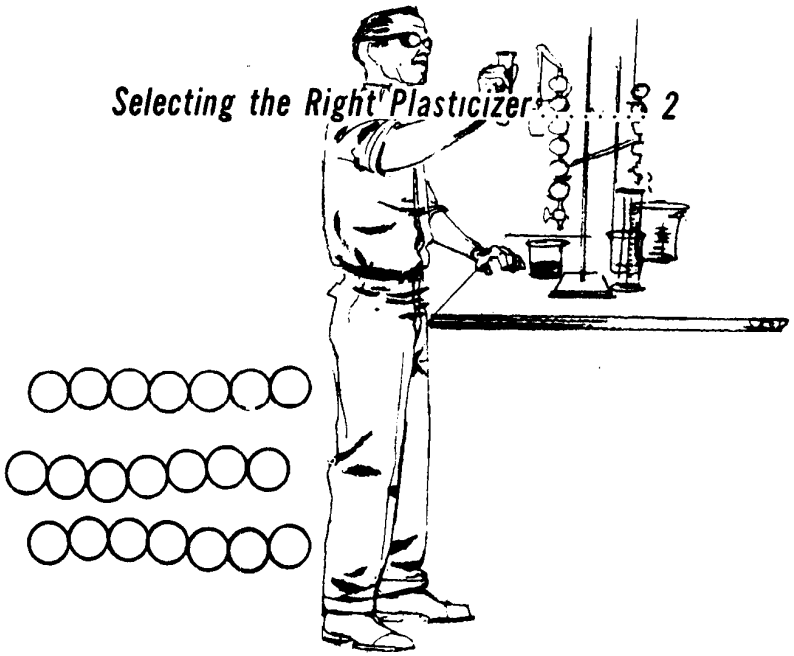
Monsanto has worked with plastics and resins processors since 1920. There is a long history of experience in supplying flexibilizing or modifying compounds for each resin commercially available to industry. Monsanto pioneered the development and introduced plasticizers new to industry; developed the concept of rapid fluxing plasticizers to minimize compounding and processing costs; was the industry leader in developing binary, ternary, and even tertiary plasticizing systems to provide maximum all-around processing ease and product performance. And Monsanto has led in developing plasticizing systems that provided **special properties** to the finished compound: flame retardance, freedom from toxicity, improved light stability, maximum stain and abrasion resistance, and others.

MONS 080631

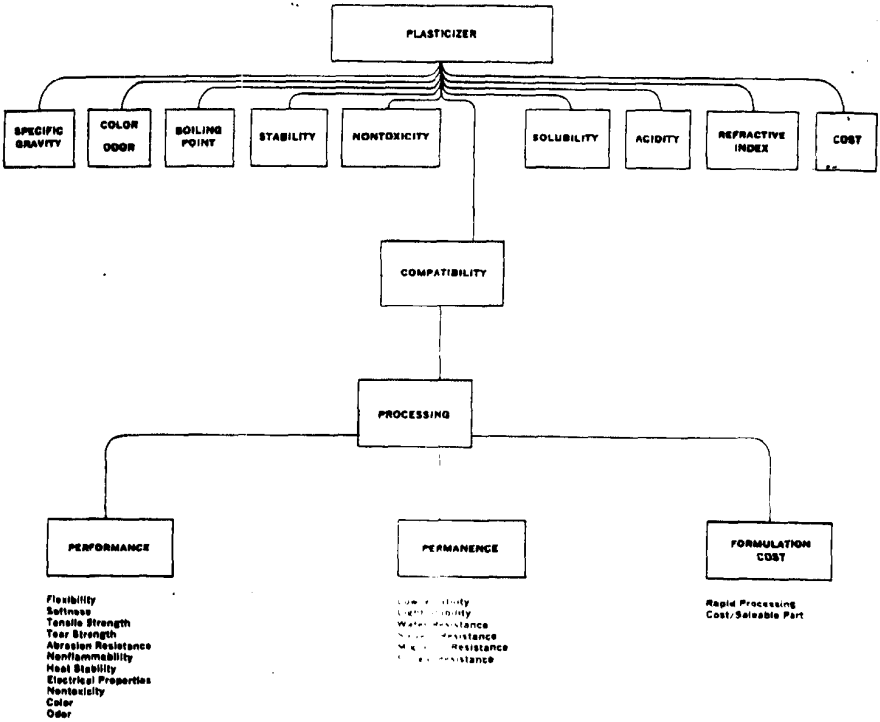
section

How a Plasticizer Works 1

Selecting the Right Plasticizer 2



REQUIREMENTS OF A PLASTICIZER



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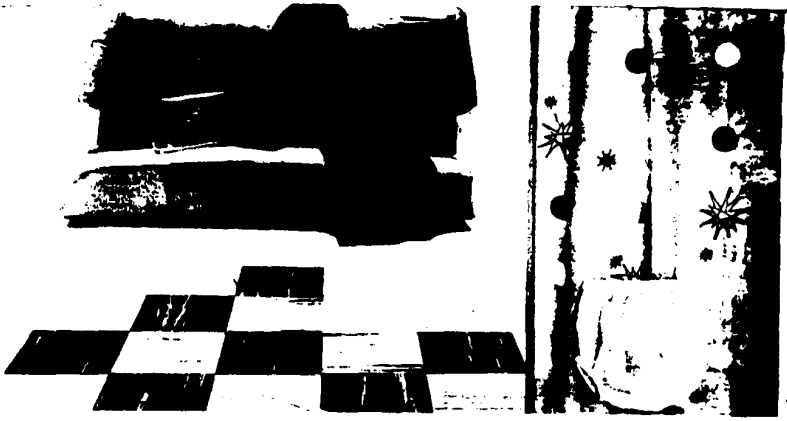


how a plasticizer works

Plasticizers are low melting solids or high boiling organic liquids. They are added to plastic compositions and surface coatings to aid flow and processing; to extend and modify the natural properties of the resins; and to develop new, improved properties not present in the resins themselves. Chemically, plasticizers are related to solvents—but they are far less volatile. They are primarily ester-type organic compounds, generally polar in structure with high molecular weight.

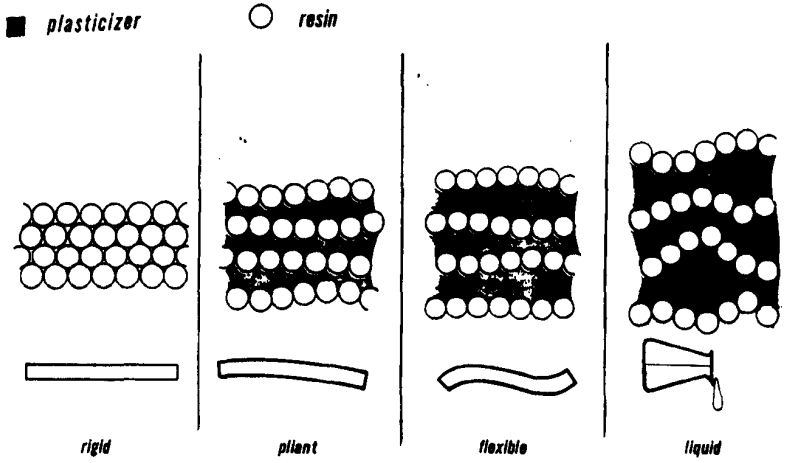
Resins are extremely high molecular weight natural or synthetic polymers. Resins fall into two classes: *thermosetting*, which are infusible and *thermoplastic*, which are fusible.

Thermosetting resins in their final infusible, insoluble state are complex molecules held together in a three dimensional network by primary chemical bonds. This structure strongly resists outside forces, whether these forces be heat or the "separating" action of a solvent or plasticizer.

Thermoplastic resins—largest "consumer" of plasticizers—are high molecular weight molecules held together by primary chemical bonds in a longitudinal direction only. These chemical bonds operate only along the length of the polymer chain. The binding forces between chains are the Van der Waal forces (secondary bonds). These between-chain bonds are of a physical rather than chemical nature and thus are susceptible to modification by external forces more readily than primary chemical bonds. Consequently, plasticizing a thermoplastic resin consists basically of a controlled modification of the attractive forces between molecular chains. The extent of plasticizing action depends in part upon the molecular structure of the polymer and in part on the molecular structure of the plasticizer.

The attractive forces or bonds between the chains vary in magnitude and number with the resin. The polymer chains of some resins are strongly bonded together by many cross-tying attractive forces, others are more loosely knit. The stronger the bonding forces between the polymer, the more highly polar must be the plasticizer. Rubber and neoprene, for example, are less strongly bonded than cellulose acetate or polyamide resins. Compounds such as hydrocarbons can be used to plasticize the more weakly bonded resins, but polyvinyl chloride or cellulose acetate require polar plasticizers plus heat, sometimes pressure, and sometimes solvents to aid in compounding.

Plasticizers, like solvents, are attracted by the polar groups on the polymer chain and replace polymer-polymer bonds with polymer-plasticizer bonds. In addition, the sheer bulk of a plasticizer



molecule and the configuration of its grouping disrupts the forces between chains. At high concentrations the plasticizer forms a continuous phase in which the separated chains can move. In such concentrations, the state of the plasticized mass is apt to be a soft gel.

Because of the relatively large size of most plasticizer molecules, it is frequently necessary to use heat, pressure, solvents, or a combination of these to aid in "loosening up" the resin structure to incorporate the plasticizer. Polyvinyl chloride, for example, is compounded with plasticizers at elevated temperatures. At room temperatures, the plasticizer does not separate adequately the polymer chains because of the strong secondary linkages or Van der Waal forces. The incorporation of camphor in cellulose nitrate, for example, is also aided by the action of heat and, in addition, solvents.

Plasticizers are an essential aid in processing most resins. Without the lower softening range imparted by the plasticizer, many resins could not be fabricated into films, sheets or useful molded articles. Plasticizers are used to improve the processing characteristics of resins during end product manufacture and to impart flexibility and added toughness to the finished product. Further, selected plasticizers can impart special qualities: flame resistance, low-temperature flexibility, higher gloss, improved adhesion, outdoor durability, and others.

Mechanically, a plasticizer reduces somewhat the tensile strength and increases the elongation and elasticity of a resin. To possess really high elasticity, the polymer chain must be able to kink readily. In cellulose derivatives, the chains are themselves relatively bulky and no amount of plasticization can ever produce the flexible elastomers that can be obtained with the more extensible molecules such as polyvinyl chloride.

By decreasing the forces holding the chains together, the plasticizer also lowers the second-order transition point, sometimes called the "flex temperature," or brittle point.

Although in practice all efficient plasticizers are usually polar compounds, the polarity characteristics are only a partial guide to the evaluation of a plasticizer. Other considerations such as compatibility, permanence, performance or efficiency of the compound, and cost determine its suitability. In addition, certain plasticizers are used to impart special properties.

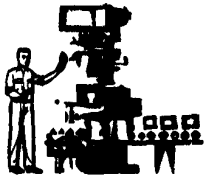
selecting the right plasticizer to build quality

In selecting and judging the value of a plasticizer, the following characteristics must be evaluated:



COMPATIBILITY

... of a plasticizer with a resin is a function of its polarity, molecular size, and structural configuration. Slightly incompatible (secondary or "extender" type) plasticizers may often be made compatible through the use of mutual solvent plasticizers.



PROCESSING

... is the degree of difficulty or ease required to manufacture successfully a finished product. Since labor costs are constantly increasing, selecting a rapid fusion plasticizer that reduces production time enables a manufacturer to maintain or reduce his cost per unit. Monsanto manufactures several plasticizers widely favored for their rapid processing characteristics.

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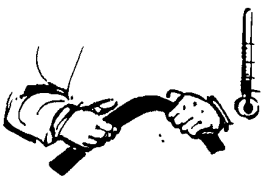
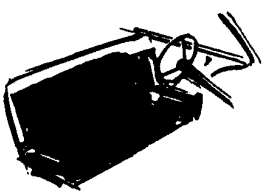


PERFORMANCE

. . . is the immediate effects that can be noted on the resin after a plasticizer is added. Low-temperature flexibility, flammability, hardness, electrical characteristics, hand, drape, gloss, odor and heat stability are all points of performance evaluation.



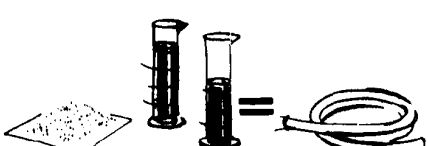
PERMANENCE

. . . is the cumulative effects of exposure during service life. Such important characteristics as low volatility, resistance to extraction by water, oils, and petroleum products, resistance to weathering, resistance to migration to materials in contact with the finished product are all desirable for the long useful life of plastic products.



SPECIAL PROPERTIES

. . . such as flame resistance, freedom from toxicity, high gloss, adhesion, abrasion resistance, resistance to specific solvents, electrical properties can be developed by the use of certain Monsanto plasticizers that are designed to add such specific properties to the end product. Through adroit plasticizer selection, wider application of resin formulation and more saleable finished products can be obtained.

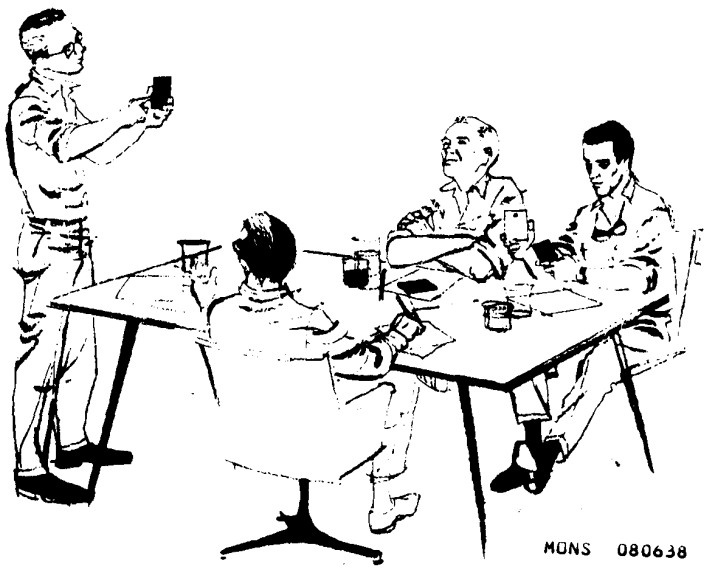


COST VERSUS UTILITY

. . . the sum of the compatibility, processing, performance, permanence, and special properties characteristics versus cost is the final decision in selecting the proper plasticizer system. With Monsanto's wide range of plasticizers, compounders are able to select a plasticizer or combination of plasticizers with the optimum balance of end product characteristics and cost.

Plasticizer Council 1
Commercial Availability 2

section



MONS 080638

[redacted] producer

assure you of:

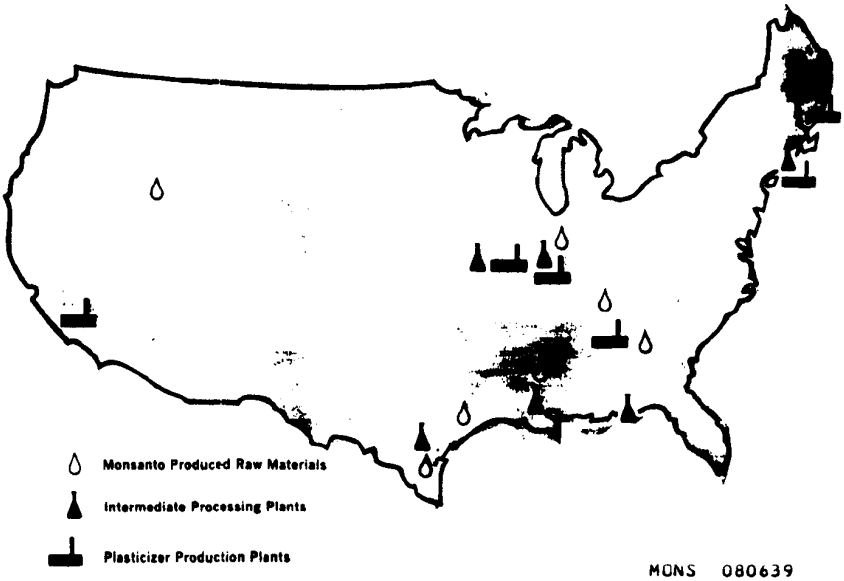
- a dependable, long-range supply of plasticizers
- controlled top-quality plasticizers · · ·

Monsanto is carrying out a planned raw-material integration and a plasticizer-production-capacity expansion. When completed—before the end of 1962—this program will make Monsanto the first plasticizer producer to be completely integrated.

With a controlled source of plasticizer intermediates, Monsanto's ability to supply plasticizers will not be hindered by nationwide shortages in naphthalene or other starting materials.

Monsanto will also have complete quality control over raw materials and hence over its plasticizers, at every production stage. Monsanto's plasticizers are always made to rigid specifications, which are often reviewed and upgraded.

The map below indicates the locations of Monsanto's plants for production of raw materials, intermediates, and plasticizers.



MONS 080639



A typical conference outlining a customer problem before laboratory work is started . . . and the final judgment of the evaluation results prior to reporting a recommendation to a plasticizer customer.

the "plasticizer council"...

Monsanto's Research and Technical Service...available to you

For many years, Monsanto researchers have carried on a regular program of synthesizing new chemical structures and evaluating these new compounds for their plasticizing properties. The many plasticizers now offered commercially by Monsanto, thus, just didn't "happen." They were carefully made up by molecular structure and then screened for plasticizing utility. Each month, several dozen new compositions of matter are prepared in the laboratory; each is checked out for its value in plasticizing resins. The compounds that offer particular benefits or distinct improvements over existing plasticizers are then evaluated thoroughly to determine their outstanding benefits as well as their limitations . . . before a new plasticizer is introduced to the trade and offered commercially.

As the supplier of almost a hundred different liquid, solid, monomeric and polymeric plasticizers —Monsanto's technical service to compounders is unique: Monsanto's commercial interest is not confined to any single particular chemical type or to any single product. In working out plasticizing systems, recommendations are based on cost versus performance characteristics entirely.

To service plasticizer users in the business of extruding, formulating plastisols, calendering film, fabric coating, or making protective coatings—Monsanto has established a PLASTICIZER COUNCIL. This is a group numbering no less than five, often as many as six or eight technologists—each a specialist in his field. This council brings together experts in basic chemistry, resin technology, analytical and physical testing, and commercial compounding to consult on your particular plasticizing problems.

The PLASTICIZER COUNCIL takes each major plasticizing problem under advisement; "blocks



The Plasticizer Council brings wide and varied experience to the assistance of resin compounders to solve problems of plastics compounding, processing, and performance. Experienced technologists staff laboratories well-equipped with performance evaluation equipment, such as this Instron Tensile Tester.

out" several possible solutions—then these are tried out in the Applications Laboratory. When the most efficient plasticizing system is proved out, both from processing ease and finished compound performance, the conclusions are passed on to the customer. Many large resin processors look upon Monsanto's PLASTICIZER COUNCIL as an extension of their own technical facilities. A number of large floor tile makers, extruders, film makers and fabric coaters regularly consult with Monsanto's technical service whenever they have a new product in view or an improvement is sought in an existing product.

The PLASTICIZER COUNCIL recommendations are unbiased by restricted commercial interest; they are supported by over thirty years of accumulated research and processing technology in the practical chemistry of resin plasticizing.

Commercial Availability... Production and Distribution

Monsanto produces plasticizers domestically at St. Louis, Mo.; East St. Louis, Ill.; Everett, Mass.; Anniston, Ala.; Long Beach, Calif.; and Bridgeport, N. J. International distribution points include Buenos Aires, Argentina; Sydney and Melbourne, Australia; Brussels, Begium; San Paulo, Brazil; Montreal and Toronto, Canada; Hong Kong, China; Milan, Italy; Tokyo, Japan; Mexico City, Mexico; and Barcelona, Spain.

Monsanto is basic in the manufacture of most of the raw materials and intermediates required by its line of plasticizer products. This ensures predictable supply, thorough quality control, and the most economical operation and pricing. Of the major intermediate chemicals needed for the manufacture of plasticizers, Monsanto is a major producer of phthalic anhydride (for phthalate plasticizers), adipic acid (for adipates), phosphorus oxychloride (for phosphates), toluenesulfonyl chlorides (for sulfonamides), phenol, chlorine, cyclohexanol, methanol, and benzyl chloride.

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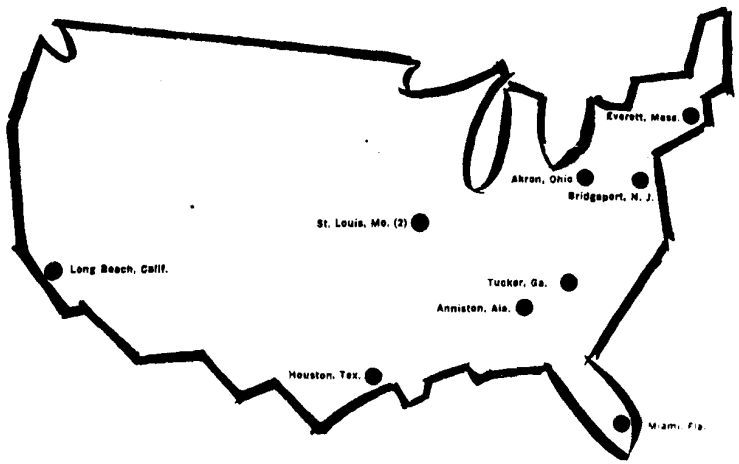


ten bulk station distribution points

To give rapid delivery and multi-product shipments, Monsanto maintains bulk station inventories at strategic industrial centers along the east coast, the south and southwest, the midwest and the west coast. These bulk stations are another customer service that enables plasticizer users to save money in the following ways:

Lowest cost/lb. With Monsanto's distribution, compounders can reduce their materials costs by purchasing in tank cars direct from the producing plant or by ordering tank truck shipments from the nearest bulk storage station. Bulk prices are about 10% lower than car- and truck-lot drum prices.

Conservation of plant storage space Since the Monsanto bulk stations are strategically located close to major manufacturing centers, minimum plasticizer storage space is needed. Supplies available in most areas for fast, short-haul delivery.

Compartmented shipments With such a broad line of plasticizers, compounders can take the savings in bulk purchasing by ordering as many as three different plasticizers in a single order. The different plasticizers are shipped in compartmented tank trucks. Multi-product combined shipments from bulk stations can also reduce in-plant inventory costs.

Mixed Car- and Truck-lot Shipments By offering such a full line of plasticizers, Monsanto can load out mixed drum orders in a single car or truck. This gives the buyer the cost economy of full carriers.

Ordering, invoicing simplified With this efficient distribution system, compounders can make additional savings by fewer shipments, fewer orders, and reduced paper work in clerical handling of invoices.

Monsanto is always ready to work with customers to establish and maintain convenient bulk station distribution centers wherever volume justifies a mutually convenient storage station.

specifications and physical characteristics

of Monsanto plasticizers

Monsanto plasticizers comprise both liquids and solids representing a variety of distinct chemical types, including

phthalate esters

adipate esters

permanent plasticizers

glycollates

sulfonamides

phosphate esters

aroclor® plasticizers

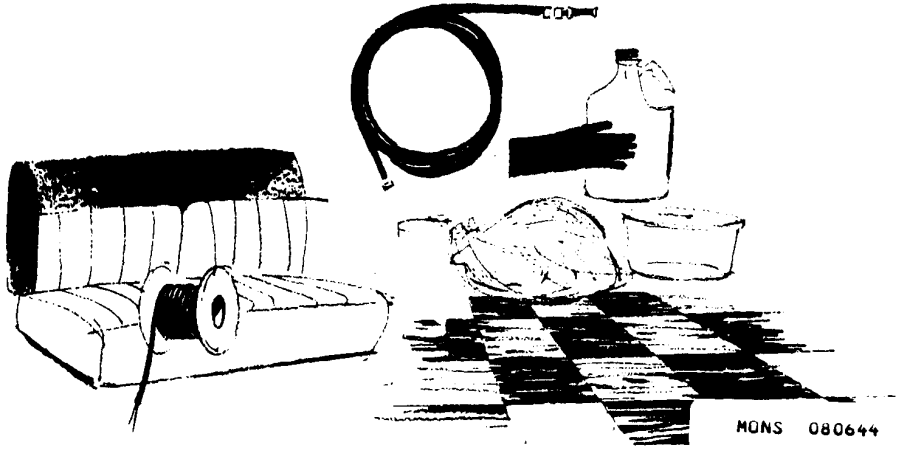
... plus a variety of "specialty" compounds and extenders.

Each of these, in themselves, but primarily in combination offer special processing or end product quality advantages in particular applications. Specific plasticizers and specially researched combinations have been developed for formulation of plastisols for slush molding, fabric and paper coating; for adhesives and surface coatings; for extrusions both profile and cross section; for floor tile; and for cast or calendered free film.

The following pages describe physical properties of the various plasticizers of choice available from Monsanto.


PLASTICIZERS
For the Widest Choice in the World

The following pages give [illegible] information on each of the plasticizers [illegible]. It is the largest selection [illegible] both as to chemical variety and [illegible] applications from any one [illegible] as the primary plasticizer [illegible] as a secondary adjuvant . . . you can [illegible] exact qualities needed in any known [illegible] formulation.



MONS 080644

Phthalates

Dibutyl 1
Dicyclohexyl 2
Diethyl 3
Diisodecyl 4
Diisooctyl 5
Dimethyl 6
Di(n-octyl,n-decyl) 7
Dioctyl 8
Diphenyl 9
Ditridecyl 10
Santicizer 160 11
Santicizer 165 12
Santicizer 213 13
Santicizer 214 14
Santicizer 215 15
Santicizer 262 16
Santicizer 278 17
Santicizer 602 18
Santicizer 603 19
Santicizer 630 20
Santicizer 631 21
Santicizer 632 22
Santicizer 636 23
Santicizer 681 24
Santicizer 683 25

Adipates

Diisodecyl ..... [illegible]
Di(n-octyl,n-decyl) ..... [illegible]
Dioctyl ..... [illegible]

Phosphates

Tributoxyethyl ..... [illegible]
Tributyl ..... [illegible]
Tricresyl ..... [illegible]
Triphenyl ..... [illegible]
Santicizer 140 ..... [illegible]
Santicizer 141 ..... [illegible]

Glycolates

Santicizer E-15 33
Santicizer B-16 34
Santicizer M-17 35

Sulfonamides

Santicizer 1-H 36
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Santicizer 8 38
Santicizer 9 39
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Santolite MS-80% 40a

Permanent

Santicizer 405 41
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MONS 080645

high-efficiency plasticizer for nitrocellulose and polyvinyl acetate

DBP

dibutyl phthalate

General Description

Dibutyl phthalate is the most widely used plasticizer for nitrocellulose; is useful in polyvinyl acetate, phenolics, and in nitrile and chlorinated rubbers. It is compatible with a wide variety of other resins.

In nitrocellulose, even in small amounts, dibutyl phthalate exerts strong solvent action, imparts good gloss and a high degree of plasticity. Larger amounts produce soft compounds with reduced tensile strength. Dibutyl phthalate tolerates high dilution with petroleum naphtha, and its use permits formulation of low-cost lacquers. For textile coatings, replacing a portion of the commonly used castor oil with dibutyl phthalate will improve the low-temperature flexibility.

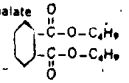
In polyvinyl acetate emulsions, dibutyl phthalate is the standard plasticizer, imparts good flexibility, has relatively low volatility, is an efficient plasticizer with good general properties. In emulsion paints, it has excellent light stability; in adhesives it imparts good tack and dependable operation of machine sealing.

In phenolics, dibutyl phthalate used in the resin formulation for making punching laminates results in cleaner-cut punches. It imparts a degree of plasticity to laminating varnish resins that permits post-forming of the cured laminated sheets for luggage, decorative panels, and other shapings.

In nitrile rubber, dibutyl phthalate is widely used to impart good Banbury and mill working properties; also develops many desirable properties in chlorinated rubber compositions.

Dibutyl phthalate has low oral toxicity; does not irritate or sensitize the skin.

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	278.34
• Appearance	Clear, oily liquid.
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color	APHA 20 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight, characteristic
Refractive Index @ 25°C.	1.4895 to 1.4915
• Specific Gravity 25°/25°C.	1.044 to 1.048
Weight per gallon @ 25°C.	8.72 lbs.
Boiling Point, 760 mm Hg	340°C.
Crystallizing Point	< -35°C.
Pour Point	−40°C.
Flash Point (C.O.C.)	340°F.
Fire Point (C.O.C.)	395°F.
Vapor pressure @ 150°C.	1 mm Hg
200°C.	9 mm Hg
300.C.	300 mm Hg
Viscosity @ 0°C.	55.0 cks.
25°C.	15.6 cks.
98.9°C.	2.4 ck.s
Surface tension @ 20°C.	35 dynes/cm
Assay (ester content)	99% min.
Solubility in water @ 30°C.	0.001%
General solubility	Soluble in all common organic solvents and oils.
Thermal expansion @ 10° to 40°C.	0.00078 cc/cc/°C.

• Specifications

MONS 080646



Dibutyl phthalate, most widely used plasticizer in nitrocellulose, imparts high gloss to nitrocellulose lacquer for furniture and other applications.

Evaluation in Various Resins

Resin	Ethyl Cellulose		Nitrocellulose		PVAc	Cellulose Acetate Butyrate
Parts/100 Resin	15	0	50	0	20	33⅓
Yield Point, p.s.i.	3625	6755	—	—	—	—
Tensile strength, p.s.i.	5120	8960	2700	8533	—	1800
Elongation, %	38	30	4	6	—	12
Hardness Index	55	100	—	—	—	—
Sward Hardness	—	—	—	—	—	38
Volatility	G	E	—	—	4.4%	—
Schopper Fold Cycles	—	—	10	20	—	—
Moisture Permeability, %	—	—	65	100	—	—
Flexibility after light exposure	E	E	—	—	—	—
T_f °C.	—	—	—	—	−6.1	—

E=Excellent

G=Good

MGNS 080647

solid plasticizer for nitrocellulose lacquers, vinyls and acrylics

DCHP

dicyclohexyl phthalate

■ General Description

Dicyclohexyl phthalate, a white solid, is an excellent plasticizer for nitrocellulose; is used in combination with other plasticizers for polyvinyl chloride, ethyl cellulose, polystyrene and methacrylate.

In *nitrocellulose*, dicyclohexyl phthalate promotes heat sealability, creates a moisture-proof barrier, resists extraction by oil and water. All of these properties are of great value in the manufacture of lacquers, heat-sealing coatings and adhesives, and films. Where liquid plasticizers often cause blocking, dicyclohexyl phthalate-plasticized films feel dry and separate easily. In nitrocellulose adhesives, dicyclohexyl phthalate greatly improves the tack and oil resistance.

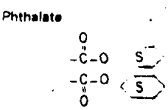
In *polyvinyl chloride* formulations, dicyclohexyl phthalate can be used as a partial replacement for liquid primary plasticizers, such as dioctyl phthalate and diisodecyl phthalate. Such combination reduces the extraction of the plasticizer by kerosene, oils, and greases. Dicyclohexyl

(continued)

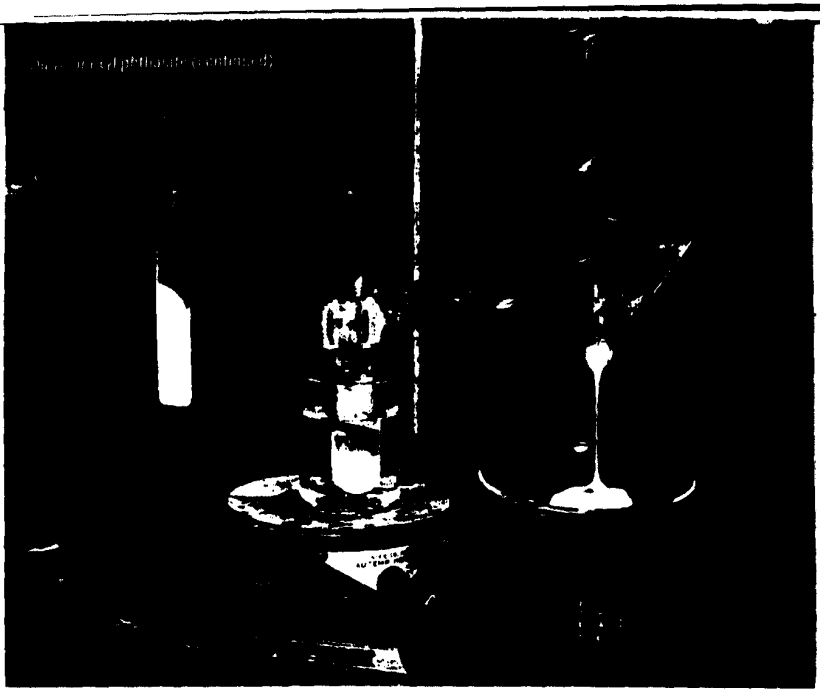


In heat-seal coatings and adhesives, dicyclohexyl phthalate imparts sharp melting points and quick tack.

■ Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	330.41
• Appearance	White lumps or granules
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color (molten)	APHA 100 max. (molten)
• Moisture	0.1% max. (KF in methanol)
• Odor	Moderate aromatic; slight phthalic characteristic
• Melting Point	63.0°C. min. to start
Density @ 25°C.	1.29 grams/ml.
Boiling Point, 4 mm Hg	220° to 228°C.
Pour Point	60°C.
Flash Point (C. O. C.)	405°F.
Fire Point (C. O. C.)	465°F.
Vapor pressure @150°C.	0.09 mm Hg
200°C.	1.1 mm Hg
Distillation range, 4 mm Hg: < 210°C.	None
< 222°C.	5% max.
< 228°C.	90%
> 235°C.	None
Surface tension @ 75°C. ± 1°	36.4 dynes per cm.
• Assay (ester content)	99.0% min.
Solubility in water @ 25°C.	<0.01%
General solubility	Soluble in acetone, n-butanol, carbon tetrachloride, cyclohexanone, ethyl acetate, ethyl ether and toluene.

• Specifications



At processing temperatures, dicyclohexyl phthalate acts as a liquid solvating-plasticizer to permit easier processing, yet it imparts rigidity to the finished product.

phthalate imparts excellent processing characteristics, aids in manufacturing formulations for rigid and semi-rigid applications such as sheets and foams. Following is a typical formulation performance:

Compound Ingredients		*Performance*	
Opalon 660	100	Volatility,	
Dicyclohexyl		% weight lost	1.34
phthalate	20	Tensile, p.s.i.	4600
Santicizer 160	10	Elongation, %	234
Epoxy soybean oil	5	Modulus, p.s.i.	
Stabilizer	3.5	(100% Elong.)	2874
		Yield, p.s.i.	1900
		Shore "D" hardness	70

In *ethyl cellulose*, *methacrylate*, and *polystyrene*, dicyclohexyl phthalate is used in combination with other plasticizers; it is also useful with cellulose acetate-butyrate and chlorinated rubber. In *acrylic lacquer* systems, dicyclohexyl phthalate increases solids without increasing viscosity, imparts good light stability and hardness. It is usually used in conjunction with Santicizer 160 which functions as the major primary plasticizer. The following is an evaluation in cellulose acetate-butyrate of 37% butyl content at 33⅓ parts of plasticizer per 100 parts of resin:

Sward hardness	30
Tensile, p.s.i.	3900
Elongation, %	31

Toxicity studies show that dicyclohexyl phthalate possesses a very low degree of toxicity and that no unusual precautions need be taken in handling.

MONS 080649

plasticizer for cellulose acetate molded products and polyvinyl acetate adhesives

DEP
diethyl phthalate

General Description

Diethyl phthalate is an excellent plasticizer for *cellulose acetate*, particularly for use in molding compounds. It has high compatibility with cellulose acetate, excellent light stability, imparts good molding properties and is low in cost. It may be used alone or in combination with dimethyl phthalate.

In polyvinyl acetate adhesives and surface coatings, diethyl phthalate in combination with dibutyl phthalate gives better low-temperature coalescence than emulsions with dibutyl phthalate alone. Diethyl phthalate imparts quick tack to polyvinyl acetate emulsions.

Performance in PVAc (40 mil, 20 PHR)

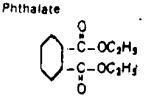
Volatility 24 hrs. @ 85°C. (% Plasticizer Lost)	4.8
Low-Temperature Flex, T_1°C.	−5.0
Extraction, 24 hr. Immersion:	
% Plasticizer Lost (kerosene)	0.85
% Plasticizer Lost (peanut oil)	0.63
% Plasticizer Lost (cottonseed oil)	0.82

In polystyrene, diethyl phthalate promotes extremely fast gelling because of its high compatibility and fast fusion characteristics.

Diethyl phthalate can be used for plasticizing acrylic resins, alkyds, ethyl cellulose, neoprene and nitrile rubbers, phenolics, and polyvinyl butyral.

Diethyl phthalate is regulated by prior sanction for use in films under the 1958 Amendment to the Food Additives Act. Its oral toxicity is low; experience indicates that it neither irritates nor sensitizes the skin.

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	222.11
• Appearance	Clear, oily liquid.
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color	APHA 10 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight aromatic max.
Refractive Index @ 25°C.	1.4990 to 1.5010
• Specific Gravity 25°/25°C.	1.115 to 1.119
Weight per gallon @ 25°C.	9.35 lb
Boiling Point, 760 mm Hg	298°C.
Crystallizing Point	< −0.3°C.
Pour Point	< −40°C. (supercools readily)
Flash Point (C.O.C.)	305°F.
Fire Point (C.O.C.)	335°F.
Vapor pressure @ 150°C.	8 mm Hg
200°C.	50 mm Hg
Viscosity @ 0°C.	31.0 cks.
25°C.	9.8 cks.
98.9°C.	1.8 cks.
Surface tension @ 20.5°C.	35.3 dynes/cm
Assay (ester content)	99% min.
Solubility in water @ 32°C.	0.1%
General solubility	Soluble in all common organic solvents and oils.
Sulfur (copper-strip test)	Negative

• Specifications



This Organoleptic panel helps further improve the odor of Monsanto plasticizers.

Performance in 20 mil Cellulose Acetate Film

	10 PHR	25 PHR	50 PHR
Volatility, 12 days @ 60°C. (% Plasticizer Lost)	0.92	2.45	—
Water Immersion (48 hrs.) (% soluble matter lost)	—	1.20	—
Tensile, p.s.i.	—	—	4760
Elongation, %	—	—	20
Flexibility			
M.I.T. Fold-endurance, cycles	7	22	—
Schopper Fold Flex, cycles	—	15	39

The following indicate the amount of diethyl phthalate required to reach a flow condition at various temperatures for cellulose acetate and cellulose acetate-butyrate.

For a Flow Temp. (F.)	PHR Diethyl Phthalate in Cellulose Acetate	PHR Diethyl Phthalate in Cellulose Acetate-Butyrate
266°	59.7	17.5
285°	49.1	12.1
307°	39.2	7.3

MONS 080651

low-volatility, soapy-water-resistant plasticizer for polyvinyl chloride

DIDP

diisodecyl phthalate

■ General Description

Diisodecyl phthalate is used to impart good heat aging and soapy-water-resistance properties to polyvinyl chloride compositions. The excellent heat aging properties developed are due to this plasticizer's low volatility. Its resistance to extraction by soapy water is superior to that of DOP and most polymeric plasticizers, once considered the best for this property.

Compared with DOP and most polymeric plasticizers, diisodecyl phthalate is superior in making polyvinyl chloride compositions with less migration when in contact with nitrocellulose lacquers and films; compared to DOP, it imparts better low-temperature flexibility upon aging, exhibits less than half the volatility, is similar in heat and light stability. Diisodecyl phthalate used in insulation has a high degree of permanence, retains good elongation under heat aging, and in 80° and 90° insulating compounds saves on formulation cost and imparts much better electrical properties than other plasticizers.

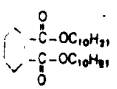
In polyvinyl chloride plastisols, diisodecyl phthalate is superior to DOP in its slower viscosity build-up and the longer storage life of the finished formulation.

Diisodecyl phthalate is used as a plasticizer for *polyurethane* foam to improve resilience. Normally about 10 parts per hundred of foam are used.

It is also compatible and useful with polyvinyl butyral, high-butyral-content cellulose acetate-butyrate, nitrocellulose, ethyl cellulose, methyl methacrylate, polystyrene, chlorinated rubber and other synthetic rubbers.

Diisodecyl phthalate has relatively low toxicity evaluated by animal feeding and contact tests.

■ Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	446.65
• Appearance	Clear, oily liquid.
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color	APHA 50 max.
• Moisture	0.10% max. (KF in methanol)
• Odor	Slight, characteristic
Refractive Index @ 25°C.	1.4794 to 1.4864
• Specific Gravity 25°/25°C.	0.963 to 0.969
Weight per gallon @ 25°C.	8.05 lb.
Boiling Point, 4 mm Hg	250-257°C.
Crystallizing Point	−53°C. (stiff clear gel)
Pour Point	−46°C.
Flash Point (C.O.C.)	450°F.
Fire Point (C.O.C.)	520°F.
Vapor pressure @ 150°C. 200°C.	0.015 mm Hg 0.35 mm Hg
Viscosity @ 0°C. 25°C. 98.9°C.	642.0 cks. 91.0 cks. 5.6 cks.
Surface tension @ 20°C.	29 dynes/cm.
Surface in water @ 25°C.	<0.005%
General solubility	Limited solubility in glycerine, the glycols and some amines. Soluble in most other organic liquids.
Thermal expansion @ 10° to 40°C.	0.00074 cc/cc/°C.

• Specifications

Diisodecyl phthalate (continued)

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	1.5	2.2	2.2
Low-Temperature Flex, T_f °C	−15	−37	−53
Water Immersion (24 hours):			
% soluble matter lost	0.01	0.02	0.03
% water absorbed	0.15	0.24	0.25
Kerosene extraction (% plasticizer lost)	10.3	>70	>70
Shore "A" Hardness (250 mil)	91	78	58
Migration, Linde Silica:			
1 day	0.55	1.51	2.55
3 days	0.88	2.93	5.29
7 days	1.53	4.76	9.30
Tensile, p.s.i. (75 mil)	3010	2300	1540
Elongation, % (75 mil)	300	390	440
Modulus @ 100% Elongation (75 mil)	1820	1140	590
Flame Retardant	No	No	–
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Excellent	Excellent	Good-Exc.
Fluxing Rate	Fair	Fair	Fair
Electrical Properties	Excellent	Excellent	–

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	4,800
7 Days	7,000
28 Days	7,000
40°C	
Initial	4,500
7 Days	12,400
28 Days	19,080
50°C	
Initial	4,200
7 Days	27,080
28 Days	19,080
Severs	
10 psi	16,750
50 psi	12,400
100 psi	8,570
Yield value, dynes/cm²	100
Flow Index	2.0
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	138
*Air Release Time, minutes	11
*Resilience steel ball, inches	5.4
*Resilience rotationally cast ball, inches	18

*Efficiency Conc. Adj. to "60" Shore A Hardness

general-purpose plasticizer for polyvinyl chloride

DIOP

diisooctyl phthalate

■ General Description

Diisooctyl phthalate is a general-purpose plasticizer for *polyvinyl chloride* and other resins; it is an alternate choice plasticizer for DOP. Its flexibilizing effect is closely akin to DOP in both the amounts used, the method of use, and in the properties imparted to the finished formulation.

In vinyl organosols and plastisols, diisooctyl phthalate imparts superior storage life to the formulations because it offers a lower viscosity build-up.

Diisooctyl phthalate is compatible with a wide variety of other resins and is commonly used with high-butyral-content cellulose acetate-butyrate, nitrocellulose, chlorinated rubber, Buna N rubber, and ethyl cellulose.



Diisooctyl phthalate is widely used to formulate plastisols for a variety of heavy coatings uses, such as glass pressure containers.

■ Properties

Chemical type	Phthalate
Chemical formula	$-C-OC_8H_{17}$ $-C-OC_8H_{17}$ O
Molecular weight	390.53
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm max (0.01% as phthalic acid)
• Color	APHA 35 max
• Moisture	0.10% max.
• Odor	Slight, characteristic max
Refractive Index @ 25°C.	1.4810 to 1.4880
• Specific Gravity 25°/25°C.	0.980 to 0.985
Weight per gallon @ 25°C.	8.21 lb.
Boiling Point, 4 mm Hg	228-237°C.
Crystallizing Point	−45°C.
Pour Point	−46°C.
Flash Point (C.O.C.)	430°F.
Fire Point (C.O.C.)	480°F.
Vapor pressure @ 150°C. 200°C	0.05 mm Hg 1.0 mm Hg
Viscosity @ 0°C. 25°C. 98.9°C.	322.0 cks. 55.0 cks. 4.3 cks.
Surface tension @ 20°C	32 dynes/cm
Assay (ester content)	99% min. to 101%
Solubility in water @ 25°C.	< 0.01%
General solubility	Insoluble or limited solubility in glycerine, glycols, and certain amines. Soluble in most other organic liquids.
Thermal expansion @ 10° to 40°C.	0.00073 cc/cc/°C
Sulfur (copper-strip test)	Negative

• Specifications

MONS 080654

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	4.0	4.3	4.7
Low-Temperature Flex, T_f °C	−16	−37	−54
Water immersion (24 hours):			
% soluble matter lost	0.01	0.03	0.04
% water absorbed	0.19	0.25	0.28
Kerosene extraction (% plasticizer lost)	6.7	28	>70
Shore "A" Hardness (250 mil)	88	74	53
Migration, Linde Silica:			
1 day	0.53	1.17	2.59
3 days	0.80	2.11	5.57
7 days	1.42	4.73	9.79
Tensile, p.s.i. (75 mil)	2850	1920	1310
Elongation, % (75 mil)	320	390	460
Modulus @ 100% Elongation (75 mil)	1810	860	430
Flame Retardant	No	No	–
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Fair	Poor
Fluxing Rate	Good	Good	Good
Electrical Properties	Good-Exc.	Good-Exc.	–

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	5,050
7 Days	6,950
28 Days	9,600
40°C	
Initial	4,000
7 Days	18,550
28 Days	25,350
50°C	
Initial	4,600
7 Days	36,650
28 Days	Gel
Severs	
10 psi	12,900
50 psi	14,700
100 psi	11,000
Yield value, dynes/cm^2	80
Flow Index	2.7
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	127
*Air-Release Time, minutes	10
*Resilience, steel ball, inches	4.6
*Resilience, rotationally cast ball, inches	–

*Efficiency Conc. Adj. to "60" Shore A Hardness

plasticizer for cellulose acetate molded products and polyvinyl acetate (also repels insects)

DMP
dimethyl phthalate

General Description

Dimethyl phthalate is one of the most commonly used plasticizers (like diethyl phthalate) for plasticizing *cellulose acetate*, particularly for molding. Dimethyl phthalate should be used as a coplasticizer with diethyl phthalate or Santicizer M-17 in cellulose acetate molding compounds; if used alone it may crystallize at low temperatures and make the finished product white and brittle. In combination with diethyl phthalate, dimethyl phthalate has high compatibility, good light stability, imparts good molding characteristics, and is economical to use.

In *polyvinyl acetate* adhesives and coatings, dimethyl phthalate imparts quick tack and better low-temperature emulsion coalescence than formulations with dibutyl phthalate alone. In a 40 mil polyvinyl acetate film, dimethyl phthalate used at a level of 20 PHR shows:

Volatility, 24 hrs. @ 85°C. (% Plasticizer Lost)	5.6
Low-Temp. Flex, T_f °C	−1.6
Extraction 24 hrs. (%Plasticizer Lost)	
In kerosene	0.92
In peanut oil	0.75
In cottonseed oil	0.93

In *polystyrene*, dimethyl phthalate causes extremely fast gelling because of its high compatibility and fast fusion.

It is compatible with nitrocellulose, ethyl cellulose, alkyds, acrylics, phenolics, polyvinyl butyral, polystyrene, and nitrile rubber.

Dimethyl phthalate is widely used as a dispersant for organic and inorganic peroxides. It makes the peroxides safer to handle before they are incorporated into plastic compounds.

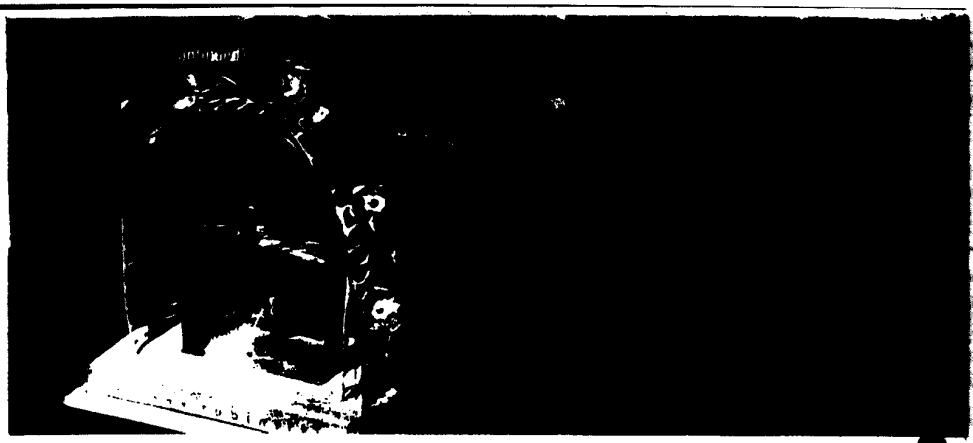
Dimethyl phthalate, a common insect-repellent ingredient, is especially effective against chiggers.

Dimethyl phthalate has an extremely low order of toxicity.

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	194.18
• Appearance	Clear, oily liquid.
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color	APHA 10 max.
• Moisture	0.20% max. (KF in methanol)
• Odor	Slight aromatic, max.
Refractive Index @ 25°C.	1.5123 to 1.5143
• Specific Gravity 25°/25°C.	1.188 to 1.192
Weight per gallon @ 25°C.	9.92 lb.
Boiling point, 760 mm Hg	282°C.
Crystallizing Point (in −2°C. bath)	0.0°C.
Pour Point	−26°C. (supercools)
Flash Point (C.O.C.)	300°F.
Fire Point (C.O.C.)	315°F.
Vapor pressure @ 150°C.	13 mm Hg
200°C.	76 mm Hg
Viscosity @ 0°C.	54.0 cks.
25°C.	11.4 cks.
98.9°C.	1.6 cks.
Surface Tension @ 20°C.	32 dynes/cm.
Assay (ester content)	99.0% min.
Solubility in water @ 32°C.	0.4%
General solubility	Insoluble in petroleum oils. Soluble in all other common organic solvents and oils.
Thermal expansion @ 0°C. to 30°C.	0.00092 cc/cc/°C.
Sulfur (copper-strip test)	Negative

• Specifications



For sparkling cosmetics packages and other molded cellulose acetate products, dimethyl phthalate (used with diethyl phthalate) imparts good mold-release and light-stability properties, with production economy.

The following data give an indication of the flow properties of dimethyl phthalate in two types of molding compounds:

For this Flow Temp. (°F.)	PHR Dimethyl Phthalate in Cellulose Acetate	PHR Dimethyl Phthalate in Cellulose Acetate-Butyrate
266°	37.3	15.1
285	30	11
307	22.7	6.5

Performance in Cellulosics

Resin	Cellulose Acetate	Cellulose Acetate-Butyrate
Dimethyl Phthalate, PHR	50	33-1/3
Hardness		
Sward	—	46
Rockwell "M"	32	—
Flexural Strength, p.s.i.	5840	—
Tensile Strength, p.s.i.	—	4200
% H_2O Absorbed (48 hrs.)	1.14	—
% Elongation	—	14

MONS 080657

general-purpose plasticizer with good low-temperature flexibility

DNODP

di(*n* octyl,*n*-decyl phthalate

General Description

Di(*n*-octyl,*n*-decyl) phthalate is an efficient primary plasticizer for polyvinyl chloride and vinyl chloride-vinyl acetate copolymers. It imparts outstanding low-temperature flexibility, coupled with good permanence and electrical properties.

In *polyvinyl chloride* film and sheeting applications di(*n*-octyl,*n*-decyl) phthalate is an excellent plasticizer for jackets, garden hose, and primary insulation. Its excellent combination of low-temperature and electrical properties make its use almost mandatory for certain critical applications.

Polyvinyl chloride plastisols plasticized with di(*n*-octyl,*n*-decyl) phthalate possess low initial viscosity and good viscosity stability.

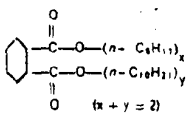
In addition to polyvinyl chloride, di(*n*-octyl,*n*-decyl) phthalate is also compatible and useful with the following resins:

cellulose nitrate
ethyl cellulose
cellulose acetate-butyrate
polystyrene
polyvinyl butyral
acrylic resins
acrylonitrile rubber
chlorinated rubber
neoprene

Di(*n*-octyl,*n*-decyl) phthalate is not compatible with polyvinyl acetate, cellulose acetate, or GRS rubber.

Toxicity studies indicate that di(*n*-octyl,*n*-decyl) phthalate is relatively nontoxic; no special precautions are necessary in normal industrial handling of this material.

Properties

Chemical type	Phthalate
Chemical Formula	 (x + y = 2)
Molecular Weight	418 Average
• Appearance	Clear, oily liquid
• Acidity	0.1 meq/100 gm. max. (0.015% as phthalic acid)
• Color	APHA 50 max.
Moisture (KF in methanol)	0.1%
• Odor	Slight, characteristic
• Refractive Index @ 25°C	1.4810 to 1.4840
• Specific Gravity @ 25°/25°C	0.9680 to 0.9770
Weight per gallon @ 25°C	8.1
Boiling Range @ 4 mm Hg	232 to 267°C
Crystallizing Point	−30°C
Pour Point	−35°C
Flash Point (C.O.C.)	435°F
Vapor pressure @ 150°C @ 200°C	 0.01 mm Hg 0.25 mm Hg
Viscosity @ 25°C	138 cks
Surface Tension @ 20°C	31 dynes/cm.
Solubility in Water @ 25°C	<0.01%
General Solubility	Soluble in most organic liquids; insoluble or limited solubility in glycerine, glycols, and amines.
Thermal Expansion	0.00071 cc/cc/°C

• Specifications

MONS 080658

Performance in PVC (40-mil sheet)

	(33⅓%) 50 PHR	(40%) 67 PHR
Volatility (% Lost)	2.7	2.8
Low-Temperature Flex, T_f, °C	−33	−47
Water immersion (24 hours)		
% soluble matter lost	0.02	0.16
% water absorbed	0.36	0.45
Kerosene extraction (% plasticizer lost)	27.2	>70
Shore "A" Hardness	84	73
Flame Retardant	No	No
Heat stability	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Good
Fluxing Rate	Fair	Fair
Electrical Properties	Excellent	Excellent

Performance In Plastisol Formulation

Viscosity, centipoises
Brookfield LVF #4 Spindle @ 30 RPM

	60 PHR	80 PHR
23°C		
Initial	4540	1940
7 days	6440	2780
28 days	7600	4340
40°C		
Initial	2780	1340
7 days	9640	4200
28 days	19,640	5260
50°C		
Initial	3060	1360
7 days	Gel	16,440
Fusion Point, °C	134 (65 PHR)	—

general-purpose plasticizer; "standard" for polyvinyl chloride

DOP

di(2 ethylhexyl) phthalate

(dioctyl phthalate)

■ General Description

Dioctyl phthalate is an excellent general purpose plasticizer, often the "standard" against which PVC plasticizers are judged. It is compatible with most common resins, affords good resin solvation, is stable to light and heat and provides the optimum performance at a reasonable cost level.

Dioctyl phthalate-plasticized *polyvinyl chloride* compositions have in general good low-temperature flexibility, heat sealability, wear resistance, good heat-aging characteristics, and fair resistance to extraction by grease, oil, water, and soap solutions. The plasticized compounds have excellent electrical properties.

In PVC plastisols, dioctyl phthalate is widely used for dip coating, fabric coating, and slush molding. It develops a medium level of initial viscosity and rate of viscosity build-up.

In nitrocellulose lacquers, dioctyl phthalate imparts good initial color and good heat and light stability. In interior lacquers, dioctyl phthalate improves cold-check resistance. In automotive lacquers, it imparts good rubbing and polishing properties in addition to good initial gloss, gloss retention, and resistance to chalking.

Dioctyl phthalate is also used in cellulose acetate-butyrate, ethyl cellulose, natural and synthetic rubber to make film, sheeting, textile coatings, packaging materials, electrical formulations, adhesives and many types of protective coatings and hot melts.

Dioctyl phthalate is regulated by the Food and Drug Administration as a nontoxic plasticizer suitable for packaging all but fatty foods. It can be used in package coatings for food of high water content; in plastics tubing for handling milk, intravenous fluids, and blood.

Properties

Chemical type	Phthalate
Chemical formula	$C_6H_4(COOC_8H_{17})_2$
Molecular weight	390.53
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm. max. (0.01% as phthalic acid)
• Color	APHA 25 max.
• Moisture	0.10% max. (KF in methanol)
• Odor	Slight, characteristic, max
Refractive Index @ 25°C.	1.4845 to 1.4858
• Specific Gravity 25°/25°C.	0.980 to 0.985
Weight per gallon @ 25°C.	8.21 lb.
Boiling point, 760 mm Hg	386°C.
Crystallizing point	−55°C. (very stiff gel)
Pour point	−47°C.
Flash point (C. O. C.)	425°F.
Fire point (C. O. C.)	480°F.
Vapor pressure @ 150°C.	0.06 mm Hg
200°C.	1.2 mm Hg
Viscosity @ 0°C.	348.0 cks.
25°C.	58.0 cks.
98.9°C.	4.3 cks.
Surface tension @ 25°C.	33 dynes/cm
Assay (ester content)	99 to 101%
Solubility in water @ 25°C.	<0.005%
General solubility	Miscible with most common solvents and with most primary and secondary plasticizers for polyvinyl chloride.
Thermal expansion @ 10° to 40°C.	0.00074 cc/cc/°C
Sulfur (copper-strip test)	Negative

• Specifications

Dioctyl phthalate (continued)

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	4.2	4.5	5.0
Low-Temperature Flex, T_f°C	−17	−39	−55
Water immersion (24 hours):			
% soluble matter lost	0.01	0.03	0.04
% water absorbed	0.22	0.25	0.27
Kerosene extraction (% plasticizer lost)	8.3	34	>70
Shore "A" Hardness	87	72	50
Migration, Linde Silica:			
1 day	0.57	1.08	2.18
3 days	1.02	2.13	4.75
7 days	1.45	3.98	8.04
Tensile, p.s.i.	2890	1960	1340
Elongation, %	320	400	470
Modulus @ 100% Elongation, psi	1780	830	420
Flame Retardent	No	No	–
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Good	Good
Fluxing Rate	Good	Good	Good
Electrical Properties	Excellent	Excellent	–

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM	
23°C	
Initial	5,040
7 Days	9,160
28 Days	11,960
40°C	
Initial	4,280
7 Days	17,240
28 Days	20,240
50°C	
Initial	5,240
7 Days	32,320
28 Days	>100,000
Severs	
10 psi	10,200
50 psi	9,870
100 psi	6,580
Yield value, dynes/cm²	100
Flow Index	2.1
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	127
*Air-Release Time, minutes	9
*Resilience, steel ball, inches	4.5
*Resilience, rotationally cast ball, inches	18

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080661

solid plasticizer for polystyrene, cellulosics and vinyls

DPP

diphenyl phthalate

General Description

Diphenyl phthalate is a fused solid with a slight yellow or brown cast. It is compatible with a wide variety of cellulosic, vinyl, phenolic, polystyrene and other resins. Diphenyl phthalate is an ideal plasticizer for use in making heat-sealing and delayed-tack adhesives. It is also useful in lacquers, molding compounds, and films.

In rigid polyvinyl chloride products, diphenyl phthalate is an effective solvent at the processing temperatures and imparts only a slight plasticizing action after the product cools. Such products are hard and rigid; the presence of diphenyl phthalate does not impair the load carrying ability of the plastic. This property is of particular value in the manufacture of vinyl foams with a chemical blowing agent.

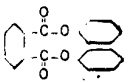
In cellulose acetate films, diphenyl phthalate may be used with other plasticizers to increase the resistance to water, moisture penetration, alcohol, and weather.

In polyvinyl acetate adhesives, diphenyl phthalate is used to make heat seal coatings with quick tack and excellent sensitivity to heat.

A eutectic mixture of equal parts of diphenyl phthalate and Santolite MHP is liquid at room temperature and makes an excellent plasticizer for cellulose and vinyl lacquers and adhesives. In ethyl cellulose, this mixture produces hard; flexible; tough; wear-, weather-, and alcohol-resistant lacquer films which maintain excellent gloss and resist alkali and discoloration on aging.

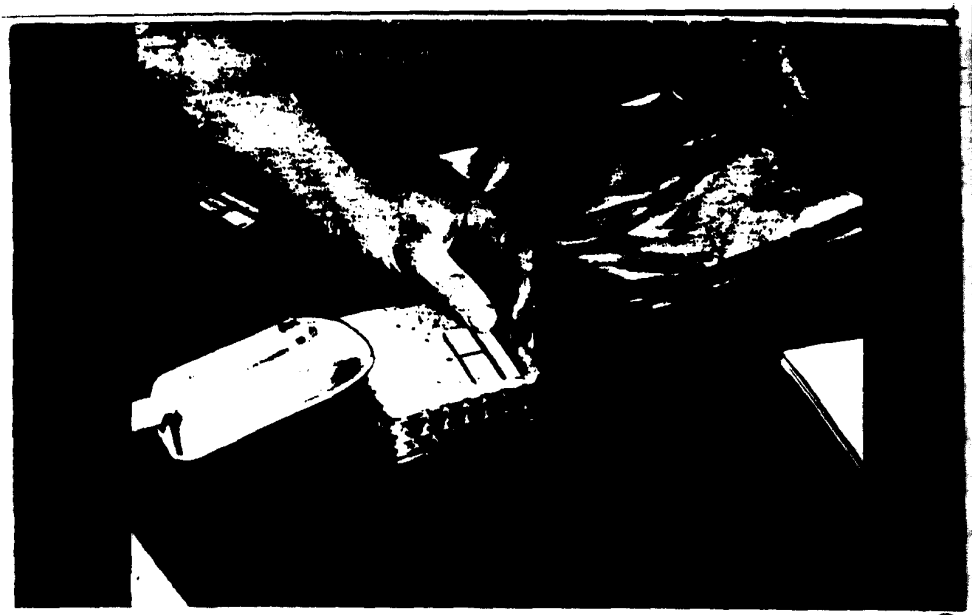
Animal toxicity studies show that diphenyl phthalate is practically harmless; it is not a skin irritant or sensitizer.

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	318.31
• Appearance	Essentially white, fused solid with a slightly yellow or brown cast.
• Acidity	1.20 meq/100 gm. max. (0.10% as phthalic acid)
Ash	0.05% max.
• Free phenol	0.20% max.
• Turbidity (20 ml. :50 ml. acetone)	Essentially clear
Moisture	0.25% max.
• Color (20 ml. :50 ml. acetone)	APHA 160 max. (20ml.:50 ml. acetone)
Refractive Index @ 74°C.	1.572
Density	1.28
Boiling point, 760 mm Hg	405°C.
Melting point	69°C.
Flash point (C. O. C.)	435°F.
Vapor pressure @ 150°C. 200°C. 300°C.	0.15 mm Hg 1.7 mm Hg 55 mm Hg
Solubility in water	<0.01%
General solubility	Readily soluble in ketones, esters, and chlorinated hydrocarbons. Low solubility in alcohols, turpentine, and linseed oil.

• Specifications

MONS 080662



Diphenyl phthalate imparts quick tack to heat-seal adhesives for meat and bread labels.

Performance in Other Resins

	Ethyl Cellulose (molding)		Cellulose Acetate Butyrate (37%) 40-mil film	Polyvinyl Acetate 40-mil film
PHR Diphenyl Phthalate	0	15	33⅓	20
Yield point, p.s.i.	6755	5405	—	—
Tensile, p.s.i.	8960	7680	3800	—
Elongation, %	30	38	28	—
Hardness Index	100	80	—	—
Sward Hardness	—	—	42	—
Volatility, % plasticizer lost (24 hrs. @ 85°C.)	very low	very low	—	5.9
Extraction by (24 hr. immersion)				
Kerosene	—	—	—	1.31
Peanut oil	—	—	—	0.90
Cottonseed oil	—	—	—	0.98

MONS 080663

permanent monomeric plasticizer

DTDP

ditridecyl phthalate

General Description

Ditridecyl phthalate is a clear, oily liquid with a characteristic odor. It was developed to meet the need for a monomeric plasticizer with outstanding low volatility. It imparts fair electrical properties, extreme resistance to soapy-water extraction, and good resistance to migration to nitrocellulose.

In *polyvinyl chloride* electrical insulation for high-temperature requirements (90°C and 105°C uses), its low volatility (good retention of elongation after heat aging) and electrical properties make ditridecyl phthalate a plasticizer worthy of evaluation. To insure the maximum electrical characteristics, Monsanto ditridecyl phthalate is stabilized with 0.75 per cent bisphenol A. Ditridecyl phthalate is generally blended with diisodecyl phthalate for 90°C wire and with Santicizer 409 for 105°C wire.

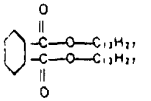
Since ditridecyl phthalate is relatively nonpolar, the compatibility of the finished compound should be carefully checked in the formulator's laboratory according to good industry practice.

The low volatility of ditridecyl phthalate and its low extraction by soapy water suggests its use in low-fogging automotive upholstery, shower curtains, and rainwear.

The good viscosity stability, extremely good soapy-water resistance, and flowability of ditridecyl phthalate-plasticized polyvinyl chloride plastisols suggests its use in dishwasher racks and coatings.

Since ditridecyl phthalate is relatively nontoxic, no special handling precautions are necessary.

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	530
• Appearance	Clear liquid
• Acidity	0.12 meq./100gm. max
• Color	APHA 100 max.
• Moisture (KF in methanol)	0.1% max.
• Odor	Characteristic
• Refractive Index @ 25°C	1.4813-1.4850
• Specific Gravity @ 25°/25°C	0.948 to 0.955
Weight per gallon @ 25°C	7.9
Boiling point @ 3.5 mm Hg	285°C
Pour point	−37°C.
Flash Point (C.O.C.)	450°F
Viscosity @ 0°C.	1500 cks
25°C.	160 cks
98.9°C.	8 cks
General Solubility	Soluble in most common organic solvents.

• Specifications

Ditridecyl phthalate is well qualified for use in 90°C and 105°C wire because of its low volatility, retention of elongation upon heat aging, and electrical properties.



MONS 080664



Performance in PVC (40-mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost)	1.4	1.4	1.5
Low-Temperature Flex, T_f °C	−16	−35	−48
Water immersion (24 hours)			
% soluble matter lost	0.06	0.11	0.13
% water absorbed	0.74	1.05	1.19
Kerosene extraction (% plasticizer lost)	43.7	>70	>70
Shore "A" Hardness	91	79	54
Flame Retardent	No	No	No
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Excellent	Excellent	Excellent
Fluxing rate	Poor	Poor	Poor
Electrical properties	Fair	Fair	Fair

Performance in Plastisol Formulation

Viscosity, centipoises Brookfield LVF #4 Spindle, 30 RPM	80 PHR
23°C	
Initial	4900
7 days	6440
28 days	9000
40°C	
Initial	3280
7 days	5040
28 days	4900
50°C	
Initial	1780
7 days	2640
28 days	Separated

MONS 080665

high-solvating, stain-resisting, general-purpose plasticizer

Santicizer 160

■ General Description

Santicizer 160 is a low-volatile, excellent general-purpose plasticizer with strong solvent action on a wide variety of resins.

In polyvinyl chloride hot-processing operations, such as calendering or extruding, Santicizer 160 imparts excellent processing characteristics since it significantly reduces the molten viscosity. This is especially useful for thick section products, such as floor tile where Santicizer 160 is frequently used as the sole plasticizer. In plasticizing thin films, Santicizer 160 is usually combined with other plasticizers such as Santicizer 141, DOP, dioctyl adipate, or with a fatty acid type ester.

Santicizer 160 imparts excellent tear, tensile and abrasion resistance. It is outstanding among primary plasticizers in its resistance to extraction by gasoline and oil and its resistance to staining by common household materials.

In polyvinyl chloride formulations, Santicizer 160 imparts good heat and light stability, sufficient permanence and low-temperature flexibility for most applications.

Santicizer 160 is an excellent plasticizer for *nitrocellulose* lacquers and films and for *polyvinyl acetate*. Compared to dibutyl phthalate it offers greatly improved permanence (lower volatility) and improved resistance to extraction by water.

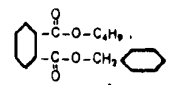
Acrylic lacquers plasticized with Santicizer 160 possess excellent gloss, resistance to water spotting and effects of humidity. It imparts excellent flowout and flexibility. These outstanding performance characteristics have made it the standard plasticizer for this type of lacquer.

With *ethyl cellulose*, Santicizer 160 produces clear sheets, moldings, films, and hot-melt (dip) compositions for packaging and protective coatings . . . imparting minimum heat degradation, maximum oil and water resistance, good permanence, clarity, toughness.

Santicizer 160 plasticizes a wide variety of resins, including difficult-to-plasticize *polyvinyl formal* (formulations up to 30% are tough, rigid; those above 40% are quite flexible); and *polyvinyl*

(continued)

Properties

Chemical type	Phthalate
Chemical formula	
Molecular weight	312.35
• Appearance	Clear, oily liquid.
• Acidity	0.37 meq/100 gm. max (0.03% as phthalic acid)
• Color	APHA 40 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight, characteristic, max.
Refractive Index @ 25°C.	1.535 to 1.540
• Specific Gravity 25°/25°C.	1.115 to 1.123
Weight per gallon @ 25°C.	9.3 lb.
Boiling point, 760 mm Hg	370°C.
Crystallizing point	<-35°C.
Pour point	-45°C.
Flash point (C.O.C.)	390°F.
Vapor pressure @ 150°C. 200°C. 300°C.	0.16 mm Hg 2 mm Hg 90 mm Hg
Viscosity @ 25°C.	41.5 cks. ± 1.5 cks
Surface tension @ 25°C.	39.9 dynes/cm
Solubility in water @ 30°C.	0.0003%
General solubility	Soluble in acetone, benzene and most organic solvents.
Thermal expansion @ 10° to 40°C.	0.00080 cc/cc/°C.

• Specifications



Because of its rapid processing characteristics, high efficiency, and outstanding stain resistance, Santicizer 160 is the preferred plasticizer for vinyl floor tile.

butyral (imparts good low-temperature properties, is less volatile than dibutyl sebacate). Santicizer 160 will plasticize lower-molecular-weight type polystyrene, chlorinated rubber, cellulose propionate, polyamides, and acrylic resins.

Santicizer 160 has relatively low toxicity, and has shown no indication of causing skin irritation or senstization.

Santicizer 160 (butyl benzyl phthalate) is FDA regulated in many food packaging applications with an extractability not to exceed 0.5 mg. per square inch of food contact area. This applies to both fatty food and high moisture content food packaging. The butyl benzyl phthalate cannot contain more than 1.0% by wt. of dibenzyl phthalate.

FDA regulation of Santicizer 160 (Federal Register, July 24, 1964) covers its use in adhesives, free film, tubing, metal and paper coatings, and moldings. Thermoplastic resins included in this sanction are polyvinyl chloride, polyvinyl acetate, polyvinylidene chloride, and nitrocellulose.

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	7.0	7.7	9.1
Low-Temperature Flex, T_f°C	−3.8	−24	−39.0
Water immersion (24 Hours):			
% soluble matter lost	0.02	0.05	0.25
% water absorbed	0.25	0.30	0.43
Kerosene extraction (% plasticizer lost)	2.0	3.0	13.3
Shore "A" Hardness	78	62	49
Migration, Linde Silica:			
1 day	0.25	1.27	4.03
3 days	0.46	2.56	7.8
7 days	0.74	4.15	11.4
Tensile, p.s.i.	3090	2240	1360
Elongation, %	320	400	460
Modulus @ 100% Elongation	1720	830	410
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Poor	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	Good	Good	—

Performance in Plastisol Formulation

		65 PHR
Viscosity, centipoises		
Brookfield HAT #6 Spindle		
50 RPM		
	23°C	
	Initial	5,000
	7 Days	7,240
	28 Days	8,240
	40°C	
	Initial	4,400
	7 Days	>100,000
	28 Days	Gel
	50°C	
	Initial	4,600
	7 Days	Gel
	28 Days	—
Severs		
	10 psi	29,800
	50 psi	51,200
	100 psi	44,200
Yield value, dynes/cm^2		60
Flow Index		6.0
Severs vis. 50 psi / Brookfield vis. 50 rpm		
Fusion Point, °C		89
*Air-Release Time, minutes		30
*Resilience,steel ball, inches		2.8
*Resilience,rotationally cast ball, inches		15

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080667

low-cost, fast-fusing primary plasticizer for polyvinyl chloride

Santicizer 165

■ General Description

Santicizer 165 is a fast-fusing primary plasticizer for polyvinyl chloride resins that offers good general properties at a cost lower than dioctyl phthalate. In the finished compound, Santicizer 165 imparts good heat and light stability and good low-temperature flexibility. Santicizer 165 is superior to dioctyl phthalate in its resistance to extraction by aliphatic solvents. Since Santicizer 165 is somewhat more volatile than dioctyl phthalate, it is recommended for average service conditions, rather than severe, sustained exposure to high temperatures.

Santicizer 165 may be used in vinyl film, sheeting, wire insulation, garden hose, plastisols, extrusions, flexible floor tile, and vinyl-asbestos floor tile.

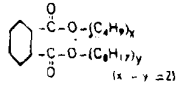
Santicizer 165 is widely used in *nitrocellulose* lacquers where its lower volatility and greater resistance to extraction by water compared to dibutyl phthalate make it of special value for surface coatings.

Santicizer 165 possesses a low degree of toxicity.



Because of its rapid fusion properties, Santicizer 165 is widely used in plastisol formulations for slush molding.

■ Properties

Chemical Type	Phthalate
Chemical formula	
• Appearance	Clear, oily liquid
• Acidity	0.12 meq /100 gm. max.
• Color	APHA 40 max.
• Moisture	0.12% max. (KF in methanol)
• Odor	Slight (similar to DOP)
• Refractive index @ 25°C.	1.484 to 1.487
• Specific gravity 25°/25°C.	0.990 to 0.996
• Saponification number	300 to 308
Weight per gallon @ 25°C.	8.28 lb.
Pour point	−51°C.
Flash point (C.O.C.)	390°F.
Vapor pressure @ 150°C.	19.6 mm Hg
200°C.	70.4 mm Hg
Viscosity @ 0°C.	250.0 cks
25°C.	45.0 cks
98.9°C.	3.9 cks
Solubility in water @ 25°C.	<0.005%
General solubility	Miscible with most common solvents and most primary and secondary plasticizers for PVC.
Sulfur (copper-strip test)	Negative
• Volatility @ 100°C.	0.35% max.

• Specifications

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	9.4	10.3	12.3
Low-Temperature Flex, T_f°C	−17	−41.0	−57
Water immersion (24 hours):			
% soluble matter lost	0.02	0.04	0.05
% water absorbed	0.24	0.28	0.30
Kerosene extraction (% plasticizer lost)	4.0	27	>70
Shore "A" Hardness	86	72	54
Migration, Linde Silica:			
1 day	0.35	0.93	2.18
3 days	1.00	3.56	6.05
7 days	1.79	5.23	10.9
Tensile, p.s.i.	2980	2015	1220
Elongation, %	290	360	440
Modulus @ 100% Elongation	1880	910	410
Flame Retardant	No	No	—
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Good	Good	Good
Electrical Properties	Good	Good	—

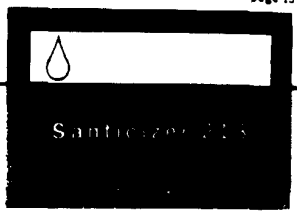
Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	2,600
7 Days	4,680
28 Days	5,200
40°C	
Initial	2,600
7 Days	7,820
28 Days	14,560
50°C	
Initial	2,600
7 Days	Gel
28 Days	—
Severs	
10 psi	5,250
50 psi	6,000
100 psi	4,100
Yield value, dynes/cm²	40
Flow Index	2.3
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	119
*Air-Release Time, minutes	20
*Resilience, steel ball, inches	5.1
*Resilience, rotationally cast ball, inches	

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080669

rapid-fusing, high-slip plasticizer for polyvinyl chloride



■ General Description

Santicizer 213 is a primary plasticizer for polyvinyl chloride and imparts a high degree of "slip" to the finished formulation. Santicizer 213 may be used alone, but it is usually blended with other plasticizers since even low concentrations will impart the high "slip" characteristic. In compounds that are fused in an oven, as little as 30% of Santicizer 213 in the total plasticizer content is sufficient to impart "slip"; in calendered or extruded compounds, 40-50% is needed.

Santicizer 213 is one of the fastest fusing plasticizers available for polyvinyl chloride; its fusion rate exceeds dioctyl phthalate's speed of fusion. Compared in other ways, it imparts much greater hardness, much better resistance to extraction by hydrocarbon, higher tensile strength and modulus, equivalent elongation.

In polyvinyl chloride plastisols, Santicizer 213 imparts low initial viscosity (about 60% that of DOP) and a low viscosity build up at room temperature, but extremely rapid fusion at elevated temperatures. In fabric coating, the use of Santicizer 213 may eliminate the need to top-coat the surface to control the slip of the material with attendant processing cost savings. In castings, Santicizer 213 improves the compound's mold-release characteristics in slush and rotational molding.

Santicizer 213 is recommended for fabric coating, extrusions, floor tile, and plastisol applications.

Santicizer 213 appears to be physiologically inert from the standpoint of both ingestion of single doses and massive exposure to the skin.

■ Properties

Chemical type	Phthalate (modified type)
• Appearance	Clear, oily liquid
• Acidity	0.25 meq/100 gm. max.
• Color	APHA 75 max.
• Moisture	0.15% max. (KF in methanol)
Odor	Characteristic. Very low.
• Refractive Index @ 25°C.	1.521 to 1.524
• Specific Gravity 25°/25°C.	1.040 to 1.045
Weight per gallon @ 25°C.	8.68 lb.
Pour Point	−43°C.
Flash Point (C.O.C.)	315°F.
Fire Point (C.O.C.)	335°F.
Vapor pressure @ 100°C. 150°C. 200°C.	1.03 mm Hg 6.90 mm Hg 30.70 mm Hg
Viscosity @ 25°C.	25.0 cks (approximately)
Surface tension @ 24°C.	33.6 dynes/cm
Solubility in water	Practically insoluble.
General solubility	Soluble in alcohols, ketones, benzene, and toluene.

• Specifications

MONS 080670

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	13.5	18.1	19.5
Low-Temperature Flex, T_f °C	−1.7	−21.0	−32
Water immersion (24 hours):			
% soluble matter lost	0.29	0.56	0.89
% water absorbed	0.46	0.80	1.10
Kerosene extraction (% plasticizer lost)	2.4	6.3	15.4
Shore "A" Hardness	92	82	61
Migration, Linde Silica:			
1 day	0.29	1.2	2.8
3 days	0.51	2.7	5.9
7 days	0.95	4.8	10.0
Tensile, p.s.i.	3010	2200	1480
Elongation, %	320	430	470
Modulus @ 100% Elongation	1950	890	440
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Excellent	Excellent	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	Good	Good	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, cantipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	2,000
7 Days	4,000
28 Days	4,120
40°C	
Initial	1,800
7 Days	>100,000
28 Days	Gel
50°C	
Initial	1,500
7 Days	Gel
28 Days	—
Severs	
10 psi	10,800
50 psi	12,500
100 psi	8,900
Yield value, dynes/cm²	50
Flow Index	5.0
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	105
*Air-Release Time, minutes	14
*Resilience, steel ball, inches	4.4
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

slow-solvating, high-slip plasticizer for polyvinyl chloride

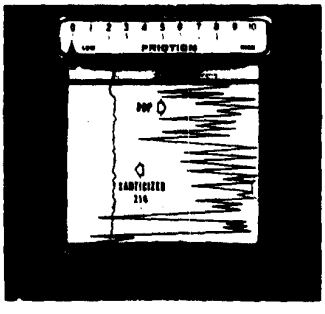
Santicizer 214

■ General Description

Santicizer 214 is a primary plasticizer for polyvinyl chloride with the characteristic of imparting a high slip to the finished compound. Santicizer 214 has a slow fusion rate; by blending Santicizer 213 and Santicizer 214 the speed of fusion can be closely controlled. In its migration resistance to nitrocellulose, Santicizer 214 is among the best of the monomeric type plasticizers available.

In plastisols, Santicizer 214 imparts very slow viscosity build up even under protracted storage in the summer time. Like Santicizer 213, it imparts the characteristic high surface slip even when blended with other plasticizers. Just 30% of the plasticizer content in compounds provides the high-slip surface. Plastisols formulated with Santicizer 214 have low initial viscosity and can be formulated to produce finished products with high rigidity.

Both Santicizer 213 and 214, if used as the sole plasticizer in compounds for calendering, have a tendency to fume on the hot roll; blending these modified phthalates with other primary plasticizers will control this fuming.



Comparative friction measurements made with the Instron tester revealed the superiority of the high surface slip imparted by Santicizer 214.

■ Properties

Chemical type	Phthalate (modified type)
• Appearance	Clear, oily liquid
• Acidity	0.15 meq/100 gm. max.
• Color	APHA 100 max.
• Moisture	0.15% max. (KF in methanol)
Odor	Characteristic, very low
• Refractive index @ 25°C	1.481 to 1.486
• Specific gravity 25°/25°C.	0.948 to 0.956
Weight per gallon @ 25°C.	7.9 lb.
Pour point	−43°C.
Flash point (C.O.C.)	325°F.
Fire point (C.O.C.)	355°F.
Vapor pressure @ 150°C.	15.0 mm Hg
200°C.	53.1 mm Hg
Viscosity @ 37.8°C.	29.6 cks
98.9°C.	4.5 cks
Surface tension @ 24°C.	31.0 dynes/cm
Solubility in water @ 25°C.	Practically insoluble
Thermal expansion @ 10° to 40°C.	0.00051 cc/cc/°C.

• Specifications

MONS 080672

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	8.8	10.0	11.0
Low-Temperature Flex, T_f °C	−12	−36	−54
Water Immersion (24 hours):			
% soluble matter lost	0.14	0.22	0.28
% water absorbed	1.2	1.8	1.9
Kerosene extraction (% plasticizer lost)	11	>70	>70
Shore "A" Hardness	92	75	58
Migration, Linde Silica:			
1 day	0.23	1.06	2.02
3 days	0.27	3.27	6.57
7 days	1.67	5.84	11.45
Tensile, p.s.i.	2810	2150	1500
Elongation,%	350	410	460
Modulus @ 100% Elongation	2070	1150	560
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Excellent	Excellent	Excellent
Fluxing Rate	Poor	Poor	Poor
Electrical Properties	Excellent	Excellent	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM	
23°C	
Initial	3,500
7 Days	4,500
28 Days	5,000
40°C	
Initial	2,800
7 Days	3,200
28 Days	2,000
50°C	
Initial	2,600
7 Days	4,500
28 Days	4,500
Severs	
10 psi	11,600
50 psi	10,400
100 psi	5,800
Yield value, dynes/cm²	40
Flow Index	2.5
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	146
*Air-Release Time, minutes	7
*Resilience,steal ball, inches	6.4
*Resilience,rotationally cast ball, inches	20

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080673

low-cost plasticizer for electrical insulation

Santicizer 215

■ General Description:

Santicizer 215, a phthalate ester plasticizer, was developed to meet the growing demand for low-cost insulation compositions that meet the Underwriters' Laboratories electrical insulation specifications. This primary plasticizer will help vinyl-insulation producers meet these spec's in the competitive 60° T and TW building wire insulations and in nonmetallic sheathing.

For applications where marring of nitrocellulose-lacquered surfaces by plasticizer migration presents a problem Santicizer 215 is recommended because of its excellent nitrocellulose resistance. It gives excellent retention of physical properties and possesses the property of imparting "slip" to the surface of vinyl coatings; plus a good outward appearance of the extrusion.

Underwriter test specifications were applied to Santicizer 215 formulations of 1 32 inch-wall insulation of #14AMG solid conductors. In all cases the formulation either exceeded or met the spec's: high and low temperature flexibility, heat shock, flammability, elongation, moisture resistance, etc. The combination of adequate electrical properties and low-cost make Santicizer 215 an excellent choice for wire insulation and nonmetallic sheathing in 60° T and TW wire.

Santicizer 215 is practically nontoxic from accidental oral ingestion and a non-irritant to excessive skin exposure.

■ Properties:

Chemical type	Phthalate ester
• Appearance	Clear, oily liquid
• Acidity, meq/100 g.	0.12 meq/100 gm. max.
• Color	APHA 100 max.
Odor	Characteristic
• Moisture (KF in methanol)%	0.10 max
• Refractive Index 25°C	1.508 to 1.516
• Specific Gravity, 25°/25°C	0.974 to 0.980
Weight per gal. — 25°C	8.14
Viscosity, 25°C, cks	75
37.8°C	35
98.9°C	4.5

• Specifications



MONS 080674

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR
Volatility, 87° C. % Lost (Activated Charcoal)	17.7	24.3
Low-Temperature Flex. T_f° C.	−9	−28
Shore "A" Hardness	86	76
Kerosene Extraction, % lost 4 days at 27° C.	0.3	34.9
Water Immersion (24 hr.)		
% water absorbed	0.80	0.94
% soluble matter lost	0.24	0.31

Migration to Nitrocellulose

	4 hours % Softening		24 hours % Softening	
	40% (67 PHR)	50% (100 PHR)	40% (67 PHR)	50% (100 PHR)
Dioctyl Phthalate (Control)	83	94	97	100
Santicizer 214	3	+3	20	14
Santicizer 215	+3	+9	3	+3
Dioctyl Isophthalate	+9	3	+9	+9
Ditridecyl Phthalate	+20	+9	+3	+14

Electrical Properties, Santicizer 215

	64 PHR
Volume Resistivity (dry slab) (ohm/cm x 10^{13})	19.2
Insulation Resistance megohm/1000 ft. of #14 wire)	
24 hrs. 25° C.	1400
24 hrs. 50° C.	62
1 wk. @ 50° C.	90
3 wks.@ 50° C.	195
6 wks.@ 50° C.	340
9 wks.@ 50° C.	470
12 wks.@ 50° C.	460
Elongation — %	
Original	277
After Heating	238
Retention	86%
Tensile Strength, psi	
Original	2710
After Heating	2740
Retention, %	101

monomeric plasticizer offering high permanence



■ General Description

Santicizer 262 is a monomeric plasticizer that offers high permanence, comparable to low molecular weight polymerics, yet still retains the easy processing features of monomeric plasticizers. It finds application in film and sheeting, coated fabrics, laminates, upholstery, plastisols, organisols, and acrylic lacquers.

In plastisols and organisols, Santicizer 262 provides relatively low initial viscosity and good viscosity stability. It offers relatively fast fusion at normal temperatures, low volatility and permanence in finished vinyl products.

In acrylic lacquers, Santicizer 262 imparts excellent durability, anti-fogging properties, better adhesions to metal undercoats, improved weatherability, and good solvent-craze resistance. It imparts excellent gloss, resists water spotting, provides good flow characteristics and flexibility without brittleness for long, handsome coating life.

In calendering and extrusions, Santicizer 262 combines efficiency of monomeric esters with permanence of low molecular weight polymerics. When compared to DOP, it is less volatile and more resistant to extraction.

Properties

Chemical type	Phthalate
Molecular weight	396.5
• Acidity, meq./100 gm.	0.37 meq./100 gm. max.
• Appearance	Clear, oily liquid
• Color	APHA 100 max.
• Moisture (KF in methanol)%	0.15 max.
• Refractive Index 25°C	1.519 to 1.523
• Specific Gravity 25°C/25°C	1.048 to 1.057
Density (25°C lb./gal.)	8.7
Flash Point (C.O.C.)	455°F
Vapor Pressure at 200°C 300°C	0.33 mm Hg 34 mm Hg
Surface Tension (25°C)	34.3 dynes/cm
Coefficient of Thermal Expansion	.00059 cc/cc/°C

• Specifications

Properties of Plasticized Acrylic Lacquers

Plasticizer (at 29%)	Hardness[1]	Weatherometer Gloss	Weatherometer Reflectance	Fog[2] Value	Adhesion[3]	Solvent 5°C.	Craze[4] 10°C.	Water[5] Immers.
Santicizer 160	F/H	Std.	Std.	37 SR	4	checked	checked	Std.
Santicizer 262	B/HB	+	+	85 SR	5	OK	OK	Equiv.

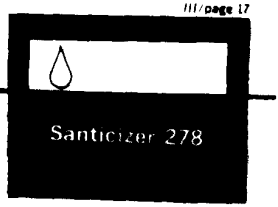
1. Pencil hardness — the film is harder than the top letter, softer than the bottom letter.
2. Specular Reflection (SR) of plate glass covers over breakers in which the plasticized films were heated for 1 hr. @ 110°C.
3. Cellophane tape method.
4. Coated panels conditioned at 5 and 10°C. — a drop of methyl ethyl ketone was applied and allowed to dry. Crazing determined by visual observation (with a magnifying lens.)
5. Panels immersed in water at 40°C. for 100 hours — rated by ASTM test D-714.

Performance in PVC (40 mil sheet)

	(40%) 67 PHR
Volatility, 87°C. % Lost (Activated Charcoal)	1.3
Low-Temperature Flex. T₁°C	−23.8
Shore "A" Hardness	66
Kerosene Extraction, % Lost 24 hours at 23°C.	2.1
Water Immersion (24 hrs. at 50°C.)	
% water absorbed	0.12
% soluble matter lost	0.00

MONS 080677

low volatility plasticizer for stain resistance



General Description

Santicizer 278 is another member of Monsanto's family of stain resistant plasticizers. It is a very low volatility product.

One of the most unique characteristics of Santicizer 278 is its plasticizing inefficiency while retaining fast fusing properties. To demonstrate its unique plasticizing inefficiency, Santicizer 278 was compared to Santicizer 160 in a vinyl asbestos tile formulation, using Opalon 506, a 20% binder level and a 2:1 limestone-to-asbestos ratio. The following information resulted from the comparative testing:

	Parts Plasticizer	Parts Resin	McBurney Hardness
Santicizer 160	37	100	7.7
Santicizer 278	60	77	7.7

The efficiency of Santicizer 278, based upon modulus versus concentration, is 1.37.

By formulating to take full advantage of the plasticizing inefficiency of Santicizer 278, new design concepts can be developed. Because this unique plasticizer also offers fast fusing properties, you can still obtain maximum physicals while using normal temperatures.

This phthalate ester has modulus and tensile properties that are somewhat similar to polymeric plasticizers. Santicizer 278 Linde Silica migration is also similar to the results obtained with polymeric products, that is, good resistance to extraction by wicking.

Properties

Chemical type	Phthalate
Molecular weight	471
• Appearance	Clear, oily liquid
• Acidity	0.24 meq/100 gm. max. (0.03% as phthalic acid)
• Color	APHA 100 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight characteristic
• Refractive Index @ 25°C.	1.570 to 1.520
• Specific Gravity 25°/25°C.	1.096 to 1.101
Weight per gallon @ 25°C.	9.18 lb.
Boiling point, 760mm Hg	>300°C
Crystallizing point	below −11
Pour point	−6.5°C
Flash point (C.O.C.)	440°F.
Fire point (C.O.C.)	535°F.
Vapor pressure @ 200°C.	0.20 mm Hg
300°C.	80 mm Hg
Viscosity @ 0°C.	above 1,000 cks.
25°C.	860
98.9°C.	11.7
Surface tension @ 25°C.	34.8 dynes/cm
Solubility in water @ 30°C.	insoluble
General solubility	Soluble in acetone, alcohol benzene and most organic solvents.
Thermal expansion @ 10° to 40°C.	0.00073 cc/cc/°C.

• Specifications

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	0.7	0.7	0.7
Low-Temperature Flex, T_f°C	+19	+2	−14
Water immersion (24 hours):			
% soluble matter lost	0.01	0.02	0.04
% water absorbed	0.28	0.33	0.36
Kerosene extraction (% plasticizer lost)	0.3	0.5	1.3
Shore "A" Hardness	97	85	65
Migration, Linde Silica:			
1 day	0.0	0.0	0.02
3 days	0.04	0.08	0.35
7 days	0.05	0.14	0.51
Tensile, p.s.i.	3180	2600	2039
Elongation, %	258	341	413
Modulus @ 100% Elongation	3144	1855	845
Flame Retardant	No	No	No
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Good	Good	Good
Fluxing Rate	Good	Good	Good
Electrical Properties	—	—	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HBT Spindle	
50 RPM	
23°C	
Initial	164,000 (7)
7 Days	198,000 (7)
28 Days	292,000 (7)
40°C	
Initial	36,000 (6)
7 Days	62,000 (6)
28 Days	84,000 (6)
50°C	
Initial	22,000 (6)
7 Days	69,000 (6)
28 Days	111,000 (7)
Severs	
10 psi	304,000
50 psi	249,000
100 psi	145,000
Yield value, dynes/cm²	9
Flow Index	1.5
Severs vis. 50 psi	
Brookfield vis. 50 rpm	
Fusion Point, °C	122

MONS 080679

primary plasticizer for polyvinyl chloride

Santicizer 602

■ General Description

Santicizer 602 is an isooctyl isodecyl type phthalate plasticizer designed for polyvinyl chloride and rubber compounds. It offers plasticizing efficiency and compound performance that closely parallels that obtained with dioctyl phthalate. Santicizer 602 in the plasticized compound results in lower plasticizer volatility than obtainable either with dioctyl phthalate or diisooctyl phthalate. The compound's performance in resistance to extraction by soapy water is also improved. Polyvinyl chloride plastisols compounded with Santicizer 602 have excellent shelf stability.

Santicizer 602 possesses a low order of toxicity.



■ Properties

Chemical type	Phthalate (isooctyl isodecyl type)
• Appearance	Clear, oily liquid
• Acidity	0.18 meq/100 gm. max.
• Color	APHA 50 max.
Moisture	0.10% max. (KF in methanol)
Odor	Characteristic, mild
• Refractive Index @ 25°C.	1.482 to 1.486
• Specific gravity 25°/25°C.	0.971 to 0.977
Weight per gallon @ 25°C.	8.1 lbs.
Pour point	−45°C.
Flash point (C.O.C.)	412°F.
Viscosity @ 37.8°C.	34.5 cks
98.9°C.	5.0 cks

• Specifications

Vinyl plastisols compounded with Santicizer 602 have excellent shelf stability, and finished products have improved resistance to extraction by soapy water.

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	2.8	3.5	3.5
Low-Temperature Flex, T_f °C	−16	−36	−54
Water Immersion (24 hours):			
% soluble matter lost	0.01	0.03	0.04
% water absorbed	0.18	0.25	0.24
Kerosene extraction (% plasticizer lost)	9.0	63	>70
Shore "A" Hardness	90	73	56
Migration, Linde Silica:			
1 day	0.75	1.05	2.81
3 days	0.90	2.58	6.70
7 days	1.60	4.22	8.94
Tensile, p.s.i.	2980	2180	1340
Elongation,%	330	390	430
Modulus @ 100% Elongation	1920	1040	520
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Excellent	Good	Good
Fluxing Rate	Fair	Fair	Fair
Electrical Properties	Excellent	Excellent	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	2,800
7 Days	3,920
28 Days	4,000
40°C	
Initial	2,600
7 Days	3,240
28 Days	4,160
50°C	
Initial	2,720
7 Days	7,680
28 Days	12,080
Severs	
10 psi	15,000
50 psi	13,000
100 psi	10,000
Yield value, dynes/cm²	90
Flow Index	2.3
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	132
*Air-Release Time, minutes	10
*Resilience, steel ball, inches	5
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080681

primary plasticizer for polyvinyl chloride

Santicizer 603

General Description

Santicizer 603 imparts good flexibility and a degree of permanence adequate for most applications to vinyl compounds. The use of Santicizer 603 results in formulations with good color and low cost. The low pound-per-volume and cost savings make Santicizer 603 especially useful for meeting price competition in thin film and sheeting, coating fabrics, and low-budget extrusions. In plastisol formulations Santicizer 603 imparts medium viscosity.

Santicizer 603 possesses a low degree of toxicity.



Properties

Chemical type	Phthalate (butyl decyl type)
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm. max.
• Color	APHA 100 max.
• Moisture	0.10% max. (KF in methanol)
Odor	Characteristic
• Refractive index @ 25°C.	1.4825 to 1.4895
• Specific gravity 25°/25°C.	0.977 to 0.987
Weight per gallon @ 25°C.	8.18 lb.
Pour point	−51°C.
Flash point (C.O.C.)	395°F.
Viscosity @ 0°C.	400.0 cks
25°C.	60.0 cks
98.9°C.	4.6 cks
Thermal expansion @ 10° to 40°C.	0.00076 cc/cc/°C.
Thermal expansion @10° to 40°C.	0.00076 cc/cc/°C.

• Specifications

Vinyl extrusions formulated with Santicizer 603 combine good flexibility with low cost.

Performance in PVC (40 mil sheet)

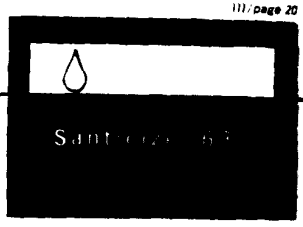
	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	11.7	12.8	14.5
Low-Temperature Flex, T_f °C	−16	−36	−54
Water Immersion (24 hours):			
% soluble matter lost	0.03	0.05	0.07
% water absorbed	0.23	0.27	0.30
Kerosene extraction (% plasticizer lost)	9.0	45	>70
Shore "A" Hardness	90	77	57
Migration, Linde Silica:			
1 day	0.51	0.96	1.86
3 days	1.13	3.14	5.37
7 days	1.88	5.82	9.87
Tensile, p.s.i.	2830	2200	1380
Elongation, %	280	350	450
Modulus @ 100% Elongation	2080	1070	510
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Good	Good
Fluxing Rate	Good	Good	Good
Electrical Properties	Excellent	Good	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM	
23°C	
Initial	2,200
7 Days	3,160
28 Days	5,240
40°C	
Initial	2,120
7 Days	4,700
28 Days	5,280
50°C	
Initial	4,600
7 Days	11,200
28 Days	35,680
Severs	
10 psi	4,400
50 psi	4,800
100 psi	4,100
Yield value, dynes/cm²	60
Flow Index	2.2
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	129
*Air-Release Time, minutes	18
*Resilience, steel ball, inches	5.1
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

low-cost, primary plasticizer for polyvinyl chloride



■ General Description

Santicizer 630 is a primary plasticizer for polyvinyl chloride. This low cost, general-purpose plasticizer is designed to provide compound quality and performance sufficiently high for many applications. Santicizer 630 offers these advantages over dioctyl phthalate:

(1) lower in cost
(2) better migration resistance to nitrocellulose
(3) better viscosity stability in formulated plastisols.

It is somewhat poorer than dioctyl phthalate in these properties: slightly poorer flexibility, more volatile, and less light stable. It is superior in color to any other commercial product in its price range, and is equivalent in general plasticizing performance. In extrusions and sheetings, Santicizer 630 imparts good color and flexibility.

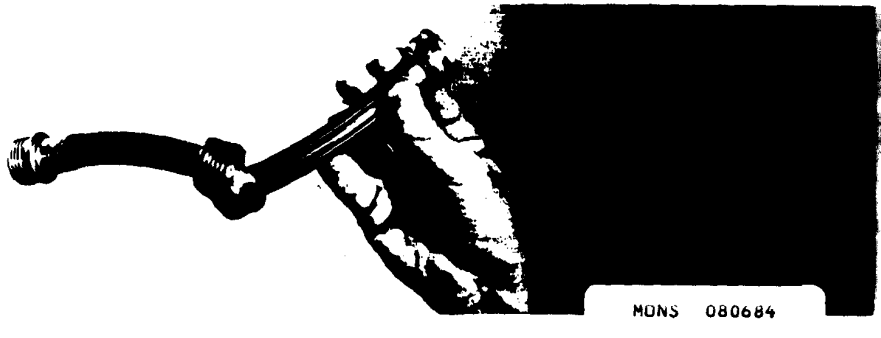
Santicizer 630 has a low order of oral toxicity.

■ Properties

Chemical type	Phthalate (modified type)
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm. max.
• Color	APHA 70 max.
• Moisture	0.10% max. (KF in methanol)
• Refractive index @ 25°C.	1.5095 to 1.5160
• Specific gravity 25°/25°C.	0.987 to 0.994
Weight per gallon @ 25°C.	8.25 lb.
Pour point	−40°C.
Flash point (C. O. C.)	370°F.
Viscosity @ 0°C.	450.0 cks
25°C.	61.0 cks
98.9°C.	4.3 cks
Thermal expansion @ 10° to 40°C.	0.00074 cc/cc/°C.

• Specifications

Light color and good flexibility are imparted to vinyl garden hose at low cost by Santicizer 630.



MONS 080684

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	14.3	18.8	19.9
Low-Temperature Flex, T_f °C	−11.7	−33	−51
Water immersion (24 hours):			
% soluble matter lost	0.06	0.10	0.10
% water absorbed	0.30	0.33	0.51
Kerosene extraction (% plasticizer lost)	6.1	35	>70
Shore "A" Hardness	93	76	57
Migration, Linde Silica:			
1 day	0.31	0.89	1.68
3 days	0.67	2.32	4.7
7 days	1.14	4.22	9.2
Tensile, p.s.i.	3120	2440	1530
Elongation, %	270	340	420
Modulus @ 100% Elongation	2340	1210	540
Flame Retardant	No	No	—
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Excellent	Excellent	Excellent
Fluxing Rate	Good	Good	Good
Electrical Properties	Excellent	Excellent	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM	
23°C	
Initial	3,200
7 Days	4,480
28 Days	4,440
40°C	
Initial	3,120
7 Days	4,600
28 Days	5,800
50°C	
Initial	3,080
7 Days	27,400
28 Days	>100,000
Severs	
10 psi	6,130
50 psi	6,490
100 psi	4,920
Yield value, dynes/cm²	60
Flow Index	2.0
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	132
*Air Release Time, minutes	6
*Resilience steel ball, inches	4.5
*Resilience rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

low-cost, primary plasticizer for polyvinyl chloride

Santicizer 631

General Description

Santicizer 631 is a modified phthalate ester designed to provide a low-cost primary plasticizer for polyvinyl chloride. It may be extended with secondary plasticizers such as HB-40. The properties it imparts and its performance in finished compounds are similar to Santicizer 630. In plastisols, Santicizer 631 imparts good viscosity control and color; in extrusion an dsheeting compounds it offers good color and flexibility.

Santicizer 631 has a low order of toxicity.



Properties

Chemical type	Phthalate (modified type)
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm. max.
• Color	APHA 40 max.
• Moisture	0.10% max. (KF in methanol)
• Refractive index @ 25°C.	1.4990 to 1.5045
• Specific gravity 25°/25°C.	0.984 to 0.990
Weight per gallon @ 25°C.	8.22 lb.
Pour point	—45°C.
Flash point (C.O.C.)	385°F.
Viscosity @ 0°C.	250.0 cks
25°C.	50.0 cks
98.9°C.	4.8 cks
Thermal expansion @ 10° to 40°C.	0.00074 cc/cc/°C.

• Specifications

Santicizer 631 is an economical plasticizer for products where costs must be closely controlled and whose performance is not highly critical. It is recommended for economy-grade garden hose, window spline, and low-cost profile extrusions.

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	13.7	16.2	17.9
Low-Temperature Flex, T_f °C	−13	−35	−52
Water immersion (24 hours):			
% soluble matter lost	0.05	0.09	0.09
% water absorbed	0.28	0.31	0.35
Kerosene extraction (% plasticizer lost)	6.9	40	>70
Shore "A" Hardness	91	74	56
Migration, Linde Silica:			
1 day	0.44	0.97	1.69
3 days	0.87	2.57	4.8
7 days	1.34	4.60	8.6
Tensile, p.s.i.	2970	2160	1430
Elongation, %	280	370	430
Modulus @ 100% Elongation	2200	1090	510
Flame Retardant	No	No	—
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Excellent	Excellent	Excellent
Fluxing Rate	Good	Good	Good
Electrical Properties	Excellent	Excellent	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	3,920
7 Days	4,600
28 Days	5,120
40°C	
Initial	2,800
7 Days	5,200
28 Days	6,480
50°C	
Initial	2,800
7 Days	33,800
28 Days	>100,000
Severs	
10 psi	6,490
50 psi	6,810
100 psi	4,860
Yield value, dynes/cm^2	20
Flow Index	2.3
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	130
*Air-Release Time, minutes	6
*Resilience, steel ball, inches	4.5
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

modified alkyl phthalate for vinyl plastisols

Santicizer 632
Santicizer 683

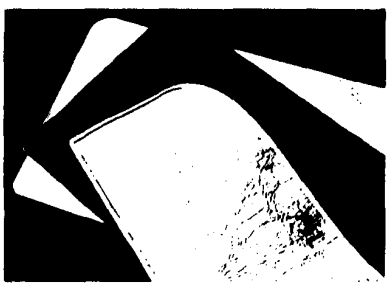
■ General Description:

Santicizer 632 and 683 are low-cost plasticizers with good flexibility, moderate volatility, excellent migration resistance, low-initial-viscosity, and improved viscosity stability in vinyl plastisols. These primary plasticizers are similar to dioctyl phthalate in general properties.

The two modified alkyl phthalates offer unusual low initial viscosity and viscosity stability which is often required in plastisol molding, casting, coating, and slush applications. They are used as primary plasticizers in such vinyl applications as film & sheeting, extrusions, wire & cable insulation, garden hose, and coatings.

Santicizer 632 is fast fusing while Santicizer 683 has a slower fusion rate and good viscosity at high temperatures. The two plasticizers are somewhat more volatile and a slightly darker color than dioctyl phthalate. They are more resistant to migration to nitrocellulose than dioctyl phthalate: this benefit plus their similar performance to dioctyl phthalate make them interesting candidates for extrusion compounds.

Santicizer 632 and 683 have relatively low order of toxicity. No specific handling precautions are necessary.



■ Properties:

SANTICIZER 632

Chemical type	Modified phthalate
• Appearance	Clear, oily liquid
• Color	APHA 100 max.
• Acidity	0.12 meq/100 gm. max.
• Moisture, (by KF in methanol) %	0.15 max.
• Refractive Index, 25°C	1.484 to 1.487
• Specific Gravity at 25/25°C	0.976 to 0.982
Density @ 25°C lb./gal.	8.15

SANTICIZER 683

Chemical type	modified phthalate
• Appearance	Clear oily liquid
• Color	APHA 40 max.
• Acidity	0.12 meq/100 gm. max.
• Moisture, (by KF in methanol) %	0.10 max.
• Refractive Index, at 25°C	1.488 to 1.489
• Specific Gravity at 25/25°C	0.975 to 0.981
Density, @ 25° C. lb./gal.	8.09

• Specifications

MONS 080688

Performance in Plastisol Formulation, 65 PHR

Viscosity, centipoises	Dioctyl Phthalate	SANTICIZER 632	SANTICIZER 683
Brookfield HAT #6 Spindle, 50 RPM			
23°C			
Initial	5040	2200	2840
7 Days	9160	4080	3560
28 Days	11,960	4800	3600
40°C			
Initial	4280	2240	2640
7 Days	17,240	6000	4400
28 Days	20,240	7840	5000
50°C			
Initial	5240	2240	2800
7 Days	32,320	100,000	10,400
28 Days	100,000		18,000
Severs Viscosimeter			
10 psi	10,200	4800	4600
50 psi	9870	5480	5030
100 psi	6580	3950	3960
*Flow Index	2.1	2.5	1.8

*Severs viscosity at 50 psi
Brookfield viscosity at 50 rpm

Performance in PVC (40 mil sheet)

67 PHR (40%)	Dioctyl Phthalate	SANTICIZER 632	SANTICIZER 683
Low-Temperature flexibility, T$_f$° C	−39	−38	−38
Volatility, Plasticizer Lost, %	4.5	15.0	8.5
Hardness, Shore A			
Before Volatility	71	68	74
After Volatility	72	76	75
Water Immersion, 24 hours			
Solubles Lost, %	0.03	0.06	0.06
Water Absorbed, %	0.25	0.75	0.80
Kerosene Extraction, 24 hours			
Plasticizer Lost, %	34	45.0	51.4
Compatibility			
Alone	OK	OK	OK
Can be extended?	Yes	Slightly	Slightly
Heat Stability	Excellent	Good	Good
Light Stability	Excellent	Good	Good
Resistance to Migration to Nitrocellulose	Good	Better than dioctyl phthalate	Better than dioctyl phthalate

primary plasticizer for polyvinyl chloride electrical compounds

Santicizer 636

General Description

Santicizer 636 is a 2-ethylhexyl, isodecyl type phthalate. It is designed to provide low-cost plasticizing of polyvinyl chloride compounds for electrical uses. Santicizer 636 exhibits a lower volatility in the finished composition than either dioctyl phthalate or diisooctyl phthalate; superior resistance to extraction by soapy water; and all other properties are comparable with the exception of the aging characteristics where Santicizer 636 is superior. Wire insulation plasticized with Santicizer 636 offers outstanding retention of elongation on heat aging.

In film and sheeting applications, Santicizer 636 offers improvement over dioctyl phthalate in permanence and resistance to extraction by soapy water.

Polyvinyl chloride plastisols compounded with Santicizer 636 have slower viscosity build-up than DOP plasticized formulations.

Santicizer 636 has a low order of toxicity.

Properties

Chemical type	Phthalate (2-ethylhexyl, isodecyl type)
• Appearance	Clear, oily liquid
• Acidity	0.12 meq/100 gm. max.
• Color	APHA 75 max.
• Moisture	0.10% max. (KF in methanol)
• Refractive Index @ 25°C.	1.478 to 1.488
• Specific Gravity 25°/25°C.	0.969 to 0.977
Weight per gallon @ 25°C.	8.11 lb.

• Specifications



Santicizer 636 imparts excellent physical and electrical properties to extruded PVC wire coatings. It is recommended for SPT, T, and TW stock and for 80°C. insulation

MONS 080690

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	2.9	3.6	3.6
Low-Temperature Flex, T_f °C	−16	−37	−54
Water immersion (24 hours):			
% soluble matter lost	0.01	0.02	0.03
% water absorbed	0.18	0.24	0.26
Kerosene extraction (% plasticizer lost)	9.0	65	>70
Shore "A" Hardness	89	72	54
Migration, Linde Silica:			
1 day	0.22	0.55	1.12
3 days	0.77	2.18	3.60
7 days	1.64	4.75	7.70
Tensile, p.s.i.	2920	2190	1350
Elongation, %	360	400	440
Modulus @ 100% Elongation	1910	1100	520
Flame Retardant	No	No	—
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Good	Good
Fluxing Rate	Good	Good	Good
Electrical Properties	Excellent	Excellent	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	3,440
7 Days	4,480
28 Days	4,400
40°C	
Initial	3,080
7 Days	4,600
28 Days	6,000
50°C	
Initial	3,160
7 Days	10,120
28 Days	18,800
Severs	
10 psi	6,130
50 psi	6,280
100 psi	4,630
Yield value, dynes/cm²	90
Flow Index	1.8
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	132
*Air-Release Time, minutes	10
*Resilience, steel ball, inches	4.9
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

primary plasticizer for plastisols

Santicizer 681

General Description

Santicizer 681 was developed as a primary plasticizer for use in polyvinyl chloride formulations. This clear liquid plasticizer imparts superior flexibility in vinyl extrusions, films, and molded products (toys, boots, etc.).

Plastisols containing Santicizer 681 have a lower initial viscosity and greater viscosity stability than those containing most other phthalate plasticizers. Santicizer 681 is particularly well suited for plastisols because of its low initial viscosity and exceptional storage stability. It is superior to most proprietary plasticizers recommended for vinyl dispersions.

This low-cost plasticizer offers low volatility, good plasticizing efficiency, relatively slow fusion for controlled processing, and unusual flexibility. Besides plastisols, these plasticizing features lend themselves to profile extrusion, and film & sheeting applications.

Santicizer 681 has a low order of toxicity and no special handling precautions are necessary.

Properties

Chemical Type	Phthalate
• Appearance, 25°C.	Clear, oily liquid
• Acidity	0.20 meq/100 gm./max.
• Color (50 ml.:50 ml. 95% ethanol)	APHA 40 max.
• Moisture (KF in methanol) %	0.10 max.
• Refractive index @ 25°C.	1.472 to 1.479
• Specific gravity, 25°/25°C.	0.963 to 0.970
Weight per gal., @ 25°C.	8.05

• Specifications

MONS 080692

Performance in PVC (40 mil sheet)

	Santicizer 681 40%	Dioctyl Phthalate 40%
Volatility, (% lost) (activated carbon)	4.6	4.5
Low-Temperature Flex, T_f°C	−50	−39
Water immersion		
% soluble matter lost	0.05	0.03
% water absorbed	0.35	0.25
Kerosene extraction (% plasticizer lost)	56.6	34
Loop compatibility	ok	ok

Performance in Plastisol Formulation

Viscosity, centipoises
Brookfield HAT #6 Spindle
50 RPM

	65 PHR
23°C	
Initial	4,160
7 Days	6,840
28 Days	7,400
40°C	
Initial	2,400
7 Days	7,400
28 Days	9,520
50°C	
Initial	3,760
7 Days	10,640
28 Days	19,800
Fusion Point °C	131

low-temperature, low-volatility plasticizer for PVC resins

DIDA

diisodecyl adipate

General Description

Diisodecyl adipate is a low-volatile, low-temperature plasticizer for polyvinyl chloride resins. The properties it develops in finished compositions are similar to those imparted by dioctyl adipate, but its permanence is of a higher order since its volatility is approximately one-third that of dioctyl adipate. The use of diisodecyl adipate enables the formulator to obtain the good low-temperature properties and permanence at a lower cost than would normally be possible with other more expensive low-temperature plasticizers. The improved permanence and exceptional flexibilizing action of diisodecyl adipate recommend it for fabric coating, **free film, garden hose, and sheeting** where low volatility and exceptional flexibility are critical.

In plastisols, diisodecyl adipate imparts an extremely low viscosity build up in storage. It may be used as a partial replacement for dioctyl phthalate.

Diisodecyl adipate is also compatible and useful with cellulose acetate-butyrate, nitrocellulose, chlorinated rubber, and synthetic rubbers.

Toxicity studies show that diisodecyl adipate is harmless to the skin or eyes or if ingested; no unusual handling precautions are necessary.



Where maximum low-temperature flexibility and outstanding permanence is required for outwear, fabric coating, or film, diisodecyl adipate can be depended upon to produce the highest quality end products.

Properties

Chemical type	Adipate
Chemical formula	$(CH_2)_4$ with two $C(=O)-O-(C_{10}H_{21})$ groups, mixed isomers
Molecular weight	426.67
• Appearance	Clear, oily liquid
• Acidity	0.50 meq./100 gm. max. (0.04% as adipic acid)
• Color	APHA 50 max.
• Moisture	0.10% max. (KF in methanol)
• Odor	Mild
Refractive index @ 25°C.	1.4485 to 1.4525
• Specific gravity 25°/25°C.	0.962 to 0.973
Weight per gallon @ 25°C.	7.63 lb.
Boiling point, 4 mm Hg	240°C.
Crystallizing point	<-50°C.
Pour point	−65°C.
Flash point (C.O.C.)	425°F.
Fire point (C.O.C.)	490°F.
Vapor pressure @ 150°C. 200°C.	0.02 mm Hg 0.58 mm Hg
Viscosity @ 37.8°C. 98.9°C.	14.5 cks 3.6 cks
Surface tension @ 20°C.	30 dynes/cm.
Solubility in water @ 25°C.	<0.01%
General solubility	Insoluble or limited solubility in glycerine, the glycols, and some amines; soluble in most other organic liquids.
Thermal expansion @ 10° to 40°C.	0.00077 cc/cc/°C.

• Specifications

MONS 080694

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	3.2	3.4	3.5
Low-Temperature Flex, T_f °C	−43.1	−63	<−70
Water immersion (24 hours):			
% soluble matter lost	0.02		
% water absorbed	0.28		
Kerosene extraction (% plasticizer lost)	63.5		
Shore "A" Hardness	90		
Migration, Linde Silica:			
1 day	6.4	9.0	16.2
3 days	10.2	17.7	28.9
7 days	16.4	27.4	38.7
Tensile, p.s.i.	2490	1840	1200
Elongation, %	370	400	430
Modulus @ 100% Elongation	1390	890	440
Flame Retardant	No	No	—
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Poor	Poor	Poor
Electrical Properties	Poor	Poor	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	1,850
7 Days	2,220
28 Days	2,500
40°C	
Initial	1,800
7 Days	3,000
28 Days	1,550
50°C	
Initial	1,950
7 Days	6,000
28 Days	4,500
Severs	
10 psi	3,920
50 psi	2,520
100 psi	1,900
Yield value, dynes/cm²	60
Flow Index	1.7
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	156
*Air-Release Time, minutes	7
*Resilience, steel ball, inches	10.4
*Resilience, rotationally cast ball, inches	26

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080695

low-temperature, general-purpose plasticizer

DNODA

di(n-octyl,n-decyl) adipate

General Description

Di(n-octyl, n-decyl) adipate is an excellent low temperature, general purpose, primary plasticizer for polyvinyl chloride and chloride-acetate resins. It is low in volatility, possesses excellent light stability, and excellent drape or hand. Di(n-octyl, n-decyl) adipate is compatible with nitrocellulose, ethyl cellulose, chlorinated rubber, SBR and Buna N synthetic rubbers, cellulose acetate-butyrate, polystyrene, methacrylate and dammar wax.

In polyvinyl chloride applications requiring good flexibility at low temperatures, di(n-octyl, n-decyl) adipate outperforms on a cost/performance basis most other low temperature plasticizers. It is recommended for compositions for garden hose, electric wire jacketing, film, sheeting, upholstery coatings, and profile extrusions when good flexibility must be maintained under severe exposure to low temperatures. In the form of film, sheeting, and coated fabrics—compositions plasticized with di(n-octyl, n-decyl) adipate possess excellent hand and drape.

In plastisols, di(n-octyl, n-decyl) adipate imparts low initial viscosity, slow viscosity build-up on aging, and freedom from dilatency for high speed operations for fabric or strand coating.

Toxicity studies show that di(n-octyl, n-decyl) adipate is relatively harmless; no special handling precautions are required in its use.

Properties

Chemical type	Adipate
Chemical formula	$\begin{matrix} O \\ \| \\ C-O-(n-C_8H_{17})_x \\ (CH_2)_4 \\ \| \\ C-O-(n-C_{10}H_{21})_y \\ \| \\ O \end{matrix}$ (x + y = 2)
Molecular weight	398 (average)
• Appearance	Clear, oily liquid
• Acidity	0.35 meq/100 gm. max.
• Color	APHA 50 max.
• Moisture	0.10% max. (KF in methanol)
Odor	Characteristic
• Refractive index @ 25°C.	1.444 to 1.458
• Specific gravity 25°/25°C.	0.914 to 0.922
Weight per gallon @ 25°C.	7.63 lb.
Copper strip test	Negative for sulfur
Crystallizing point	−5°C.
Pour point	0°C.
Flash point (C.O.C.)	401°F.
Fire point (C.O.C.)	480°F.
Vapor pressure @ 150°C. 200°C.	0.04 mm Hg 0.80 mm Hg
Viscosity @ 37.8°C. 98.9°C.	9.5 cks 2.8 cks
Surface tension @ 20°C.	29 dynes/cm
Solubility in water @ 25°C.	<0.01%
General solubility	Soluble in most organic liquids.
Thermal expansion @ 10° to 40°C.	0.00076 cc/cc. °C.

• Specifications

MONS 080696

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	7.8	8.1	9.0
Low-Temperature Flex, T_f °C	−47.9	−66	<−70
Water Immersion (24 hours):			
% soluble matter lost	0.07	0.08	0.12
% water absorbed	0.61	0.53	0.45
Kerosene extraction (% plasticizer lost)	51.0	>70	>70
Shore "A" Hardness	86	68	49
Migration, Linde Silica:			
1 day	5.3	7.8	12.7
3 days	15.7	22.8	31.1
7 days	27.3	35.9	47.0
Tensile, p.s.i.	2620	1940	1280
Elongation, %	410	430	460
Modulus @ 100% Elongation	1290	800	440
Flame Retardant	No	No	–
Heat Stability	Excellent	Excellent	Excellent
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Fair	Fair	Fair
Electrical Properties	Fair	Fair	–

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	520
7 Days	560
28 Days	800
40°C	
Initial	520
7 Days	600
28 Days	900
50°C	
Initial	600
7 Days	12,000
28 Days	3,500
Severs	
10 psi	1,430
50 psi	1,790
100 psi	1,440
Yield value, dynes/cm²	60
Flow Index	3.5
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	148
*Air-Release Time, minutes	7
*Resilience, steel ball, inches	9.2
*Resilience, rotationally cast ball, inches	–

*Efficiency Conc. Adj. to "60" Shore A Hardness

low-temperature plasticizer for PVC resins and synthetic rubbers

DOA

di(2-ethylhexyl adipate

(dioctyl adipate)

General Description

Dioctyl adipate is a high quality plasticizer for imparting low-temperature flexibility to polyvinyl chloride and synthetic rubber compositions.

In polyvinyl chloride and synthetic rubber, dioctyl adipate imparts softness, hand, and good heat and light stability. It offers excellent processing performance for a low-temperature plasticizer. Dioctyl adipate is an excellent plasticizer for vinyl electrical jacketing compounds, for high quality garden hose, top quality vinyl films, and upholstery coatings.

In vinyl dispersions, dioctyl adipate makes formulations that have excellent flow properties because of low initial viscosity. The viscosity does not build up greatly during storage, nor do the dispersions significantly increase in viscosity on exposure to high speed mixing (dilatency) or rapid spreading equipment. The high yield value of dioctyl adipate aids in making no-sag spray coatings or no-drip plastisol dip coatings.

Dioctyl adipate is compatible and contributes a valuable plasticizing effect to nitrocellulose, ethyl cellulose, vinyl co-polymers, and chlorinated rubbers. It is also useful in plasticizing polyvinyl butyral, cellulose acetate-butyrate, polystyrene, and dammar wax.

It has been regulated by the Food and Drug Administration for use in food-packaging materials under the provisions of the 1958 Food Additives Amendment to the Federal Food, Drug, and Cosmetics Act.

Properties

Chemical type	Adipate
Chemical formula	$\overset{O}{\overset{\|}{C}}-O-CH_2CH(C_2H_5)C_4H_9$ $(CH_2)_4$ $\overset{O}{\overset{\|}{C}}-O-CH_2CH(C_2H_5)C_4H_9$
Molecular weight	370.56
• Appearance	Clear, oily liquid
• Acidity	0.25 meq/100 gm. max. (0.02% as adipic acid)
• Color	APHA 25 max.
• Moisture	0.10% max. (KF in methanol)
• Odor	Mild
Refractive index @ 25°C.	1.444 to 1.448
• Specific gravity 25°/25°C.	0.921 to 0.927
Weight per gallon @ 25°C.	7.72 lb.
Boiling point, 5 mm Hg	214°C.
Crystallizing point	<-70°C.
Pour point	−65°C.
Flash point (C.O.C.)	377°F.
Fire point (C.O.C.)	450°F.
Vapor pressure @ 150°C. 200°C.	<0.15 mm Hg 2.5 mm Hg
Viscosity @ 37.8°C. 98.9°C.	8.2 cks 2.4 cks
Surface tension @ 20°C.	29 dynes per cm
Solubility in water @ 25°C.	<0.01%
General solubility	Insoluble, or limited solubility, in glycerine, glycols and amines. Soluble in most other organic liquids
Thermal expansion @ 10° to 40°C.	0.00078 cc/cc/°C.

• Specifications

MONS 080698

Dioctyl adipate (continued)

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	13.7	13.9	14.0
Low-Temperature Flex, T_f °C	−46	−66	<−70
Water immersion (24 hours):			
% soluble matter lost	0.05	0.10	0.07
% water absorbed	0.40	0.66	0.82
Kerosene extraction (% plasticizer lost)	19.5	>70	>70
Shore "A" Hardness	83	65	48
Migration, Linde Silica:			
1 day	5.1	7.5	11.5
3 days	9.5	13.5	22.0
7 days	14.6	21.0	28.7
Tensile, p.s.i.	2360	1710	1090
Elongation, %	390	430	460
Modulus @ 100% Elongation	1150	630	350
Flame Retardant	No	No	–
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Fair	Fair	Fair
Electrical Properties	Fair	Fair	–

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM	
23°C	
Initial	3,200
7 Days	5,500
28 Days	6,000
40°C	
Initial	2,500
7 Days	9,000
28 Days	12,500
50°C	
Initial	2,000
7 Days	Gel
28 Days	–
Severs	
10 psi	2,020
50 psi	1,840
100 psi	1,310
Yield value, dynes/cm^2	160
Flow Index	0.96
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	139
*Air-Release Time, minutes	7
*Resilience,steel ball, inches	10.9
*Resilience,rotationally cast ball, inches	34

*Efficiency Conc. Adj. to "60" Shore A Hardness

clear liquid plasticizer for synthetic resin floor polishes and waxes

Tributoxyethyl Phosphate

General Description

Tributoxyethyl Phosphate is a clear liquid plasticizer primarily used in synthetic resin floor polishes and waxes. It is a compatible plasticizer and strong solvent for most resins.

In polyacrylate, polystyrene, and styrene-acrylate copolymer formulations for high quality floor polishes, TBEP is an industry standard. It has wide compatibility and high solvency for the many components and imparts flexibility, optimum gloss, depth, and leveling properties to the coating. TBEP may be used alone or in combination with other plasticizers such as Santicizer 160 or Dibutyl Phthalate.

In acrylonitrile and synthetic rubbers, TBEP is an industry standard for imparting low temperature flexibility, TBEP imparts good tack to synthetic rubbers and is a strong solvent and gelling agent for most resins.

Tributoxyethyl Phosphate imparts flame-retardance to polymer systems but is not as effective as Santicizer 140, Santicizer 141, or Tricresyl Phosphate.

In plastisols, the low viscosity per se of TBEP is useful if used in small amounts to reduce viscosity of partially gelled plastisols. If used as the only plasticizer or at high concentrations in plastisols, TBEP imparts very fast gellation.

In nitrocellulose, ethyl cellulose, acrylics, and polystyrene, TBEP imparts plasticizing efficiency, clarity, and good UV stability.

Properties

Chemical type	Phosphate
• Appearance	Clear, oily liquid *
• Acidity	1.0 meq/100 gm. max.
• Color	APHA 75 max.
• Moisture	0.20% max. (KF in methanol)
• Odor	Characteristic, mild
• Refractive Index at 25°C	1.434 to 1.438
• Specific Gravity 25°C/25°C	1.017 to 1.023
Density at 25°C.	8.50 lb/gal.
Cystallizing point	<-70°C
Pour point	<-70°C
Boiling point at 760 mm Hg	215 to 228°C
Vapor pressure at 150°C 200°C	<0.10 mm Hg 1.6 mm Hg
Viscosity at 20°C	12.0 cks
Surface tension at 20°C	30 dynes per cm
Thermal expansion at 10° to 40°C	0.00081 cc/cc °C
Fire point (C.O.C.)	485°F
Flash point (C.O.C.)	435°F
Solubility in water at 25°C	0.11%

* Specifications

MONS 080700

Tributyl Phosphate

anti-foaming agent and high-boiling solvent

General Description

Tributyl Phosphate is a clear liquid plasticizer used primarily as an anti-foaming agent and a high-boiling solvent. It is a primary plasticizer for nitrocellulose, cellulose acetate, and chlorinated rubber. It is compatible with vinyl resins but volatile and used only in specialized applications.

Tributyl Phosphate is used as an anti-foaming agent in paper coatings, inks, water-based adhesives, surface coatings, lattices, textile sizes, detergent solutions, etc.

In weed killer acids formulated with 2-4D, Tributyl Phosphate is used as a solvent and for blending concentrations.

In uranium recovery, TBP is used in the solvent extraction process.

Properties

Chemical Type	Phosphate
Molecular weight	266.32
• Appearance	Clear, oily liquid
• Acidity	0.61 meq/100 gm. max.
• Color	APHA 75 max.
• Moisture	0.20% max. (KF in methanol)
• Odor	Characteristic
• Refractive index at 25°C	1.422 to 1.424
• Specific gravity 25°C/25°C	0.973 to 0.978
Density at 25°C	8.14 lbs./gal.
Crystallizing point	$<-80°C$
Pour point	$<-80°C$
Boiling point at 760 mm Hg	137 to 145°C
Vapor pressure at 150°C 200°C	7.3 mm Hg >500 mm Hg
Viscosity at 20°C	3.8 cks
Surface tension at 20°C	29 dynes per cm
Thermal expansion at 10° to 40°C	0.00086 cc/cc/°C
Fire point (C.O.C.)	450°F
Flash point (C.O.C.)	380°F
Solubility in water at 25°C	0.1%

• Specifications

MONS 080701

flame-retarding plasticizer

Tricresyl Phosphate

General Description

Tricresyl phosphate is a standard flame-retardant plasticizer for vinyl resins, synthetic rubbers and cellulosic resins with the exception of cellulose acetate. It is miscible with all common solvents and thinners.

In vinyl films, tricresyl phosphate is used for flame retardance and as a processing aid; in electrical insulation for its additional value of low volitility and permanence.

In nitrocellulose lacquers and coatings, tricresyl phosphate is an excellent solvent, has high retentivity, and can be used in high proportion to the resin without danger of "sweating" or separation. It imparts excellent flexibility, and increasing amounts do not proportionately decrease film tensile strength as do other plasticizers. It is compatible with most lacquer resins and produces clear, tough films with excellent weathering properties.

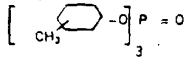
In phenolic laminating resins, tricresyl phosphate imparts a degree of flame retardancy, some flexibility, and improves the punching characteristics.

In cellulose acetate, although tricresyl phosphate has low compatibility, it can be blended with more compatible plasticizers such as triphenyl phosphate and dimethyl phthalate to impart a degree of flame retardance.

Tricresyl phosphate has good lubricating properties and shear stability . . . making it valuable as a special fire-resistant lubricant, cutting-oil additive, dust-entrapping agent, and pump seal.

To assure maximum quality and low toxicity Monsanto makes tricresyl phosphate from cresol with a specification maximum of 1.0 per cent ortho isomer (usually from 0.1 to 0.5 per cent).

Properties

Chemical type	Phosphate
Chemical formula	
Molecular weight	368.18
• Appearance	Clear, oily liquid
• Acidity	0.20 meq/100 gm. max. (0.01% as phosphoric acid)
• Color	APHA 75 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	No foreign odor
Refractive index @ 25°C.	1.556
• Specific gravity 25°/25°C.	1.157 to 1.173
• Stability to $MKnO_4$	65% transmission min.
Weight per gallon @ 25°C.	9.7 lb.
Boiling point, 760 mm Hg	420°C.
Crystallizing point	<-35°C.
Flash point (C.O.C.)	470°F.
Fire point (C.O.C.)	695°F.
Vapor pressure @ 200°C.	0.5 mm Hg
300°C.	29 mm Hg
Viscosity @ 0°C.	1256.0 cks
25°C.	89.0 cks
98.9°C.	4.0 cks
Surface tension	44.5 dynes/cm.
Solubility in water @ 25°C.	$<$0.002 g/100 ml
General solubility	Soluble in common solvents and thinners.
Thermal expansion @ 10 to 40°C.	0.00067 cc/cc °C.

• Specifications

MONS 080702

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	0.8	1.0	1.6
Low-Temperature Flex, T_f °C	+10.5	−10	−29
Water immersion (24 hours):			
% soluble matter lost	0.01	0.03	0.03
% water absorbed	0.24	0.26	0.35
Kerosene extraction (% plasticizer lost)	0.4	2.4	4.4
Shore "A" Hardness	100	79	62
Migration, Linde Silica:			
1 day	0.08	0.4	0.65
3 days	0.16	0.8	2.51
7 days	0.28	1.6	4.39
Tensile, p.s.i.	3120	2490	1560
Elongation, %	250	360	460
Modulus @ 100% Elongation	2540	1000	470
Flame Retardant	Yes	Yes	—
Heat Stability	Fair	Fair	Fair
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	Good	Good	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	23,600
7 Days	34,000
28 Days	>100,000
40°C	
Initial	11,720
7 Days	>100,000
28 Days	Gel
50°C	
Initial	>100,000
7 Days	Gel
28 Days	—
Severs	
10 psi	49,500
50 psi	104,000
100 psi	107,500
Yield value, dynes/cm²	0
Flow Index	4.0
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	92
*Air Release Time, minutes	25
*Resilience, steel ball, inches	1.7
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

flame-retarding plasticizer for cellulosic materials

Triphenyl Phosphate

■ General Description

Triphenyl phosphate is the most commonly used, solid, flame-retarding plasticizer for cellulose acetate. It is compatible with a wide variety of vinyl resins, with cellulosics, and with synthetic rubber. In vinyl compounds, however, a solvent type plasticizer should be used in conjunction with triphenyl phosphate to prevent crystallizing and blooming.

When mixed in equal parts by weight with Santolite MHP, triphenyl phosphate forms a eutectic liquid mixture at room temperature that is most effective for plasticizing polyvinyl acetate and cellulosic resins. The combination has very low volatility, provides good permanence, and imparts flame resistance, good gloss, and resistance to extraction by aliphatic hydrocarbons. In films, it promotes adhesion.

In cellulose acetate films, triphenyl phosphate imparts flame resistance, good clarity, excellent water resistance, good flexibility and toughness with no tendency toward tackiness.

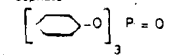
Mixed with Santicizer M-17, triphenyl phosphate dissolves cellulose acetate at temperatures above 120°C. Using this combination makes excellent heat-resistant paper lacquers and produces effective "dopes" for coating, tautening, and water proofing cloth. Cellulose acetate heat-resistant paper lacquers can be made with this mixture, and fire-resistant pigmented acetate sheets.

In nitrocellulose films, triphenyl phosphate improves tensile strength and imparts other favorable properties analogous to its effect in cellulose acetate.

In synthetic rubbers, triphenyl prosphate provides fair softening action and is highly resistant to extraction by gasoline and mineral oils.

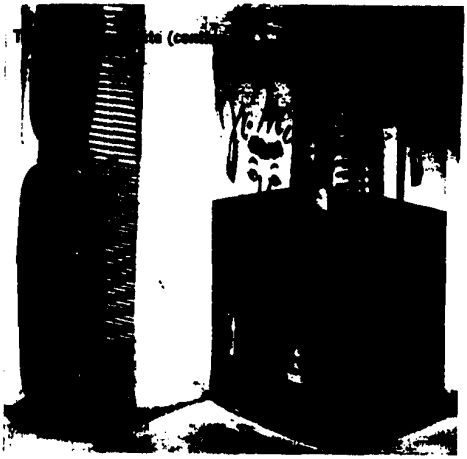
Triphenyl phosphate has relatively low toxicity; it neither irritates nor sensitizes the skin.

Properties

Chemical type	Phosphate
Chemical formula	
Molecular weight	326.31
• Appearance	White flakes
• Acidity	0.06 meq/100 gm. max. (0.003% as phosphoric acid)
Color (molten)	APHA 20
• Odor	Very faint aromatic max.
Refractive index @ 60°C.	1.550
Specific gravity 60°/20°C.	1.268
• Stability to $KMnO_4$	65% transmission, min.
Weight per gallon (25°C.)	10.5 lbs.
Boiling point, 760 mm Hg	370°C.
Crystallizing point	49°C.
• Melting point	48.5°C. min. to start
Flash point (C.O.C.)	437°F.
Vapor pressure @ 150°C.	0.15 mm Hg
200°C.	1.9 mm Hg
Viscosity @ 55°C.	7.83 cks
98.9°C.	2.90 cks
Solubility in water 34°C.	0.001%
General solubility	Soluble in all common organic solvents, thinners, and vegetable oils.

• Specifications

MONS 080704



The flame retardance, clarity, flexibility, toughness, and nontackiness imparted to cellulose acetate by triphenyl phosphate are major benefits in many packaging applications.

Performance in Various Resins

Resin	Cellulose Acetate	Ethyl Cellulose		Nitro-Cellulose		Cellulose Acetate-Butyrate	Polyvinyl Acetate
PHR	42.5	0	15	0	50	33⅓	20
Solution Temperature °C.	180	—	—	—	—	—	—
Yield, p.s.i.	—	6755	4550	—	—	—	—
Tensile, p.s.i.	—	8960	6685	8533	4410	2500	—
Elongation, %	—	30	30	6	8	10	—
Hardness	81	100	70	—	—	—	—
Sward Hardness	—	—	—	—	—	40	—
Volatility	—	E	E	—	—	—	2.0
Flexibility Schopper Fold Cycles	—	—	—	20	24	—	—
Flexural Strength, p.s.i.	9020	—	—	—	—	—	—
Moisture Permeability, %	—	—	—	100	56	—	—
% Water Absorbed in 24 hrs.	1.17	—	—	—	—	—	—
Extraction %							
Kerosene	—	—	—	—	—	—	0.02
Peanut Oil	—	—	—	—	—	—	0.37
Cottonseed Oil	—	—	—	—	—	—	0.38



Triphenyl phosphate imparts flame retardance, water resistance, clarity, and toughness to cellulose acetate photographic film and photograph-album sleeves.

MONS 080705

superior flame-retarding plasticizer

Santicizer 140

■ General Description

Santicizer 140 is a flame-retarding plasticizer, similar to tricresyl phosphate, but more *efficient* . . . a smaller portion to resin produces greater plasticizing effect. It has good resin solvating action and is heat and light stable.

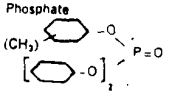
In polyvinyl chloride compositions, Santicizer 140 affords more efficient plasticizing action and provides easier processing compared to tricresyl phosphate. The compositions possess much greater resistance to staining than obtainable with most other monomeric plasticizers. Santicizer 140 imparts better low-temperature flexibility and higher abrasion resistance than tricresyl phosphate.

In polyvinyl acetate, Santicizer 140 improves the flexibility, the film formation, and the composition's water resistance. With *polyvinyl formal*—it forms clear, tough compositions with good abrasion resistance.

In cellulose acetate, acetate-butyrate, acetate-propionate, Santicizer 140 has sufficient compatibility to be used as an alternate plasticizer to solid triphenyl phosphate, with the further advantage of being a liquid. With cellulosics—Santicizer 140 can be used to produce stiff, hard, clear compositions suitable for lacquers.

Based on its chemical composition, Santicizer 140 appears to be toxicologically similar to tricresyl phosphate. At the elevated temperatures of extrusion and calendering operations, adequate ventilation for fume removal should be provided.

Properties

Chemical type	Phosphate
Chemical formula	
Molecular weight	340.2
• Appearance	Clear, oily liquid.
• Acidity	0.20 meq/100 gm. max. (0.01% max. as H_3PO_4)
• Color	APHA 40 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Essentially odorless
Refractive index @ 25°C.	1.550 to 1.570
• Specific gravity 25°. 25°C.	1.203 to 1.213
• Stability to $KMnO_4$	65% transmission, min.
Weight per gallon @ 25°C.	10 lb.
Boiling point, 760 mm Hg	390°C.
Crystallizing point	<-35°C.
Pour point	−37°C.
Flash point (C.O.C.)	450°F.
Fire point (C.O.C.)	None @ 625°F.
Vapor pressure @ 150°C.	0.08 mm Hg
200°C.	1 mm Hg
390°C.	760 mm Hg
Viscosity @ 0°C.	208.0 cks
25°C.	33.0 cks
98.9°C.	2.8 cks
Surface tension @ 20°C.	42 dynes/cm
Solubility in water @ 25°C.	<0.005%
General solubility	Insoluble or limited in certain amines, mineral oil, glycerine and glycols. Soluble in most other organic liquids.
Thermal expansion @ 10° to 40°C.	0.00067 cc/cc/°C.

• Specifications

MUNS 080706

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	3.4	3.6	4.0
Low-Temperature Flex, T_f °C	+5.4	−15	−36
Water immersion (24 hours):			
% soluble matter lost	0.03	0.04	0.07
% water absorbed	0.27	0.30	0.38
Kerosene extraction (% plasticizer lost)	0.4	2.1	7.6
Shore "A" Hardness	93	76	65
Migration, Linde Silica:			
1 day	0.0	0.63	2.91
3 days	0.08	1.63	7.47
7 days	0.21	2.70	11.8
Tensile, p.s.i.	3170	2700	1680
Elongation, %	290	380	440
Modulus @ 100% Elongation	2020	1080	540
Flame Retardant	Yes	Yes	—
Heat Stability	Fair	Fair	Fair
Migration Resistance to Nitrocellulose	Fair	Poor	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	Fair	Fair	—

Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	20,300
7 Days	23,000
28 Days	35,000
40°C	
Initial	3,650
7 Days	12,050
28 Days	27,500
50°C	
Initial	35,000
7 Days	Gel
28 Days	—
Severs	
10 psi	51,800
50 psi	118,000
100 psi	140,000
Yield value, dynes/cm^2	0
Flow Index	5.7
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	100
*Air Release Time, minutes	24
*Resilience steel ball, inches	2.7
*Resilience rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

nontoxic, flame-retarding, low-temperature general-purpose plasticizer

Santicizer 141

■ General Description

Santicizer 141 is an excellent, *nontoxic* plasticizer for the more important commercial resins including polyvinyl chloride and its copolymers, cellulose nitrate, cellulose acetate-butyrate, ethyl cellulose, polymethyl methacrylate, and polystyrene.

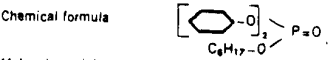
In polyvinyl chloride, Santicizer 141, as a general-purpose low-volatility plasticizer, imparts flame resistance; good low-temperature flexibility; low odor; good heat-sealing characteristics; light and heat stability; compounds plasticized with Santicizer 141 show good resistance to abrasion, oil and grease, and weathering. Santicizer 141 improves the processing characteristics of most formulations because of its excellent resin-solvating power. Used in combination with a phthalate-ester plasticizer, Santicizer 141 significantly increases resistance to embrittlement and improves weather resistance over compounds plasticized with phthalate ester alone. It also offers superior light stability and low-temperature flexibility compared to tricresyl phosphate. Its compatibility and the special properties it confers make Santicizer 141 particularly useful in vinyl film and sheeting, textile coatings, protective coatings, plastisols, organosols, adhesives, and packaging materials.

In vinyl plastisols Santicizer 141 imparts a low initial viscosity. As would be expected from a rapid fusion plasticizer, the viscosity builds up rapidly during aging. Rapid fusion is advantageous in formulations for slush molding, textile coating, and spray coatings. However, when more constant viscosity value must be maintained, the advantages of Santicizer 141 plasticizing can be retained by addition of a viscosity-control agent.

Santicizer 141 is compatible with and makes an excellent plasticizer for Buna N rubber, nitrocellulose, cellulose acetate-butyrate, ethyl cellulose, poly methyl methacrylate, polystyrene, and polyvinyl butyral.

Santicizer 141 has been regulated by prior sanction as an ingredient for films under the 1958 Amendment to the Food Additives Act. It is an excellent nontoxic plasticizer for use in plastic products (containers, wrapping films, beverage tubing, packaging materials, etc.) that are intended for contact with food items. It is nonirritating to human tissues. Santicizer 141 has found wide acceptance in manufacture of such critical products as vinyl hospital sheeting and tubing, plastic baby clothing, shoes, dentures, and anatomical restorations.

Properties

Chemical type	Phosphate
Chemical formula	
Molecular weight	362.40
• Appearance	Clear, oily liquid
• Acidity	0.20 meq/100 gm. max. (0.01% as H_3PO_4)
• Color	APHA 60 max.
• Moisture	0.10% max.
• Odor	Slight, sweet
Refractive index @ 25°C.	1.507 to 1.510
• Specific gravity 25°/25°C.	1.089 to 1.093
Weight per gallon @ 25°C.	9.1 lb.
Boiling point, 760 mm Hg	375°C.
Pour point	−54°C.
Flash point (C.O.C.)	435°F.
Fire point (C.O.C.)	460°F.
Vapor pressure @ 150°C.	0.095 mm Hg
200°C.	1.3 mm Hg
Viscosity @ 0°C.	61.0 cks
25°C.	16.4 cks
98.9°C.	2.5 cks
Surface tension @ 23°C.	36.7 dynes/cm
Solubility in water @ 25°C.	0.003%
General solubility	Soluble in most organic solvents.

• Specifications

MONS 080708

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	6.8	7.4	8.4
Low-Temperature Flex, T_f °C	−17	−39	−58
Water Immersion (24 hours):			
% soluble matter lost	0.02	0.06	0.25
% water absorbed	0.24	0.36	0.50
Kerosene extraction (% plasticizer lost)	3.0	7.3	24
Shore "A" Hardness	86	65	50
Migration, Linde Silica:			
1 day	0.34	1.55	4.2
3 days	1.18	4.6	12.3
7 days	2.10	9.0	22.4
Tensile, p.s.i.	2930	1960	1200
Elongation, %	320	440	510
Modulus @ 100% Elongation	1500	700	380
Flame Retardant	Yes	Yes	—
Heat Stability	Fair	Fair	Fair
Migration Resistance to Nitrocellulose	Poor	Poor	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	Fair	Fair	—

Performance in Plastisol Formulation

Viscosity, centipoises
Brookfield HAT #6 Spindle
50 RPM

	65 PHR
23°C	
Initial	4,250
7 Days	12,350
28 Days	12,400
40°C	
Initial	9,000
7 Days	Gel
28 Days	—
50°C	
Initial	Gel
7 Days	—
28 Days	—
Severs	
10 psi	6,250
50 psi	5,950
100 psi	4,990
Yield value, dynes/cm^2	60
Flow Index	2.1
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	105
*Air-Release Time, minutes	15
*Resilience.steel ball, inches	5.8
*Resilience.rotationally cast ball, inches	27

*Efficiency Conc. Adj. to "60" Shore A Hardness



Santicizer E-15 is an excellent plasticizer for cellulose acetate moldings and for copolymer films for food wrapping.

Performance in Various Resins

Resin	Cellulose Acetate	Ethyl Cellulose		Cellulose Acetate-Butyrate
PHR	34	0	15	33⅓
Solution Temperature °C.	148	–	–	–
Yield, p.s.i.	–	6755	4265	–
Tensile, p.s.i.	–	8960	6685	2000
Elongation, %	–	30	40	14
Hardness Index	50	100	65	–
Sward Hardness	–	–	–	34
Volatility	–	E	G	–
Flexural Strength, p.s.i.	6930	–	–	–
% Water Absorbed in 24 hrs.	0.97	–	–	–

nontoxic plasticizer for cellulosic films

Santicizer E 15

■ General Description

Santicizer E-15 is a nontoxic, colorless plasticizer highly recommended for use in cellulose acetate and nitrate, particularly for lacquers, heat-seal coatings, adhesives, and films that will be used in food wrap and packaging. It is light-stable and relatively nonvolatile, even from thin films.

In cellulose acetate, Santicizer E-15 compositions make sheeting that has greater elongation than when made with Santicizer M-17 but with somewhat less folding endurance and resistance to tear. The films are tough and flexible and have great resistance to water penetration. Molding compounds possess good molding properties and resistance to water absorption (@ 50 PHR only 0.97% after 48 hours immersion).

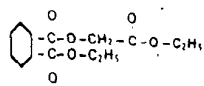
In cellulose nitrate, Santicizer E-15 rapidly solvates the resin, produces clear, tough, flexible films with greatly increased resistance to water penetration. It imparts good light resistance and dimensional stability.

Santicizer E-15 is an active solvating plasticizer for polyvinylidene chloride, polyvinyl acetate (good permanence and resistance to extraction by fats and oils), polyvinyl butyral, alkyds, and a number of cellulose copolymers.

Santicizer E-15 is regulated by prior sanction as a plasticizer for films under the 1958 Amendment to the Food Additives Act for use with all types of foods.



Properties

Chemical type	Glycollate
Chemical formula	
Molecular weight	280.27
• Appearance	Clear, oily liquid
• Acidity	0.17 meq. 100 gm. max. (0.01% as acetic acid)
• Color	APHA 20 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight max.
Refractive index @ 25°C.	1.496 to 1.500
• Specific gravity 25°/25°C.	1.180 to 1.185
Sulfur (copper-strip test)	Negative
Weight per gallon @ 25°C.	9.85 lb.
Boiling point, 760 mm Hg	320°C.
Crystallizing point	20°C. (supercools readily)
Flash point (C.O.C.)	386°F.
Vapor pressure @ 150°C.	0.47 mm Hg
200°C.	7 mm Hg
300°C.	480 mm Hg
Viscosity @ 0°C.	616.0 cks
25°C.	58.0 cks
98.9°C.	2.9 cks
Solubility in water @ 30°C.	0.0175%
General solubility	Soluble in acetone and benzene and most organic solvents.

• Specifications

Many meat and poultry products are safely, economically, and attractively wrapped in polyvinylidene chloride film plasticized with nontoxic and highly compatible Santicizer E-15.

nontoxic plasticizer for plastic food packaging

Santicizer B-16

General Description

Santicizer B-16 is a nontoxic, extremely light-stable plasticizer that is colorless, odorless, and tasteless.

In polyvinyl chloride compositions, Santicizer B-16 imparts good processing performance and top quality end-product performance. Finished films, sheetings and extrusions are clear and colorless and show good heat and light stability.

In nitrocellulose, Santicizer B-16 probably offers more desirable performance properties than any other plasticizer. Lacquer films are clear, brilliant, flexible, tough, moisture resistant, and have good weathering properties. It produces the same degree of film flexibility as dibutyl phthalate but with less softening action.

In protein compositions, Santicizer B-16 may be used in combination with Santolite MS-80® in a variety of mixtures to plasticize casein and corn proteins, incorporating the combination either as a solution in organic solvents or as an emulsion. One part of Santicizer B-16 to 2-10 parts Santolite MS-80® may be combined with from 0.3 to 1.5 parts of protein resins. Protein resins plasticized in this way possess vastly improved water resistance.

Santicizer B-16 is a good plasticizer for chlorinated rubber and its presence promotes adhesion. It can also be used to soften shellac and Kauri gum and to modify paraffin wax. It is an exceptionally good plasticizer for polystyrene molding or coating compositions, greatly improving weather resistance and slowing the gelling time in latices.

In polyvinyl acetate, Santicizer B-16 offers an outstanding balance of properties.

Santicizer B-16 is regulated by prior sanction under the 1958 Amendment to the Food additives Act as an ingredient for films. It is recommended for beverage tubing, food packaging, hospital sheeting, jar and bottle cap seals and liners, anatomical restorations, adhesives, dress shields, paper lacquers, and coatings.

Properties

Chemical type	Glycollate
Chemical formula	
Molecular weight	336.37
• Appearance	Clear, oily liquid
• Acidity	0.33 meq/100 gm. max. (0.02% max. as acetic acid)
• Color	APHA 45 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight, characteristic
Refractive index @ 25°C.	1.488 to 1.492
• Specific gravity 25°/25°C.	1.095 to 1.105
Sulfur (copper-strip test)	Negative
Weight per gallon @ 25°C.	9.15 lb.
Boiling point, 760 mm Hg	345°C.
Crystallizing point	< −35°C.
Pour point	< −40°C.
Flash point (C.O.C.)	390°F.
Vapor pressure @ 150°C.	0.1 mm Hg
200°C.	1.8 mm Hg
300°C.	190 mm Hg
Viscosity @ 0°C.	279.0 cks
25°C.	46.0 cks
98.9°C.	3.6 cks
Solubility in water @ 30°C.	0.0012%
General solubility.	Solunble in all common organic solvents, thinners and vegetable oils.

• Specifications

MONS 080712

Performance in PVC (40 mil sheet)

	(30%) 43 PHR	(40%) 67 PHR	(50%) 100 PHR
Volatility (% Lost) (Activated Carbon)	10.9	12.0	14.0
Low-Temperature Flex, T_f °C	−8.3	−35	−49
Water Immersion (24 hours):			
% soluble matter lost	0.08	0.12	0.28
% water absorbed	0.27	0.39	0.55
Kerosene extraction (% plasticizer lost)	1.1	3.8	11.4
Shore "A" Hardness	87	68	53
Migration, Linde Silica:			
1 day	0.20	0.76	2.22
3 days	0.55	2.9	7.27
7 days	0.93	5.34	13.9
Tensile, p.s.i.	3090	2180	790
Elongation, %	310	370	450
Modulus @ 100% Elongation	1880	830	440
Flame Retardant	No	No	—
Heat Stability	Good	Good	Good
Migration Resistance to Nitrocellulose	Fair	Poor	Poor
Fluxing Rate	Excellent	Excellent	Excellent
Electrical Properties	—	—	—

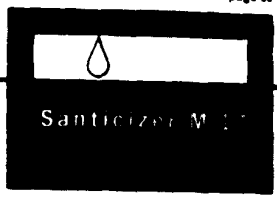
Performance in Plastisol Formulation

	65 PHR
Viscosity, centipoises	
Brookfield HAT #6 Spindle	
50 RPM	
25°C	
Initial	7,200
7 Days	22,200
28 Days	27,000
40°C	
Initial	10,000
7 Days	40,000
28 Days	Gel
50°C	
Initial	Gel
7 Days	—
28 Days	—
Severs	
10 psi	36,800
50 psi	37,700
100 psi	23,600
Yield value, dynes/cm²	130
Flow Index	5.0
Severs vis. 50 psi / Brookfield vis. 50 rpm	
Fusion Point, °C	100
*Air-Release Time, minutes	—
*Resilience,steel ball, inches	—
*Resilience,rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080713

grease-resistant, high solvency plasticizer for cellulose acetate



■ General Description

Santicizer M-17 is one of the best plasticizers available for cellulose acetate; it readily solvates both acetate and nitrocellulose. It is nontoxic, imparts a high degree of plasticity, has only a faint odor. Santicizer M-17 is light-stable and may be used in light-tinted and transparent products without danger of yellowing.

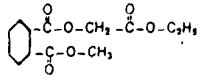
In cellulose acetate compositions, Santicizer M-17 lowers processing costs because it may be hot mixed directly with the resin flake without the use of volatile solvents. It shows high solvency and rapid resin solvation, offers good permanence, and imparts good dimensional stability. Its retentivity varies somewhat with the amount of combined acetic acid in the resin; in 56% combined acetic acid resin, it is compatible up to 66% plasticizer; in 52% combined acetic acid resin, it is much less compatible. In molding compounds, Santicizer M-17 imparts a high degree of resistance to moisture penetration and good flexural strength. It offers excellent light stability and is recommended for cellulose acetate sheets and grease-resistant lacquers. In acetate molding compounds, Santicizer M-17 imparts high resistance to water penetration.

In polyvinyl acetate adhesives and emulsion paints, Santicizer M-17 shows low volatility and imparts a high degree of grease and oil resistance; the paints show a much lower coalescence temperature than ones plasticized with dibutyl phthalate.

Santicizer M-17 is compatible with alkyd, vinyl, polystyrene, chlorinated rubber, and many phenolic resins. Frequently as little as five parts per hundred produces a marked flexibility. Combined with Santolite MHP resin, Santicizer M-17 forms a composition that will plasticize a variety of film forming materials; the combination itself will produce coatings that are resistant to oil, gasoline, and grease.

Santicizer M-17 possesses a low degree of toxicity. Human arm immersion studies show that it is not a skin irritant, a sensitizer, nor a fatiguing agent.

Properties

Chemical type	Glycollate
Chemical formula	
Molecular weight	266.24
• Appearance	Clear, oily liquid
• Acidity	0.33 meq/100 gm. max. (0.02% as acetic acid)
• Color	APHA 20 max.
• Moisture	0.15% max. (KF in methanol)
• Odor	Slight, characteristic max
Refractive index @ 25°C.	1.504
• Specific gravity 25°/25°C.	1.217 to 1.227
Weight per gallon @ 25°C.	10.20 lb.
Sulfur (copper-strip test)	Negative
Boiling point, 760 mm Hg	310°C.
Crystallizing point	< −35°C.
Pour point	−26°C.
Flash point (C.O.C.)	380°F.
Vapor pressure @ 150°C. 200°C. 300°C.	0.5 mm Hg 8 mm Hg 600 mm Hg
Viscosity @ 0°C. 25°C. 98.9°C.	1476.0 cks 82.0 cks 2.8 cks
Surface tension @ 25°C.	43.6 dynes/cm.
Solubility in water @ 30°C.	0.09%
General solubility	Soluble in most organic solvents. Insoluble in linseed oil, caster oil, Chinawood oil, and petroleum hydrocarbons.

• Specification

MONS 080714



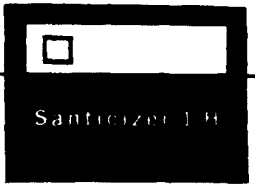
Santicizer M-17 has low volatility from polyvinyl acetate-emulsion paints. It also imparts a high degree of grease and oil resistance and a low coalescence temperature to paint.

Performance in Various Resins

Resin	Cellulose Acetate	Ethyl Cellulose		Cellulose Acetate-Butyrate	Polyvinyl Acetate
PHR	34	0	15	33⅓	20
Solution Temperature, °C	148	—	—	—	—
Yield, p.s.i.	—	6755	4125	—	—
Tensile, p.s.i.	—	8960	7965	1800	—
Elongation, %	—	30	38	18	—
Hardness Index	65	100	60	—	—
Sward Hardness	—	—	—	52	—
Volatility	—	E	G	—	3.6
Flexural Strength, p.s.i.	7110	—	—	—	—
% Water Absorbed in 24 hrs.	0.77	—	—	—	—
Extraction %					
Kerosene	—	—	—	—	0.19
Peanut Oil	—	—	—	—	0.50
Cottonseed Oil	—	—	—	—	0.48

MONS 080715

solid plasticizer for heat-sealing adhesives and lacquers



■ General Description

Santicizer 1-H is a sharp-melting-point solid plasticizer for use in formulating heat-sealing adhesives, lacquers, and a variety of specialty coatings for paper, textiles, and packaging films. As a solid, with a high, sharp melting point—Santicizer 1-H is an excellent resin modifier for heat-sealing adhesives, hot-melt coatings, and crystallizing lacquers. As a solid it makes possible the delayed-tack property in delayed-tack adhesives.

Santicizer 1-H is compatible with a variety of resins, including nitrocellulose, polystyrene, polyvinyl acetate, alkyd, nylon, polyamides, shellac and kauri resin. It acts as a "compatibility extender" for paraffin making it possible to incorporate paraffin in resins, such as nitrocellulose, for the formulation of moisture-proof coatings.

In nitrocellulose, Santicizer 1-H imparts a fairly sharp softening point for heat-sealing compositions but does not impart high flexibility; greater flexibility may be obtained by including Santicizer 141 or 160 as a coplasticizer.

Used *in cellulose acetate*, Santicizer 1-H improves the water resistance; *in ethyl cellulose*, it imparts good flexibility, hardness, and light stability. Since retentivity in these resins is low, Santicizer 1-H is used in combination with other plasticizers. *In polyamides*, Santicizer 1-H imparts excellent high-temperature resistance. In shellac, kauri resin, and cyclicized rubber — it imparts excellent flexibility. (In rubber, however, the flexibility, obtained with as little as 5% Santicizer 1-H, rapidly disappears when the rubber becomes oxidized.)

Santicizer 1-H haa a very low order of toxicity. It is FDA regulated for use in adhesives for food packaging.

Properties

Chemical type	Sulfonamide
Chemical formula	CH_3  $-SO_2NH-$ 
Molecular weight	253.36
• Appearance (molten)	Yellow-brown fused mass.
• Clarity (molten)	Slightly turbid, max.
• Color (molten)	APHA 300, max.
• Moisture	0.15% max. (*KF* in methanol)
Density	1.125
Boiling point, 760 mm Hg	350°C.
• Crystallizing point (in vacuum jacket)	82.5°C. min.
Vapor pressure @ 350°C.	760 mm Hg
Solubility in water @ 30°C.	0.00045%
General solubility	Soluble in alcohols, esters, ketones, aromatic hydrocarbons, and vegetable oils.

• Specifications

Performance in Various Resins

Resin	Ethyl Cellulose		Nitrocellulose		Cellulose Acetate Butyrate (37%)	Polyvinyl Acetate
PHR	0	15	0	50	33⅓	20
Yield, p.s.i.	6755	5475	—	—	—	—
Tensile, p.s.i.	8960	7750	8533	3270	3900	—
Elongation,%	30	32	6	7	46	—
Hardness Index	100	80	—	—	—	—
Sward Hardness	—	—	—	—	46	—
Volatility	Excellent		—	—	—	1.5
Flexibility (Schopper Fold Cycles)	—	—	20	10	—	—
Moisture Permeability,%	—	—	100	41	—	—
Extraction, %						
Kerosene	—	—	—	—	—	0.96
Peanut Oil	—	—	—	—	—	0.36
Cottonseed Oil	—	—	—	—	—	0.53

Santicizer 1-H imparts the advantage of a high, sharp melting point to heat-sealing and delayed-tack coatings and adhesives.



MONS 080717

highly-polar, solid plasticizer

Santicizer 3

General Description

Santicizer 3 is a solid, sulfonamide plasticizer, with a melting point of about 58 °C. Though it is miscible in varying degrees with a broad range of resins, it has limited compatability with many and is usually used in combination with other, more-active-solvent plasticizers. Since Santicizer 3 sharpens the softening point of thermoplastics, it is a useful plasticizer in heat-sealing adhesives and lacquer coatings.

In *cellulose acetate* compositions it is readily incorporated with a compatibility limit of 45 PHR. When used either alone or with other plasticizers it improves gloss, toughness, hardness, and flow characteristics; sharpens the softening point; and lowers moisture permeability.

Santicizer 3 is slightly more compatable with both *cellulose acetate-propionate* and *cellulose acetate-butyrate*, and sharpens their softening points. Cellulose acetate-butyrate film containing Santicizer 3 at a concentration of 33⅓ PHR has a sward hardness of 34, tensile strength of 1800 psi, and 27-per cent elongation.

Nitrocellulose lacquers plasticized with Santicizer 3 have improved film properties and heat-sealing characteristics, which are important for cellophane and paper lacquers.

Improved toughness, gloss, and film characteristics are imparted to *ethyl cellulose* by plasticizing with a low concentration of Santicizer 3.

Santicizer 3 is a useful plasticizer for *nylon:* it imparts flexibility. Santicizer 3 is more heat stable than Santicizer 8 in this application. The heat stability may be further improved by the addition of 3-per cent triphenyl phosphite based on the plasticizer. In *polyamides* based on dimer acids Santicizer 3 is an excellent plasticizer.

Santicizer 3 is compatible with *polyvinyl formal* to the extent of about 45 PHR. It imparts excellent gloss and good flow. For best results it should be used in combination with other plasticizers. *(continued)*

Properties

Chemical type	Sulfonamide
Chemical formula	$CH_3-C_6H_4-SO_2NHC_4H_9$
Molecular weight	199.23
• Appearance	Practically white solid
• Acidity	1.60 meq/100 gm. max.
• Color (molten)	APHA 60 max.
• Moisture (KF in methanol)	0.25% max.
Refractive index @ 65°C	1.512 to 1.532
• Chlorine hydrolyzable	0.010% max.
Specific gravity @ 65°C/65°C	1.166 to 1.176
• Crystallizing point	58.0°C min.
Boiling point @ 760 mm. Hg	340°C approx.
Flash point (C.O.C.)	371°F
Vapor pressure @ 160°C	0.8 mm. Hg

• Specifications

The improved heat-sealing characteristics imparted to nitrocellulose lacquers for cellophane and paper are of major importance in many applications.



MONS 080718



With Santicizer 213

Inclusion of Santicizer 213 greatly improves mold release of vinyl plastisols.

With Dioctyl Phthalate



Plasticizer Performance in Other Resins

PLASTICIZER PERFORMANCE IN ETHYL CELLULOSE FILM

Control (no plasticizer)	6755	8960	30	100	E	E
Dibutyl Phthalate	3625	5120	38	55	G	E
Diphenyl Phthalate	5405	7680	38	80	E	G
Tricresyl Phosphate	4550	7470	48	70	E	E
Santicizer 140	5405	8535	38	80	E	E
Triphenyl Phosphate	4550	6685	30	70	E	E
Santicizer E-15	4265	6685	40	65	G	E
Santicizer B-16	3485	4905	36	50	G	E
Santicizer M-17	4125	7965	38	60	G	E
Santicizer 1-H	5475	7750	32	80	E	E
Santicizer 8	4625	6900	34	70	G	E
Santicizer 9	4625	7325	40	70	G	E
Aroclor 1242	4905	7395	36	75	P	G
Aroclor 1248	5475	7540	30	80	P	G
Aroclor 1254	6185	7825	28	90	G	G
Aroclor 1262	7110	9035	22	105	E	G
Aroclor 4465	8535	9030	22	125	G	P

*Yield Point Plasticized Film / Yield Point Unplasticized Film x 100

E = Excellent
G = Good
P = Poor

MONS 080818

PLASTICIZER PERFORMANCE IN NITROCELLULOSE FILM (12 MIL)

Control (no plasticizer)	20	20	8533	8533	6	6	100	100
Santicizer 1-H	26	10	——	3270	—	7	45	41
Santicizer 8	22	16	——	2275	—	11	31	63
Santicizer 9	27	—	——	——	—	—	60	—
Santicizer 160	11	14	——	3555	—	10	10	19
Dibutyl Phthalate	25	10	——	2700	—	4	36	65
Triphenyl Phosphate	29	24	——	4410	—	8	52	56
Tricresyl Phosphate	20	—	——	1210	—	24	16	28
Camphor	—	—	——	5405	—	6	—	—

PLASTICIZER PERFORMANCE IN CELLULOSE ACETATE (LOW ACETYL) MOLDING COMPOSITIONS (52.5–53.5%)

Plasticizer	Solution Temp., °C	Hardness at 70° C. Rockwell "M" Scale	Flexural Strength (p.s.i.)	Per Cent Water Absorbed 48 hrs.
Dimethyl phthalate	120	32	5840	1.14
Diethyl phthalate	140	15	5680	1.20
Santicizer M-17	148	65	7110	0.77
Santicizer E-15	148	50	6930	0.97
Santicizer 8	133	75	6860	0.94
Santicizer 9	153	90	9160	0.85
Triphenyl phosphate (42.5 PHR)	180	81	9020	1.17

MONS 080819

PLASTICIZER PERFORMANCE IN CELLULOSE ACETATE-BUTYRATE FILM

(37% Butyrate, 13% Acetate)

(50 PHR)

Dimethyl Phthalate	46	4200	14
Dibutyl Phthalate	38	1800	12
Santicizer 160	42	2700	9
Dioctyl Phthalate	44	2900	19
Dicyclohexyl Phthalate	30	3900	31
Diphenyl Phthalate	42	3800	28
Santicizer E-15	34	2000	14
Santicizer B-16	40	1800	15
Santicizer M-17	52	1800	18
Santicizer 140	42	2700	13
Santicizer 141	44	2300	15
Tricresyl Phosphate	54	3000	20
Triphenyl Phosphate	40	2500	10
Dioctyl Adipate	28	2100	12
Santicizer 1-H	46	3900	46
Santicizer 3	34	1800	27

MONS 080820

PLASTICIZER PERFORMANCE

Control	C	C	C	12,800 (30 rpm)	7,900
Dibutyl phthalate	C	C	C	1,550	1,300
Di-2-ethyl hexyl phthalate	C	Cl P.S.	SlCl	2,650	2,700
Diisodecyl phthalate	C	Cl P.S.	SlCl	3,250	2,450
Diisodecyl adipate	C	Cl	W	1,200	1,100
Santicizer E-15	C	C	C	3,050	2,100
Santicizer M-17	C	C	C	3,150	2,450
Santicizer B-16	C	C	C	2,300	2,000
Tricresyl phosphate	C	C	C	3,750	3,000
Santicizer 140	C	C	C	2,850	2,200
Santicizer 141	C	C	C	1,500	1,400
HB-40	C	SlCl	SlCl	3,900	2,300
Aroclor 1248	C	C	C	7,700	4,300
Aroclor 1221	C	C	C	1,650	1,200
Mod-Epox	C	C	C	1,650	1,250

C	= Compatible
Cl	Cloudy
Cl/P.S.	= Cloudy, Phase Separation
SlCl	= Slightly Cloudy
W	= White

MONS 080821

IN EPOXY RESINS (EV. = 200)

0.2	3.0	78	86	−0.012
—	3.5	10	78	−0.734
0.5-1.9	8.0	31	82	−0.368
0.5-0.8	7.0	48	83	−0.168
0.5-0.8	94.0	56	82	−0.181
—	2.5	10	80	+0.119
—	3.0	6	85	−0.131
—	4.5	7	85	−0.013
—	3.5	15	86	−0.222
—	3.5	22	79	−0.284
—	4.0	5	82	−0.425
0.5-0.6	4.0	27	84	−0.648
0.6	3.0	40	88	−0.682
—	3.0	8	81	−2.118
0.8-0.9	4.0	84	88	+0.134

MONS 080822

PLASTICIZER PERFORMANCE IN POLYVINYL ACETATE-EMULSION ADHESIVES

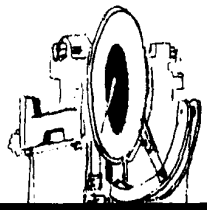
Aroclor 1221	5.2	—5.0	0.63	—	—
Aroclor 1232	4.8	4.0	0.54	—	—
Aroclor 1242	4.4	5.3	0.57	—	—
Triphenyl Phosphate	2.0	5.7	0.02	0.37	0.38
Tricresyl Phosphate	0.75	3.6	0.16	0.38	0.46
Dimethyl Phthalate	5.6	—1.6	0.92	0.75	0.93
Diethyl Phthalate	4.8	—5.0	0.85	0.63	0.82
Dibutyl Phthalate	4.4	—6.1	0.59	0.51	0.59
Diphenyl Phthalate	5.9	—	1.31	0.90	0.98
Santicizer B-16	2.2	—3.9	0.08	0.46	0.36
Santicizer M-17	3.6	1.5	0.19	0.50	0.48
Santicizer 1-H	1.5	—	0.96	0.36	0.53
Santicizer 8	3.6	6.4	0.43	0.60	0.64
Santicizer 9	3.1	—	1.13	0.57	0.63
Santicizer 140	1.2	5.0	0.15	0.34	0.36
Santicizer 141	1.8	—3.3	0.17	0.42	0.31
Santicizer 160	2.1	1.9	0.20	0.39	0.34

MONS 080823

Viscosity-Conversion Chart

Saybolt Universal (sec.)	Ford Cups #3 (sec.)	Ford Cups #4 (sec.)	Gardner-Holdt (Units)	Gardner-Holdt (sec.)	Gardner Vertical (sec.)	Parlin Cups 7	Parlin Cups 10	Parlin Cups 15	Parlin Cups 20	Parlin Cups 25	Parlin Cups 30	Brookfield (c.p.s.)	Poises
Multiply instrument reading by specific gravity of material													
			A-3									10	0.10
96			A-2									20	0.20
238			A									50	0.50
476	42	30	D			77	21					100	1
954	84	55	H			154	42	10				200	2
2380	208	135	S	5	5	385	104	25	8			500	5
4760	416	270	W	10	10	770	208	47	17			1000	10
9540	834	540	Y-Z	20	20	1540	416	93	33	15		2000	20
23,800	2081	1350	Z_3	50	50	3850	1040	232	83	36	19	5000	50
47,600	4160	2700	Z_5	100	100	7700	2080	465	167	72	38	10,000	100
95,400	8340	5400	Z_6-Z_7	200	200	15,400	4160	930	333	143	77	20,000	200
	20,810	13,500	Z_7-Z_8	500	500	38,500	10,400	2320	833	357	192	50,000	500
	41,600	27,000	Z_{10}	1000	1000	77,000	20,800	4650	1667	715	384	100,000	1000
	83,400	54,000			2000		41,600	9300	3330	1430	770	200,000	2000
					5000				8330	3570	1920	500,000	5000

*Poises = Stokes × Specific Gravity . . . (Approximated)



MONS 080824

APHA	ASTM D-1500	NPA	Saybolt	Gardner Standards	Gardner-Holdt	Rosin Standards	Parlin	$K_2Cr_2O_7$ (g. 100 ml. H_2SO_4)
3			-29					
5			-27					
8			-26					
10			-24					
15			-23					
20			-22					
23								
25			-21					
30			-19					
35			-17					
40			-16					
45			-15					
50			-14					
60			-12					
65								
70			-11					
80			-10					
90			-9					
100			-6					
125			0					
130								
150			9					
170								
200		0.5	13					
250		0.75		1	1		4	0.0039
300	0.5	1.0						
400		1.25		2			5	0.0048
500		1.25						0.0071
				3			8	
		1.25-						
	1.0	1.5		4	2		10	0.0112
	1.5	1.75		5			20	
		2-		6		X	30	0.0205
		2.0					35	0.0322
	2.0	2-		7	3	WW		0.0384
		2.25		8		WG	45	0.0515
	2.5	2.5		9	4	N	60	0.0780
		2.75		10		M K	80	0.1640
	3.0	3.0		10-11		K		0.2070
		3.25		11		I	100	0.2500
	3.5	3.5			5			
	4.0	3.75		12		H	125	0.3800
		3.75			6			
		4.0		13		G		0.5720
	4.5*	4.25		14	7	F		0.7630
	5.0*	4.5					175	
	5.5*	4.75					200	
	6.0*	5.0		15			250	1.0410
		5.75						
	6.5	6.0		16	8	E	300	1.2800
	7.0*	7.0						
	7.5*	7.5		17			350	2.2200
		8-						
		8.0						
	8*	8+		18	9	D	500	3.0000

*Approximate

MONS 080825

TEMPERATURE CONVERSION CHART

Centigrade to Fahrenheit

C	F	C	F	C	F	C	F	C	F	C	F
−68	−90.	−13	8.6	41	105.8	96	204.8	151	303.8	206	402.8
−67	−88.6	−12	10.4	42	107.6	97	206.6	152	305.6	207	404.6
−66	−86.8	−11	12.2	43	109.4	98	208.4	153	307.4	208	406.4
−65	−85.0	−10	14.0	44	111.2	99	210.2	154	309.2	209	408.2
−64	−83.2	− 9	15.8	45	113.0	100	212.0	155	311.0	210	410.0
−63	−81.4	− 8	17.6	46	114.8	101	213.8	156	312.8	211	411.8
−62	−79.6	− 7	19.4	47	116.6	102	215.6	157	314.6	212	413.6
−61	−77.8	− 6	21.2	48	118.4	103	217.4	158	316.4	213	415.4
−60	−76.0	− 5	23.0	49	120.2	104	219.2	159	318.2	214	417.2
−59	−74.2	− 4	24.8	50	122.0	105	221.0	160	320.0	215	419.0
−58	−72.4	− 3	26.6	51	123.8	106	222.8	161	321.8	216	420.8
−57	−70.6	− 2	28.4	52	125.6	107	224.6	162	323.6	217	422.6
−56	−68.8	− 1	30.2	53	127.4	108	226.4	163	325.4	218	424.4
−55	−67.0	− 0	32.0	54	129.2	109	228.2	164	327.2	219	426.2
−54	−65.2	0	32.0	55	131.0	110	230.0	165	329.0	220	428.0
−53	−63.4	1	33.8	56	132.8	111	231.8	166	330.8	221	429.8
−52	−61.6	2	35.6	57	134.6	112	233.6	167	332.6	222	431.6
−51	−59.8	3	37.4	58	136.4	113	235.4	168	334.4	223	433.4
−50	−58.0	4	39.2	59	138.2	114	237.2	169	336.2	224	435.2
−49	−56.2	5	41.0	60	140.0	115	239.0	170	338.0	225	437.0
−48	−54.4	6	42.8	61	141.8	116	240.8	171	339.8	226	438.8
−47	−52.6	7	44.6	62	143.6	117	242.6	172	341.6	227	440.6
−46	−50.8	8	46.4	63	145.4	118	244.4	173	343.4	228	422.4
−45	−49.0	9	48.2	64	147.2	119	246.2	174	345.2	229	444.2
−44	−47.2	10	50.0	65	149.0	120	248.0	175	347.0	230	446.0
−43	−45.4	11	51.8	66	150.8	121	249.8	176	348.8	231	447.8
−42	−43.6	12	53.6	67	152.6	122	251.6	177	350.6	232	449.6
−41	−41.8	13	55.4	68	154.4	123	253.4	178	352.4	233	451.4
−40	−40.0	14	57.2	69	156.2	124	255.2	179	354.2	234	453.2
−39	−38.2	15	59.0	70	158.0	125	257.0	180	356.0	235	455.0
−38	−36.4	16	60.8	71	159.8	126	258.8	181	357.8	236	456.8
−37	−34.6	17	62.6	72	161.6	127	260.6	182	359.6	237	458.6
−36	−32.8	18	64.4	73	163.4	128	262.4	183	361.4	238	460.4
−35	−31.0	19	66.2	74	165.2	129	264.2	184	363.2	239	462.2
−34	−29.2	20	68.0	75	167.0	130	266.0	185	365.0	240	464.0
−33	−27.4	21	69.8	76	168.8	131	267.8	186	366.8	241	465.8
−32	−25.6	22	71.6	77	170.6	132	269.6	187	368.6	242	467.6
−31	−23.8	23	73.4	78	172.4	133	271.4	188	370.4	243	469.4
−30	−22.0	24	75.2	79	174.2	134	273.2	189	372.2	244	271.2
−29	−20.2	25	77.0	80	176.0	135	275.0	190	374.0	245	473.0
−28	−18.4	26	78.8	81	177.8	136	276.8	191	375.8	246	474.8
−27	−16.6	27	80.6	82	179.6	137	278.6	192	377.6	247	476.6
−26	−14.8	28	82.4	83	181.4	138	280.4	193	379.4	248	478.4
−25	−13.0	29	84.2	84	183.2	139	282.2	194	381.2	249	480.2
−24	−11.2	30	86.0	85	185.0	140	284.0	195	383.0	250	482.0
−23	− 9.4	31	87.8	86	186.8	141	285.8	196	384.8	251	483.8
−22	− 7.6	32	89.6	87	188.6	142	287.6	197	386.6	252	485.6
−21	− 5.8	33	91.4	88	190.4	143	289.4	198	388.4	253	487.4
−20	− 4.0	34	93.2	89	192.2	144	291.2	199	390.2	254	489.2
−19	− 2.2	35	95.0	90	194.0	145	293.0	200	392.0	255	491.0
−18	− 0.4	36	96.8	91	195.8	146	294.8	201	393.8	256	492.8
−17	1.4	37	98.6	92	197.6	147	296.6	202	395.6	257	494.6
−16	3.2	38	100.4	93	199.4	148	298.4	203	397.4	258	496.4
−15	5.0	39	102.2	94	201.2	149	300.2	204	399.2	259	498.2
−14	6.8	40	104.0	95	203.0	150	302.0	205	401.0	260	500.0

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PRESSURE CONVERSION CHART

PSI to Kilo/Cm²

psi or kg/cm² to be converted		
psi	⇔	kg/cm²
14.2	1	0.07
28.4	2	0.14
42.7	3	0.21
56.9	4	0.28
71.1	5	0.35
85.3	6	0.42
99.6	7	0.49
114	8	0.56
128	9	0.63
142	10	0.70
156	11	0.77
171	12	0.84
185	13	0.91
199	14	0.98
213	15	1.05
228	16	1.12
242	17	1.20
256	18	1.27
270	19	1.34
284	20	1.41
299	21	1.48
313	22	1.55
327	23	1.62
341	24	1.69
356	25	1.76
370	26	1.83
384	27	1.90
398	28	1.97
412	29	2.04
427	30	2.11
441	31	2.18
455	32	2.25
469	33	2.32
484	34	2.39
498	35	2.46
512	36	2.53
526	37	2.60
540	38	2.67
555	39	2.74
569	40	2.81
583	41	2.88
597	42	2.95
612	43	3.02
626	44	3.09
640	45	3.16
654	46	3.23
668	47	3.30
683	48	3.37
697	49	3.45
711	50	3.52
725	51	3.59
740	52	3.66
754	53	3.73
768	54	3.80
782	55	3.87
796	56	3.94
811	57	4.01
825	58	4.08
839	59	4.15
853	60	4.22
868	61	4.29
882	62	4.36
896	63	4.43
910	64	4.50
924	65	4.57
939	66	4.64
953	67	4.71
967	68	4.78
981	69	4.85
996	70	4.92
1010	71	4.99
1020	72	5.06
1040	73	5.13
1050	74	5.20
1070	75	5.27
1080	76	5.34
1100	77	5.41
1110	78	5.48
1120	79	5.55
1140	80	5.62
1150	81	5.70
1170	82	5.77
1180	83	5.84
1190	84	5.91
1210	85	5.98
1220	86	6.05
1240	87	6.12
1250	88	6.19
1270	89	6.26
1280	90	6.33
1290	91	6.40
1310	92	6.47
1320	93	6.54
1340	94	6.61
1350	95	6.68
1370	96	6.75
1380	97	6.82
1390	98	6.89
1410	99	6.96
1420	100	7.03
1490	105	7.38
1560	110	7.73
1640	115	8.09
1710	120	8.44
1780	125	8.79
1850	130	9.14
1920	135	9.49
1990	140	9.84
2060	145	10.2
2130	150	10.5
2200	155	10.9
2280	160	11.2
2350	165	11.6
2420	170	12.0
2490	175	12.3
2560	180	12.7
2630	185	13.0
2700	190	13.4
2770	195	13.7
2840	200	14.1
2920	205	14.4
2990	210	14.8
3060	215	15.1
3130	220	15.5
3200	225	15.8
3270	230	16.2
3340	235	16.5
3410	240	16.9
3480	245	17.2
3560	250	17.6
3630	255	17.9
3700	260	18.3
3770	265	18.6
3840	270	19.0
3910	275	19.3
3980	280	19.7
4050	285	20.0
4120	290	20.4
4200	295	20.7
4270	300	21.1
4340	305	21.4
4410	310	21.8
4480	315	22.1
4550	320	22.5
4620	325	22.9
4690	330	23.2
4760	335	23.6
4840	340	23.9
4910	345	24.3
4980	350	24.6
5050	355	25.0
5120	360	25.3
5190	365	25.7
5260	370	26.0
5330	375	26.4
5400	380	26.7
5480	385	27.1
5550	390	27.4
5620	395	27.8
5690	400	28.1
5760	405	28.5
5830	410	28.8
5900	415	29.2
5970	420	29.5
6040	425	29.9
6120	430	30.2
6190	435	30.6
6260	440	30.9
6330	445	31.3
6400	450	31.6
6470	455	32.0
6540	460	32.3
6610	465	32.7
6680	470	33.0
6760	475	33.4
6830	480	33.7
6900	485	34.1
6970	490	34.5
7040	495	34.8
7110	500	35.2
7180	505	35.5
7250	510	35.9
7320	515	36.2
7400	520	36.6
7470	525	36.9
7540	530	37.3
7610	535	37.6
7680	540	38.0
7750	545	38.3
7820	550	38.7
7890	555	39.0
7960	560	39.4
8040	565	39.7
8110	570	40.1
8180	575	40.4
8250	580	40.8
8320	585	41.1
8390	590	41.5
8460	595	41.8
8530	600	42.2
8600	605	42.5
8680	610	42.9
8750	615	43.2
8820	620	43.6
8890	625	43.9
8960	630	44.3
9030	635	44.6
9100	640	45.0
9170	645	45.3
9240	650	45.7
9310	655	46.1
9390	660	46.4
9460	665	46.8
9530	670	47.1
9600	675	47.5
9670	680	47.8
9740	685	48.2
9810	690	48.5
9880	695	48.9
9960	700	49.2
10030	705	49.6
10100	710	49.9
10170	715	50.3
10240	720	50.6
10310	725	51.0
10380	730	51.3
10450	735	51.7
10530	740	52.0
10600	745	52.4
10670	750	52.7
10740	755	53.1
10810	760	53.4
10880	765	53.8
10950	770	54.1
11020	775	54.5
11090	780	54.8
11170	785	55.2
11240	790	55.5
11310	795	55.9
11380	800	56.2
11450	805	56.6
11520	810	56.9
11590	815	57.3
11660	820	57.6
11730	825	58.0
11810	830	58.4
11880	835	58.7
11950	840	59.1
12020	845	59.4
12090	850	59.8
12160	855	60.1
12230	860	60.5
12300	865	60.8
12370	870	61.2
12450	875	61.5
12520	880	61.9
12590	885	62.2
12660	890	62.6
12730	895	62.9
12800	900	63.3
12870	905	63.6
12940	910	64.0
13010	915	64.3
13090	920	64.7
13160	925	65.0
13230	930	65.4
13300	935	65.7
13370	940	66.1
13440	945	66.4
13510	950	66.8
13580	955	67.1
13650	960	67.5
13730	965	67.8
13800	970	68.2
13870	975	68.6
12940	980	68.9
14010	985	69.3
14080	990	69.6
14150	995	70.0
14220	1000	70.3

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Test Methods for Evaluating Plasticizers

POLYVINYL CHLORIDE SHEETING

Unless otherwise noted, the tests cited below are made on a plasticizer-resin formulation containing dibasic lead stearate at a concentration of 0.5 PHR) milled and molded to 6-inch-square by 40-mil sheet. The specimen prior to testing is conditioned in a constant-temperature room at 23°C and 50-percent relative humidity for 24 hours.

Volatility — (carbon) ASTM D1203-61T

Discs are conditioned for three hours at 50°C, dried, weighed and placed in a jar of 6-14 mesh activated charcoal (discs must have at least ¼" of carbon between them). The jar is placed in a forced draft oven adjusted to 86°. The discs are removed from the jar, wiped free of carbon, dried, weighed and the percent of plasticizer lost is calculated.

Low-temperature flexibility — ASTM D1043-61

This method is intended to provide an indication of the low temperature flexibility of a plasticized formulation by determining the Flex Temperature. After the sample has been molded, it is conditioned in the Constant Temperature Room for 24 hours. Following the method in TM D-1, a sheet of ½" wide and 2½" long strip is cut and stamped from the molded sheet using a cutting die placed in a special jig. After mounting holes are cut, average thickness is calculated using the Vernier micrometer. The strip is mounted in the jaws of the apparatus, the stopwatch started, and powdered dry ice added until there is a temperature of 50°C-100°. The procedure is repeated in two-degree intervals until twist is greater than 200° of arc. Flex temperature and the formulation tested are then reported.

Water sensitivity —(Absorption) ASTM D570-[illegible]

This method is intended to provide an indication of the sensitivity of a plasticized formulation to water. It measures water absorbed and the plasticizer lost during extraction. A sheet of milled sample is molded; a disc cut from the molded sheet. The disc is placed with [illegible] bottle of distilled water in the 50C oven for 24 hours. The disc is transferred to a desiccator, cooled and weighed. The disc is placed in the conditioned bottle of distilled water, capped and placed in the oven for 24 hours. The disc is then removed from the bottle, dried and reweighed. It is placed in the oven for a 24 hour drying period. The disc is removed from the oven, dried, cooled and reweighed analytically.

Soluble matter	ASTM D[illegible] modified to 2[illegible] instead of 2-[illegible] square

Water sensitivity — (extraction) ASTM D[illegible]

This method provides a means of determining the extraction resistance of plasticizers in PVC. Discs are conditioned 24 hours for aqueous extractants 15 hours for non-aqueous extractants, dried for 15 minutes and weighed analytically. The disc is then immersed in the required extractant. Usually not more than 2 discs are placed in a bottle. After immersion for the specified time, the disc is removed from the extractant and dried. The disc is removed from the oven, dried for 15 minutes and reweighed analytically.

Kerosene Extraction — A 2-inch disc is weighed, then immersed in Shell odorless 350 kerosene for 24 hours at 23°C. The disc is removed from the kerosene and placed in an air-circulating oven for 4 hours at 80°C to remove absorbed kerosene. It is weighed again after cooling to room temperature in a desiccator, and the percent plasticizer loss is calculated.

Shore Hardness — ASTM D676-49T

This test determines the penetration hardness of plastic compositions by measuring the relative resistance to the penetration of a standard point under a standard load. Test specimens should be 1" x 2" and 0.25" thick, and be conditioned for one week at 23°±1°C. and 50 ± 2% relative humidity prior to the test. The specimen is placed on the platform and the instrument lowered as rapidly as possible without shock. Timer is started. After 10 seconds, the dial is read and the instrument raised without shock. Measurement is repeated on at least two positions on the specimen. The average of the readings is calculated and reported as the Shore "A" Hardness at 0.25" thickness.

Migration

1. *To a Nitrocellulose-Lacquered Surface* — A 1-inch-square sheet is placed in contact with a nitrocellulose lacquered surface. A pressure of 1.5 pounds per square inch of sheet surface is applied using lead weights. The assembly is placed in the constant-temperature room and examined weekly for lifting, marring, and softening. It can also be checked for weight gain or loss.
2. *To Finely Divided Solids (Leak Stain)* — A 2-inch disc is weighed, then placed in a jar between two 30-mil layers of finely divided silica. The jar is placed in the constant-temperature room at 23°C for 1 to 7 days, when the disc is removed from the jar, brushed clean, and reweighed. Percent plasticizer loss is calculated.

Tensile strength, ultimate elongation, and modulus — ASTM D638-58T

POLYVINYL CHLORIDE PLASTISOL

Viscosity — Brookfield Viscosimeter — a low-shear instrument — has been used to characterize the flow of plastisols from the standpoint of such applications as slush and dip molding where the shear rates are low.

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Severs Extrusion Rheometer—has been used to define the flow properties of plastisols at a high shear rate for such applications as roller coating, knife coating, or spraying.

Yield value—The force that must be applied to a plastisol to initiate flow. The yield value is calculated from the Brookfield viscosities as follows:

$$Y = \frac{5(V_{2.5} - V_5)}{100}$$

$V_{2.5}$ = Brookfield viscosity at 2.5 RPM
V_5 = Brookfield viscosity at 5 RPM

Flow index—is an overall estimation of the type of flow. The flow index is the ratio of the viscosity at high shear (Severs, 50 psi) to the viscosity at low shear (Brookfield, 50 rpm). When the index is greater than one, dilatency is present to the degree indicated. If the index is less than one, plasticity is present.

Fusion point—of a plastisol is the temperature at which a given plasticizer/resin system becomes clear. A useful test, employing the Fisher-Johns Melting-Point Apparatus, assigns a relative rating to each plasticizer according to its ability to solvate the resin. Although the results obtained from this method are relative and are not to be considered as actual processing temperatures, they are nevertheless reproducible and are valuable in ranking the various plasticizers according to their respective fusion ability.

Air-release time—A measured amount of plastisol is charged to a 1-liter, glass, Ace Reactor equipped with a 3-neck head. A vacuum system, consisting of vacuum pump, manometer, and cold trap, is connected to the flask. The flask is evacuated to a pressure of 2-4 mm. Hg. The time required to essentially deaerate the plastisol is then recorded. The height of the foam column and the ease of breaking it are noted.



Resilience

steel ball—A ½-inch-diameter steel ball is dropped by an electromagnet 40 inches onto a ½-inch-thick plastisol casting. The height of the bounce is recorded as the rebound.

rotationally-cast ball—A 2-inch rotationally-cast ball of the composition, inflated to a standard pressure, is dropped 90 inches. The height of the bounce from the floor is recorded as the rebound.

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ETHYL CELLULOSE

Yield, Tensile Strength, and Elongation— Standard tensile-strength tester with recording chart

Hardness Index— Ratio of the yield point of the plasticized film to that of the unplasticized film times 100

Volatility— Aged 2 weeks in oven at 70°C

E=no change in yield point
G=loss than 25% plasticizer lost
P=greater than 25% plasticizer lost

Light Stability— Fade-Ometer exposure

E=greater than 200 hours
G=loss of flexibility in 100-200 hours
P=brittle in less than 100 hours

NITROCELLULOSE

Tensile Strength and Elongation

Standard tensile-strength tester.

Schopper Fold—A strip of film is clamped in the jaws of the Schopper fold-test machine. The machine is started, and the number of folds made before failure is recorded.

Moisture permeability—About 10-15 g. of calcium chloride is placed in a 4-ounce, wide-mouth bottle. A plastic disc is placed between two wax-coated gaskets and placed on top of the bottle. The sample is held in place with a metal screw cap which has a 1¾-inch-diameter hole. The assembly is weighed and placed in a desiccator in which the desiccant has been replaced by 25 ml. of water. After 48 hours the assembly is removed and reweighed. An unplasticized film is always used as a control. Its water-vapor transfer is taken as 100 per cent.



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POLYVINYL ACETATE

Volatility — 20 hours @ 87°C in active carbon. Procedure similar to ASTM D1203-52T

Low-Temperature Flexibility — ASTM D-1043-51

Oil Extraction— See Polyvinyl Chloride kerosene extraction.

CELLULOSE ACETATE-BUTYRATE

Tensile Strength and Elongation— Conditioned cast films are pulled on the Instron machine

Sward Hardness— Sward rocker test conducted on conditioned films cast on glass plates

CELLULOSE ACETATE

Solution Temperature, °C — Temperature required to dissolve 0.5 grams of cellulose acetate in 1 gram of plasticizer in a ½" x 6" test tube heated at 1°C per minute.

Rockwell Hardness— ASTM D-785-51

Flexural Strength— ASTM D-790-58T

Water Absorption— ASTM D-570-57T

[redacted]



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TECHNICAL LITERATURE ABOUT MONSANTO PLASTICIZERS

The following technical bulletins and brochures give complete technical information about the properties and applications of the Monsanto plasticizers that are mentioned in this catalog. Monsanto technical literature is continuously revised to contain the most recent and reliable information possible. Your request for any literature will be promptly and cheerfully filled — without obligation, of course.

Title	Technical Bulletin No.
Phthalate Plasticizers	
Dibutyl Phthalate	PL-302
Dicyclohexyl Phthalate	PL-312
Diethyl Phthalate and Dimethyl Phthalate	PL-303
Diisodecyl Phthalate	PL-300
Di-(2 ethylhexyl) Phthalate (DOP)	PL-318
Diphenyl Phthalate	PL-319
Ditridecyl Phthalate	PL-329
Di(n-octyl,n-decyl) Phthalate	PL-330
Santicizer 160 (butyl benzyl) Phthalate	PL-160
Santicizer 165	PL-165
Santicizer 213 and Santicizer 214	O/PL-213
Santicizer 215	PL-215
Santicizer 218	PL-218
Santicizer 262	PL-262
Santicizer 602 and Santicizer 636	PL-602
Santicizer 603	PL-603
Santicizer 630 and Santicizer 631	PL-630
Santicizer 632 and Santicizer 683	PL-632
Santicizer 681	PL-681
Adipate Plasticizers	
Diisodecyl Adipate	PL-308
Di(n-octyl,n-decyl) Adipate	PL-316
Dioctyl Adipate	PL-304
Phosphate Plasticizers	
Tricresyl Phosphate	PL-305
Triphenyl Phosphate	PL-301
Santicizer 140	PL-140
Santicizer 141	O/PL-141

(continued)

Title	Technical Bulletin No.
Phthalyl Glycollate Plasticizers	
Santicizer E-15 (Ethyl phthalate ethyl glycollate)	PL-15
Santicizer B-16 (Butyl Phthalyl butyl glycollate)	PL-16
Santicizer M-17 (Methyl phthalate ethyl glycollate)	PL-17
Sulfonamide Plasticizers	
Santicizer 1-H	O/PL-1-H
Santicizer 3	PL-3
Santicizer 8	O/PL-339
Santicizer 9	O/PL-9
Santolite MHP and Santolite MS-80%	O/PL-320
Permanent Plasticizers	
Santicizer 405	PL-405
Santicizer 406	PL-406
Santicizer 409	PL-409
Santicizer 411	PL-411
Santicizer 462	PL-462D
Permanent Plasticizer Selector	O/PL-344
Other Plasticizers	
Aroclor Plasticizers	O/PL-306
HB-40 (partially hydrogenated terphenyl)	PL-40
Modaflow	O/PL-338
Mod-Epox (epoxy-resin modifier)	PL-313
Montar Compounds	PL-328
Phosgard C-22-R	O/PL-22
Triphenyl Phosphite	PL-317
General	
Monsanto Solid Plasticizers	O/PL-345
Monsanto Plasticizers in Synthetic-Resin Adhesives	PL-307
Monsanto Plasticizers in Protective Coatings	PL-327
Bulk Receiving of Plasticizers	PL-314
Monsanto Modifiers for Thiokol® Polysulfide Liquid Polymers	PL-331
Monsanto Plasticizers for Food Packaging Applications	PL-500
Monsanto Plasticizers for Hard-to-Plasticize Resins	PL-332
Chemical Resistance of Plasticizers in Plastisols	PL-333

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PL-_____ PL-_____ PL-_____

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MONS 008834

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PL-_____ PL-_____ PL-_____

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MONS 080835

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[redacted]

Combinations of Santicizer 160 and Santicizer 3 are useful in plasticizing *polyvinyl acetate* adhesives useful for bonding wood, paper and cellophane.

Santicizer 3 is perhaps the best plasticizer available for *zein*. It is compatible to a high plasticizer level. Formulations plasticized with Santicizer 3, sometimes in combination with Santolite MHP or rosin derivatives, are useful in making decorative lacquers, hot-melt adhesives, and release coatings for pressure-sensitive tapes. Santicizer 3 is also compatible with casein, and is FDA regulated for use in adhesives for food packaging.

■ Typical Starting Formulations Containing Santicizer 3

Nitrocellulose Heat-Sealing Coating

Ingredients	Parts by Weight
SS Nitrocellulose, ½ sec.	100
Diethylene glycol ester of terpene dibasic acid	50
Santicizer 3	14
Santolite MHP	22
Dicyclohexyl phthalate	14
Solvent System	
Ethanol	80
Butanol	80
Toluene	400
Ethyl acetate	80
Butyl acetate	160

For lacquers on paper, cellophane, or metal foil to be heat-sealed.

Nitrocellulose Paper-Coating Lacquer (Moisture proof and heat-sealing)

Ingredients	Parts by Weight
SS Nitrocellulose, ½ sec.	100
Damar resin (dewaxed)	16
Santicizer 3	28
Santolite MHP	20
Santicizer 160 or Dibutyl phthalate	30
Paraffin wax (135°F.)	6
Solvent System	
Ethanol	80
Butanol	80
Toluene	400
Ethyl acetate	80
Butyl acetate	160

Polyvinyl Acetate Adhesive

Ingredients	Parts by Weight
Polyvinyl acetate emulsion (50% solids)	100
Santicizer 3	2-3
Santicizer M-17 or Dibutyl phthalate	5

Useful for bonding wood, paper, and cellophane. Santicizer 3 should be pre-emulsified before addition to the polyvinyl acetate emulsion.

Zein Decorative Metallic Paper Coatings

Ingredients	Parts by Weight
Zein	100
Santicizer 3	50
Santolite MHP	35
Aluminum powder (optional)	(92.5 to 185)
Bronze powder (optional)	(185 to 545)
91% Isopropanol or 95% Ethanol	300

Zein Release or Back-Coating For Pressure-Sensitive Tape

Ingredients	Parts by Weight
Zein	100
Santicizer 3	25
Triethylene glycol	25
Proprietary alcohol	280

Zein Hot-Melt Adhesive For Paper

Ingredients	Parts by Weight
Zein	100
WW Gum Rosin	140
Santicizer 3	60
Acetanilide	13
Zinc stearate	7

This paper adhesive has a minimum of cold flow and shows good flexibility and excellent non-wicking characteristics. This melt softens in the range of 70° to 75°C. and can be applied at an application temperature slightly below 100°C.

MONS 080719

plasticizer with wide compatibility

Santicizer 8

General Description

Santicizer 8 is one of the most widely compatible plasticizers. It is highly polar and readily plasticizes the more difficult resins, such as nylon and other polyamides, shellac, cellulose acetate, zein and other protein materials. It is outstanding for making compounds resistant to oils, greases, and solvents.

In nitrocellulose lacquers, Santicizer 8 imparts excellent adhesion; flexibility; and resistance to moisture, gasoline, oils, and greases. It is frequently combined with Santolite MHP to make lacquers with maximum resistance to grease and aliphatic hydrocarbons.

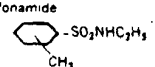
In cellulose acetate compositions, Santicizer 8 imparts a brilliance and polish not obtainable with other plasticizers. It also imparts good water and scuff resistance, oilproofness, and adequate heat and light stability. In cellulose acetates, Santicizer 8 imparts flexibility, good strength, and high resistance to aliphatic hydrocarbons and greases in adhesives.

In polyvinyl acetate emulsion adhesives, Santicizer 8 imparts good grease resistance and flexibility and develops good tack for joining difficult surfaces, such as metal to rubber. The use of Santicizer 8 improves flexibility in hot melts used in formulating bookbinding and shoe adhesives.

For *synthetic polyamides*, Santicizer 8 is one of the best plasticizers known. It imparts toughness without adversely affecting other properties; aids the processing of these resins by lowering melting point; and it improves low-temperature flexibility of the final formulation.

Santicizer 8 has a low order of toxicity. It is FDA regulated for use in adhesives for food packaging.

Properties

Chemical type	Sulfonamide
Chemical formula	 (mixed *o* and *p*)
Molecular weight	199.22
• Appearance	Light-yellow, viscous liquid
• Acidity	0.80 meq/100 gm. max.
• Color (molten)	APHA 200 max.
• Free Amides	9 to 13%
• Chlorine	0.01% max.
• Odor	Slight characteristic
Refractive index @ 25°C.	1.540
Specific gravity 25°/25°C.	1.190
Weight per gallon @ 25°C.	9.92 lb.
Boiling point, 760 mm Hg	340°C.
Crystallizing point	< 40°C.
Solidification temperature	0°C.
Flash point (C. O. C.)	345°F.
Vapor pressure @ 150°C.	0.45 mm Hg
200°C.	5.5 mm Hg
Viscosity @ 0°C.	10,000 cks
25°C.	358.0 cks
98.9°C.	6.0 cks
Surface tension @ 25°C.	44.5 dynes/cm.
Solubility in water @ 23°C.	0.13%
General solubility	Negligible solubility in petroleum hydrocarbons. Readily miscible in all other common organic solvents.

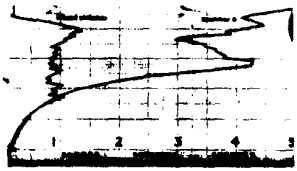
• Specifications

MONS 080720



Dibutyl Phthalate

Santicizer 8 imparts better rubber-to-metal adhesion of polyvinyl acetate adhesive than does dibutyl phthalate. It also contributes excellent adhesivity and flexibility to polyvinyl acetate hot-melt adhesives for bookbinding and shoes.

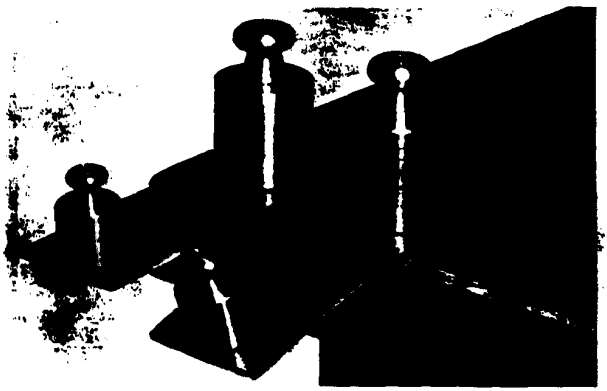




Santicizer 8

Performance in Various Resins

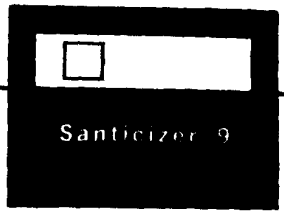
Resin	Cellulose Acetate	Ethyl Cellulose		Nitro-Cellulose		Polyvinyl Acetate
PHR	34	0	15	0	50	20
Solution Temperature, °C	133	–	–	–	–	–
Yield, p.s.i.	–	6755	4625	–	–	–
Tensile, p.s.i.	–	8960	6900	8533	2275	–
Elongation, %	–	30	34	6	11	–
Hardness Index	75	100	70	–	–	–
Volatility	–	E	G	–	–	3.6
Flexibility (Schopper Fold Cycles)	–	–	–	20	16	–
Flexural Strength, p.s.i.	6860	–	–	–	–	–
Moisture Permeability, %	–	–	–	100	63	–
% Water Absorbed in 24 hours	0.94	–	–	–	–	–
Extraction, %						
Kerosene	–	–	–	–	–	0.43
Peanut Oil	–	–	–	–	–	0.60
Cottonseed Oil	–	–	–	–	–	0.64



In polyamides, Santicizer 8 improves flexibility, especially at low temperatures—and toughness.

MONS 080721

plasticizer for thermosetting compounds



General Description

Santicizer 9 is an excellent solid plasticizer for thermosetting resins. Relatively small amounts in melamine, urea, and phenolic resins develop smooth-working, uniform-curing resins, and impart a good gloss to final product. Santicizer 9 improves a resin's wetting action with fillers, thus promoting easier mixing and more uniformly filled finished products, such as brake bands, wood-flour filled moldings, and composition wallboard. It blends readily with a variety of resins and does not have the softening action of liquid plasticizers.

In phenolics, Santicizer 9 reduces the viscosity at processing temperatures and improves flow. It aids the mixing of filled compositions, promotes uniformity of final moldings or laminates.

In melamines, Santicizer 9 improves the stability and the compatibility of resin solutions; increases the strength and abrasion resistance of finished products. During the heat curing, its presence lessens pigment discoloration and improves flow-out to produce a higher gloss in the final finish.

In polyvinyl acetate, Santicizer 9 imparts the sharp melting point so essential in heat-sealing coatings. It is highly resistant to extraction by oils and hydrocarbons.

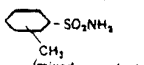
In urea resins, Santicizer 9 is one of the few plasticizers that can be used at all, and it is most valuable for formulating molding compounds. Its presence increases hardness of the moldings, and in the molding cycle it promotes better flow.

In nylon and other polyamides, Santicizer 9 increases flexibility significantly with only a minor decrease in tensile strength.

In casein, Santicizer 9 increases the tolerance for formaldehyde in adhesives and coatings formulations without causing reversible gels. It has temporary plasticizing effect on corn and soybean proteins. Because solubility increases in alkaline solutions, Santicizer 9 may be used as a swelling agent or actual plastic solvent. With protein materials, it may be used alone or with some other material such as glycerin.

Santicizer 9 is only slightly toxic, and no special handling precautions are necessary. It is FDA regulated for use in food packaging adhesives.

Properties

Chemical type	Sulfonamide
Chemical formula	 (mixed *o* and *p*)
Molecular weight	171.1
• Appearance	Fine, white to light-cream granular particles.
Acidity	pH 4.0 min.
• Color (33-1/3% by weight in acetone)	APHA 85 max.
• Moisture	1.0% max. (KF in methanol)
Odor	Essentially none
Density (solid)	1.353
• Turbidity (30.2 w/v in acetone)	APHA 40 max.
Boiling point, 760 mm Hg	360°C. approx.
Crystallizing point	105°C.
Melting point	105°C. (beginning of softening range)
Flash point (C.O.C.)	420°F.
Vapor pressure @ 150°C. 200°C.	0.25 mm Hg 3.2 mm Hg
Solubility in water @ 34°C.	1% (solubility in 50/50 mixture of water and conventrated ammonia solution is 5% @ 20°C.)
General solubility	Soluble in many organic solvents, hot linseed oil, Chinawood oil, and castor oil. Limited solubility in coal tar and petroleum hydrocarbons.

• Specifications



Santicizer 9 imparts a high gloss to melamine-formaldehyde resins.

Performance in Various Resins

Resin	Cellulose Acetate	Ethyl Cellulose		Nitro-Cellulose		Polyvinyl Acetate
PHR	34	0	15	0	25	20
Solution Temperature, °C	153	–	–	–	–	–
Yield, p.s.i.	–	6755	4625	–	–	–
Tensile, p.s.i.	–	8960	7325	–	–	–
Elongation, %	–	30	40	–	–	–
Hardness Index	90	100	70	–	–	–
Volatility	–	E	G	–	–	3.1
Flexibility (Schopper Fold Cycle)	–	–	–	20	27	–
Flexural Strength, p.s.i.	9160	–	–	–	–	–
Moisture Permeability, %	–	–	–	100	60	–
% Water Absorbed in 24 hours	0.85	–	–	–	–	–
Extraction, %						
Kerosene	–	–	–	–	–	1.13
Peanut Oil	–	–	–	–	–	0.57
Cottonseed Oil	–	–	–	–	–	0.63

MONS 080723

plasticizing resin for cellulosic specialties

Santolite MHP

General Description

Santolite MHP is compatible with cellulose esters and meets many highly exacting requirements for specialty formulations. Santolite MHP is also compatible with and useful for modifying polyvinyl acetate, polyvinyl chloride and copolymers, and vegetable proteins.

In nitrocellulose compositions, Santolite MHP's high compatibility, absence of noticeable color and adhesion are three very important (of many) properties that make it outstanding for use in formulating fingernail polish and spray lacquers; for use in cellophane coatings for heat sealing, moisture proofing, and mold resistance; for use in adhesives and for formulating strawhat lacquers. In nitrocellulose films, Santolite MHP increases moisture resistance and hardness; in nitrocellulose lacquers, it develops lower solution viscosity than most other resins. In both film and coatings it is also more light stable than many natural resins. Its low viscosity and strong solvency make possible the formulation of lacquers with high solids content, resulting in fewer coats and lower costs for laying down a given thickness of the coating. Because of Santolite MHP's high softening point, practical heat-sealing temperatures can be imparted to heat-seal coatings. In fingernail polishes, Santolite MHP reduces whitening and water spotting — major advantages in quality nail lacquers.

In cellulose acetate formulations, Santolite MHP has an almost unlimited range of compatibility and it is the clearest and most brilliant resin available. Its high mutual solvency power increases the retentivity of the formulation for plasticizers and other resins to eliminate blooming. It imparts greatly improved gloss, adhesion, and moisture resistance. Formulations containing Santolite MHP possess excellent gasoline and oil resistance particularly when other plasticizers like Santicizer M-17 or 8 are also used.

Properties

Chemical type	Sulfonamide-formaldehyde resin
• Appearance	Hard, practically colorless resin
Acidity	1 mg. KOH/gm.
• Color (25 gm. in 75 gm. butyl actate)	APHA 50 max.
• Penetration (200 gm. load)	1.2 mm max.
Odor	Faint formaldehyde odor that disappears after heating. (Odor not imparted to products. If objectionable, odor may be minimized by adding 2 to 5% of urea during compounding.)
• Refractive index @ 25°C. (25 mg. in 75 gm. butyl acetate)	1.4275 to 1.4325
• Solubility (25 gm. in 75 gm. butyl acetate)	Complete
Density	1.35 gm./ml.
Crystallizing point	62°C.
Softening point	62°C.
Solubility in water @ 25°C.	Practically insoluble
General solubility	Soluble in usual lacquer solvents (alcohols, ethers, esters, ketones, aromatic hydrocarbons). Insoluble in aliphatic hydrocarbons (gasoline, mineral oil) and vegetable oils.

• Specifications

MONS 080724

In ethyl cellulose, Santolite MHP increases both flexibility and toughness—a unique action. It also improves moisture and oil resistance, brilliance and adhesion, and gives good outdoor weathering properties to films.

In polyvinyl acetate adhesives, Santolite MPH imparts quick tack, excellent clarity, toughness, and water resistance. It is especially useful in adhesives for bonding cellophane to cellophane or to paper and for bonding aluminum foil to itself or to paper.

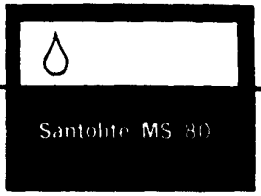
In vinyl lacquers, Santolite MHP greatly improves adhesion and gloss without materially changing hardness and flexibility and makes possible high-solids-content formulations.

In protein compositions, Santolite MHP improves brilliance, adhesion, and moisture resistance and as a mutual solvent makes possible the use of other plasticizers that are otherwise incompatible. In zein adhesives, it improves remarkably both the adhesion and water resistance.

In polyamide formulations for molding or solution coating, Santolite MHP acts as an extender resin; does not detract from desirable properties of the polyamide, yet materially reduces the net cost of the compositions.

Santolite MHP has a low order of toxicity. It is FDA regulated for use in food packaging adhesives.

plasticizing resin-solution



Santolite MS-80% (a softer resin than Santolite MHP) is available as an 80% solution in butyl acetate with the following properties:

■ General Description

Santolite MS-80% is a light-colored, viscous liquid that is free flowing above 20°C. It is used where greater flexibilizing is desired than can be obtained with Santolite MHP. Otherwise, the action of the solid and liquid resins, such as the high compatibility and solubility in cellulose esters, are very similar.

In nitrocellulose and cellulose acetate, Santolite MS-80% and plasticizer combinations make permanently flexible compositions. It imparts unusually high gloss with light color for a resin material. It is excellent for water-white lacquers that will not be exposed to extreme weather conditions.

Santolite MS-80% has a low order of toxicity. It is FDA regulated for use in food packaging adhesives.

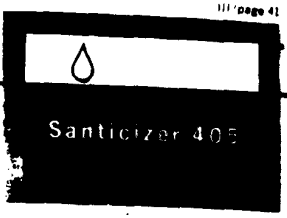
Properties

• Appearance	Light-colored, viscous liquid. Free flowing above 20°C.
• Butyl acetate content	20 ± 1.2%
• Color (25 gm. in 35 gm. butyl acetate)	APHA 80 max.
Specific Gravity 25°/25°C.	1.256
Weight per gallon @ 25°C.	10.5 lb.
Flash Point (C.O.C.)	90-95°F
Solubility in water @ 25°C.	Nil
General solubility	Miscible with all common organic solvents and thinners except petroleum hydrocarbons. Does not mix with paint and varnish oils.

• Specifications

MONS 080725

unusual migration resistance in critical environments



■ General Description:

Santicizer 405 is a polymeric plasticizer developed specifically to meet the increasingly stringent applications to which vinyl plastics are being exposed. This exceptional plasticizer has unusual permanence in three major areas: migration resistance, extraction resistance, and low-volatility.

Some applications where Santicizer 405 is used to impart superior permanence, include industrial & electrical tapes, oil and soapy water resistant film and sheeting (upholstery) and electrical insulation. This permanent polymeric plasticizer has demonstrated good resistance to both natural and synthetic rubber migration. This property is extremely important in tapes and other adhesive-backed vinyl film and sheeting.

With the use of vinyls in outerwear, formulators must now, not only give increasing attention to extraction resistance to dry-cleaning solvents, but require a balance of performance properties, i.e. low-temperature flexibility, volatility and compatibility, to this balance Santicizer 405 fills the need. When used in a plastisol formulation — in combination with Santicizer 160 — the formulation still retains its superior extractant resistance.

In vinyl outerwear, Santicizer 405 is neither a skin irritant or a sensitizer. No unusual handling precautions need be followed when using this plasticizer.

■ Properties

Chemical type	Polymeric
• Appearance	Clear, viscous liquid
• Acidity	1.0 meq./100 gm. max
• Color (50 ml. in 50 ml. 95% ethanol)	APHA 250 max.
• Odor	Characteristic
• Specific Gravity 25°/25°C.	1.128 to 1.132
Refractive Index @ 25°C.	1.476
Iodine Number	0.6
Weight per gallon 25°C.	9.41
Pour Point, °C.	1.1
Flash Point (C.O.C.) °F.	555
Density, 25°C. lb/gal.	9.41
• Viscosity, cks @ 25°C.	10,500 to 13,500
• Moisture (KF in methanol) %	0.15 max.
Solubility in Water	Practically insoluble
General Solubility	Soluble in toluene

• Specifications

MONS 080726

Performance in PVC

	(33⅓%) 50 PHR	(40%) 67 PHR
Volatility, % lost (Activated Carbon)		
1 day	0.4	0.5
2 days	0.8	1.0
6 days	1.5	1.6
Low Temp. Flex. T_f, °C.	−1.4	−11.8
Kerosene Extraction, % Lost	0.3	0.5
Shore "A" Hardness	93	79
Migration Linde Silica		
1 day	0.15	—
3 days	0.20	—
7 days	0.25	—
Tensile, psi	2900	—
Elongation, %	300	—
Modulus @ 100% Elongation	2450	—
Caustic Extraction, 5% — 96 hrs.	0.3	0.5
Soap Extraction, 1% — 96 hrs.	5.1	7.4
Hexane Extraction, 4 hr. R.T.	0.24	0.4
Mineral Oil Extraction, 96 hrs. R.T.	0.2	0.4
Gasoline Extraction, 1 hr. R.T.	0.3	0.5
Flame Retardant	No	No
Heat Stability	Excellent	Excellent
Migration Resistance to Nitrocellulose	Fair	Fair
Fluxing Rate	Poor	Poor
Electrical Properties	Fair	Fair

Performance in Plastisol Formulation

Viscosity, Poises
Brookfield HAT # 6 Spindle
50 RPM

	23°C	40°C	50°C
Initial	970	424	352
1 day	984	464	416
7 days	930	410	327
28 days	926	400	398

extraction-resistant permanent plasticizer

Santicizer 406

General Description

Santicizer 406 is a medium molecular weight polymeric plasticizer developed to meet industries growing needs for permanence in critical environments. This speciality plasticizer has exceptional resistance to extraction by kerosene, hexane, gasoline and soapy water. It has excellent migration resistance characteristics to polystyrene and ABS terpolymers.

Refrigerator gasketing and electrical tapes are this polymerics main areas of application. Due to its balance of efficiency, permanence, and performance properties it is also recommended for use in mar-resistant jacketing, wall covering, high temperature wiring, adhesive backed film, injection molding, and other severe performance applications.

In refrigerator gasketing Santicizer 406 easily meets the appliance industries specifications, that plasticized vinyl extrusion have humidity compatibility, and impart minimum odor and taste to foods.

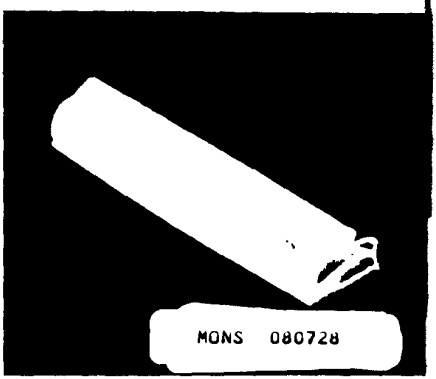
In a Dow Mandrel test Santicizer 406 had 50% retention of critical elongation and after the stringent Westinghouse Stress-Mandrel test the polymeric had 87.5% retention of flexural strength. Santicizer 406 in electrical tapes has excellent electrical properties, insulation resistance, dielectric strength, retention of physical properties, and non-migration to rubber mastic.

Santicizer 406 is classified as practically nontoxic and can be handled as safely as other innocuous plasticizers.

Properties

Chemical type	Polymeric
• Appearance, 25°C	Clear, oily liquid
• Acidity	1.0 meq/100 gm. max.
Color (50 ml: 50 ml.) 95% ethanol	APHA 200 max.
• Moisture (KF in methanol)%	0.15 max
• Odor	Very slight characteristic
Pour Point, °F	−60
Refractive Index @ 25°C.	1.476
• Specific gravity, 25°/25°C.	1.089 to 1.091
Weight per gal. @ 25°C.	9.08
Viscosity, cks @ 25°C.	9100
@ 50°C.	1500
Flash Point (C.O.C.)	535°F
General Solubility	Soluble in toluene
Solubility in Water	Practically insoluble

• Specifications



Performance in PVC (40 mil sheet)

	(33⅓%) 50 PHR	(40%) 67 PHR
Volatility, 87° C. % Lost (Activated Carbon)		
1 day	0.47	0.6
2 days	0.71	0.8
6 days	1.3	1.5
Low-Temperature Flex., T$_f$°C.	2	−11
Kerosene Extraction (% Plasticizer Lost)	0.4	0.8
Shore "A" Hardness	92	80
Tensile, p.s.i.	2715	2385
Elongation, %	320	390
Modulus @ 100% Elongation	2330	1530
Caustic Extraction, 5%—96 hrs. R.T.	0.1	0.2
Ivory Soap Extraction, 1%—96 hrs. R.T.	2.6	4.8
Hexane Extraction, 4 hrs. R.T.	0.3	0.5
Mineral Oil Extraction, 96 hrs. R.T.	0.2	0.5
Gasoline Extraction, 1 hr. R.T.	0.3	0.4
Flame Retardant	No	No
Heat Stability	Excellent	Excellent
Migration Resistance to Nitrocellulose	Fair	Fair
Fluxing Rate	Poor	Poor
Electrical Properties	Fair	Fair

Performance in Refrigerator Gasketing

	Plasticizer Concentration Resin/ plasticizer only 50PHR	67PHR	100PHR
Tensile			
Elongation %	320	390	465
Strength, psi	2715	2385	1945
100% Modulus, psi	2330	1530	730
Volatility			
1 day	0.47%	0.47%	0.51%
2 days	0.71%	0.74%	0.75%
6 days	1.3 %	1.5 %	1.9 %
Flexibility, T$_f$°C	2	−11	−23
Shore "A" hardness	92	80	61
Humidity Stability (days to exude @ 80°C)	20	14	11

- **RESISTANCE TO STYRENE MIGRATION**
  - Dow Mandrel Test (Retention of critical elongation) 50%
  - Westinghouse Stress Mandrel Test (Retention of Flexural Strength) 88%
  - Frigidaire Test very slight marking

- Formulation

Resin	100
Santicizer-406	98
Epoxy Soya Oil	10
Stabilizer	2
Atomite	55
TiO_2	5

MONS 080729

high-permanence, permanent plasticizer for superior performance

Santicizer 409

General Description

Santicizer 409 is a true polymeric plasticizer, a chemically linked dibasic acid and a glycol, not an epoxidized oil. It combines the best properties of several general and special polyvinyl chloride plasticizers into one primary plasticizing material that maintains excellent "permanence" in finished compositions.

Santicizer 409 produces vinyl compounds that have excellent heat resistance; high electrical resistivity for a polymeric plasticizer; negligible loss of plasticizer by volatilization or oil and hexane extraction; and maximum resistance to migration. It has a low specific gravity to provide a low pound/volume cost. Santicizer 409 is low in color and odor; it produces compositions with superior heat and light stability. Santicizer 409 is extremely efficient in processing due to its faster-fusion (approximately 20% more than ordinary polymeric plasticizers) with polyvinyl chloride resins. Santicizer 409 is an excellent plasticizer for wire and cable coatings (high electricals, low odor, easy processing, and retention of elongation on heat aging), for refrigerator gasketing (resistance to migration to polystyrene, low odor, high humidity compatibility); for film, tape, and coated fabrics (compatibility with epoxy plasticizers, migration resistance to rubber, excellent oil and hexane resistance, low volatility).

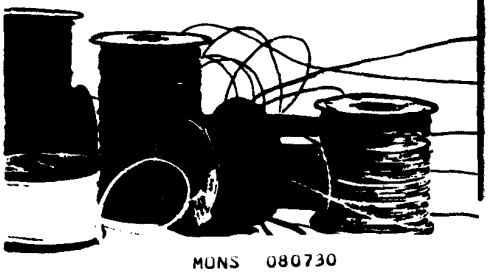
While developed specially for use with polyvinyl chloride, Santicizer 409 is compatible up to a practical working-requirement range with ethyl cellulose, nitrocellulose, and cellulose acetate-butyrate.

Animal toxicity studies show that Santicizer 409 may be handled as safely as other innocuous plasticizers.

Properties

Chemical type	Polymeric
• Appearance	Clear liquid
• Acidity	1.5 meq/100 gm. max
• Color (50 ml. in 50 ml. 95% ethanol)	APHA 150 max.
• Moisture	0.15% max. (KF in methanol)
Odor	Very faint ester
Refractive index @ 25°C.	1.4654
• Specific gravity 25°/25°C.	1.080 to 1.084
Weight per gallon @ 25°C.	9.01 lb.
Iodine Number	0
Pour point	39.2°F.
Flash point (C.O.C.)	530°F.
Fire point (C.O.C.)	570°F.
• Viscosity @ 25°C.	2900 - 3500 cks
Solubility in water @ 25°C.	Practically insoluble
General solubility	Soluble in toluene
Thermal expansion @ 10° to 40°C.	0.00071 cc/cc/°C.

• Specifications



In vinyl insulation for high-temperature electrical wire and cable, Santicizer 409 imparts superior retention of elongation on heat aging, high electrical resistivity, low odor, and easy processability.

MONS 080730



No corrosion of copper, no exudation with Santicizer 409...



...compared to this corrosion and exudation with another polymeric plasticizer...

after 12-week immersion of vinyl-covered copper electrodes in water at 50°C.

Performance in PVC (40 mil sheet)

	(33-1/3%) 50 PHR	(40%) 67 PHR
Volatility (% Lost) (Activated Carbon) 6 days	2.0	2.2
Low-Temperature Flex, T_f °C	−9.3	−21.6
Kerosene extraction (% plasticizer lost)	1.2	1.1
Shore "A" Hardness	92	75
Migration, Linde Silica:		
1 day	0.4	0.5
3 days	0.7	1.2
7 days	1.0	2.0
Tensile, p.s.i.	3100	2510
Elongation, %	370	450
Modulus @ 100% Elongation	2500	1305
Caustic extraction, 5%—96 hrs. R.T.	0.6	0.9
Ivory Soap extraction, 1%—96 hrs. 50°C	6.0	11.2
Hexane extraction,		
4 hrs. R.T.	—	1.2
24 hrs. R.T.	1.9	2.4
Flame Retardant	No	No
Heat Stability	Excellent	Excellent
Migration Resistance to Nitrocellulose	Fair	Fair
Fluxing Rate	Fair	Fair
Electrical Properties	Good	Good

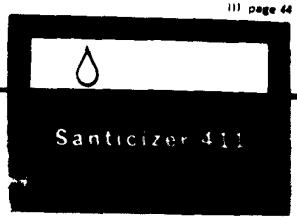
Performance in Plastisol Formulation

	130 PHR
Viscosity, Poises	
Brookfield HAT #6 Spindle	
50 RPM	
23°C	
Initial	314
7 Days	202
28 Days	246
40°C	
Initial	152
7 Days	212
28 Days	151
50°C	
Initial	110
7 Days	138
28 Days	118
Fusion Point, °C	148
*Air-Release Time, minutes	60
*Resilience, steel ball, inches	3.1
*Resilience, rotationally cast ball, inches	—

*Efficiency Conc. Adj. to "60" Shore A Hardness

MONS 080731

low-cost, general purpose permanent plasticizer



■ General Description:

Santicizer 411 is designed as a low-cost permanent polymeric plasticizer with superior performance in specific areas: resistance to extraction, low migration to rubber or styrene and excellent heat stability.

Highly competitive end products requiring polymeric permanence will find Santicizer 411 of great benefit. Such applications include outer-wear, baby pants, coated cloth (both automotive and furniture), wall covering, wire and cable insulation, modifiers for organisols and plastisols, coated paper and vinyl-metal laminates.

This low-cost polymeric plasticizer has great resistance to such extractants as kerosene, caustic, gasoline, soapy water, mineral oil, and hexane . . . Santicizer 411 has excellent rubber migration resistant properties to natural rubber, styrene, butadiene, neoprene WRT, Enjay Butyl 217, and Hycar 1002. Heat and light stability of vinyl formulations plasticized with Santicizer 411 and stabilized with either lead or barium-cadmium-zinc stabilizing systems has been found to be acceptable for even the most stringent requirements.

Animal toxicity studies indicate that Santicizer 411 may be handled as safely as other innocuous plasticizers.



■ Properties

Chemical type	Polymeric
• Appearance, 25°C.	Light yellow, viscous liquid; some solids on standing
• Acidity	1.0 meq./100 gm. max.
• Color, (50 ml.: 50 ml. 95% ethanol)	APHA 175 max.
• Moisture (KF in methanol)%	0.15 max.
• Odor	Slight, characteristic
• Specific gravity, 25°/25°C.	1.104 to 1.110
Refractive Index @ 25°C.	1.4772
Weight per gallon @ 25°C.	9.20
Pour Point	+21.1°C.
Viscosity, cks	
@ 25°C.	9400
50°C.	1200
90°C.	170
Solubility in water @ 25°C.	Practically insoluble
General Solubility	Soluble in toluene

• Specifications

MONS 080732

Performance in PVC (40 mil sheet)

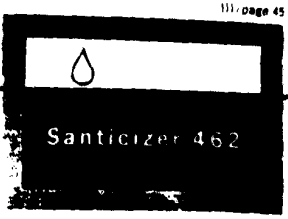
	(33⅓%) 50 PHR	(40%) 67 PHR
Volatility, 87° C., % Lost (Activated Carbon)		
1 day	0.5	0.6
2 days	0.8	0.9
6 days	1.4	1.5
Low Temperature Flex, T, ° C.	+3.0	−8.3
Kerosene Extraction (% Plasticizer Lost)	0.4	0.9
Shore "A" Hardness	92	83
Migration, Linde Silica		
1 day	0.07	0.23
3 days	0.2	0.4
7 days	0.3	0.6
Tensile, psi	2800	2575
Elongation, %	340	400
Modulus @ 100% Elongation	2760	1680
Caustic Extraction, 5%-96 hrs., R.T.	0.3	0.8
Ivory Soap Extraction, 1%-96 hrs., 50° C.	2.8	6.4
Hexane Extraction, 4 hrs., R.T.	0.3	0.6
Mineral Oil Extraction, 96 hrs., R.T.	0.2	0.3
Gasoline Extraction, 1 hr., R.T.	0.3	0.5
Flame Retardant	No	No
Heat Stability	Excellent	Excellent
Fluxing Rate	Poor	Poor
Migration Resistance to Nitrocellulose	Fair	Fair
Electrical Properties	Fair	Fair

Hexane-Extraction Resistance. (23°C)

Calendered PVC Film or Sheet at 50 PHR	Plasticizer Lost (%)		
Thickness - (mil)	1 hour	4 hours	24 hours
4	8.0	16.1	27.2
10	2.6	6.2	14.2
20	0.73	2.0	5.4
40	0.08	0.14	0.21

MUNS 080733

permanent plasticizer with monomeric processability and viscosity



■ General Description

Santicizer 462 is designed to provide polymeric permanence and monomeric performance to plasticized PVC. This plasticizer offers excellent humidity-compatibility, DOP-like processability, good plastisol viscosity, minimum migration, and volatility of a polymeric plasticizer.

Dus to its permanence and performance, Santicizer 462 finds excellent application in coatings of rubber-saturated paper, for cloth coating (wall covering, foamed vinyl for outer-wear, automotive and furniture upholstery) and general purpose unsupported film and sheeting.

Compared to low molecular weight polymerics, Santicizer 462 is more migration resistant in vinyl coated natural rubber, styrene butadiene, and neoprene rubber-saturated paper. It has excellent resistance to extraction by mineral oils, hexane, soapy water, and silica gel (the wicking action test). Santicizer 462 was tested in a humidity chamber, at a 100 PHR concentration for 210 days and showed no trace of exudation. It also has good heat and light stability.

Santicizer 462 is practically non-toxic, a non-irritant to skin and is only slight eye irritant.

■ Properties

• Acidity	0.24 meq./100 gm. max.
• Appearance	Clear, oily liquid
• Color	APHA 150 max.
Odor	Characteristic
• Moisture (KF in methanol)%	0.15 max.
• Refractive Index (at 25°C.)	1.508 to 1.510
• Specific Gravity (25°/25°C.)	1.072 to 1.077
Density (at 25° C.) (lb./gal.)	8.95
Pour Point (°C.)	−18.4
Viscosity, cks @ 25°C.	380
37.8°C.	160
98.9°C.	11.7
Solubility in water (at 25°C.) (%)	Practically insoluble
General Solubility	Soluble in toluene

• Specifications

MONS 080734

Performance in PVC

	Concentration 40%-67 PHR
Volatility	
Activated Carbon, 6 days @ 87°C., % Lost	4.8
Extraction Resistance (% lost)	
5% Caustic, 96 hrs. @ 23°C.	0.3
1% Ivory Soap, 96 hrs. @ 50°C.	5.5
Hexane, 4 hrs. @ 23°C.	12.7
Humidity Compatibility, 80°C, days to exude	>210
Loop Compatibility, 1 week	C
Low-temperature Flexibility T_f°C.	−19.6
Shore "A" Hardness	70

Plasti-Corder Brabender / Fusion Studies

Dry Blends (Henschel® type mix, 52 PHR)	Dry Time* (sec.)	Equilibrium Torque After Mixing (meter grams)
Santicizer® 462	330	38
Santicizer® 160	110	35
Dioctyl Phthalate	275	41
Santicizer® 409	682	62

Fusion Studies	Peak Torque** (meter-grams)	Equilibrium Torque*** (meter-grams)
Santicizer 462	2520	1140
Santicizer 160	2720	900
Santicizer 409	1950	1150
Dioctyl Phthalate	2200	940

* Dry Time — Time to "sand out", no caking.
** Peak Torque — Point of highest melt viscosity.
***Equilibrium Torque — Complete fusion of plasticizer & resin.

Resistance to Rubber Migration* (% weight loss)

	Natural	GRS-100	Neoprene WRT	Enjay Butyl	Hycar 1082
Santicizer 462	+2.1	+1.9	+3.9	−0.14	+3.6
DOP	+16.1	+12.9	+15.2	+0.8	+4.2

*39 hours at 23°C.

Electrical Properties in PVC*

Volume Resistivity (10¹⁴ ohm — cm)	0.22
Insulation Resistance (meg. ohm/1000 ft. #14 wire)	
24 hours 25°C.	49.4
24 hours 50°C.	1.0
1 week 50°C.	2.2
5 weeks 50°C.	5.3
9 weeks 50°C.	4.9
13 weeks 50°C.	4.7
Retention of Elongation (after heat aging for 7 days)	
At 136°C.	92%
At 152°C.	69%
Plasticizer Lost (after heat aging for 7 days)	
At 136°C.	5.9%
At 152°C.	14.3%

*Concentration 62.5%

MONS 080735

permanent plasticizer with monomeric efficiency

Santicizer 480

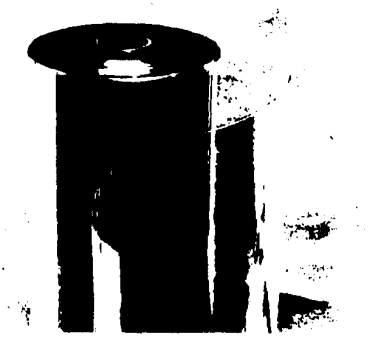
General Description

This plasticizer was developed specifically to meet the needs of highly competitive, low-cost, end products where a measure of permanence is required. Santicizer 480 finds application in supported and unsupported vinyl film, coated fabrics, vinyl foam and wall coverings.

Santicizer 480 offers formulators high efficiency (comparable to monomeric esters) plus excellent processability. Finished products formulated with Santicizer 480 show low color and odor; have excellent compatibility when measured under humidity, exposed in north window, or by loop tests. Santicizer 480 also imparts excellent extraction resistance to soap, oil, caustic, and hexane.

While Santicizer 480 was designed primarily for polyvinyl chloride it also has excellent compatibility in other resins, i.e., polyvinyl acetate, acrylics, and cellulose acetate.

Detailed toxicity studies show that Santicizer 480 is relatively innocuous and can be handled safely.



Properties

• Acidity	0.60 meq./100 gm. max.
• Appearance	Clear, oily liquid
• Color	APHA 200 max.
• Moisture (KF in methanol)%	0.15 max.
Odor	Slight, characteristic
Refractive Index (At 25°C.)	1.4943
• Specific Gravity (25°/25°C.)	1.039 to 1.046
Density (lbs/gal at 25°C.)	8.72
Pour Point (°C.)	−1
Viscosity cks	
@ 25°C.	556.
@ 37.8°C.	243.
@ 98.9°C.	21.2
Flash Point °F.	475
Fire Point °F.	535
Solubility in water (25°C.)	Practically insoluble

• Specifications

MONS 080736

Performance in PCV (40%–67 PHR)

Volatility, % loss 6 days	3.5
Low Temp. Flex., T_f	−22.0
Hardness, Shore "A"	72
Extraction Resistance	
5% Caustic, 96 hrs. @ 23°C.	0.3
1% Ivory Soap, 96 hrs. @ 50°C.	6.9
Hexane, 24 hrs. @ 23°C.	7.0
Humidity Comp. 80°C. Days to Exude	34
Loop Comp., 1 wk.	C

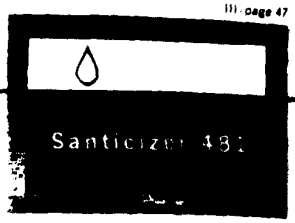
Performance in Plastisol

Viscosity Stability, Poises
80 PHR, 50 RPM

23°C.	
1 day	188
28 days	296
40°C.	
1 day	156
28 days	202
50°C.	
1 day	138
28 days	210

MONS 080737

permanent plasticizer for film, sheeting and expanded vinyl



■ General Description

Santicizer 481 is designed to give exceptional permanence at minimum cost, i.e., low volatility and good extraction resistance to hexane, caustic and soapy water. It is also very efficient, better than most high molecular weight plasticizers for film and sheeting.

Santicizer 481 in expanded vinyl formulations helps develop uniform and consistent cell structures. This results in good physical properties, excellent resilience, and good "hand" for improved quality in expanded vinyl products.

Santicizer 481 has good electrical properties and is ideally suited for 90° C. wire and cable insulation. In electrical tapes it has migration resistance to adhesive backings.

Detailed toxicity studies show that Santicizer 481 may be handled as safely as other innocuous plasticizers.



■ Properties

• Acidity	0.85 meq./100gm. max.
• Appearance	Clear, oily liquid
• Color	APHA 300 max.
• Moisture (KF in methanol)%	0.15
Order	Slight characteristic
Refractive Index (at 25°C.)	1.4795
• Specific Gravity (25°/25°C.)	1.072 to 1.078
Density (lbs/gal at 25°C.)	8.96
Pour Point (°C.)	10
Viscosity cks	
@ 25°C.	3878.
@ 37.8°C.	1318.
@ 98.9°C.	79.4
Flash Point °F.	485
Fire Point °F.	535
Solubility in water at 25°	Practically insoluble

• Specifications

MONS 080738

Performance in PVC (40% – 67 PHR)

Volatility, % loss 6 days	2.9
Low Temp. Flex., T_f	−15.0
Hardness Shore "A"	78
Extraction Resistance	
5% Caustic, 96 hrs. @ 23°C.	0.4
1% Ivory Soap, 96 hrs. @ 50°C.	6.7
Hexane, 24 hrs. @ 23°C.	1.2
Humidity Comp. 80°C.	
Days to Exude	13

Performance in Plastisol

Viscosity Stability, Poises
80 PHR, 50 RPM

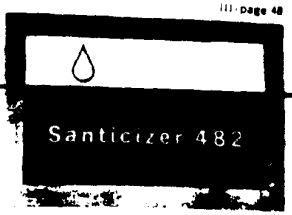
23°C.	
1 day	755
28 days	1360
40°C.	
1 day	432
28 days	480
50°C.	
1 day	345
28 days	369

Electrical Properties

Dry-Slab Resistivity (ohm-cm. x 10¹⁴)	3.4
Water-Immersion Resistivity (megohms/1000 ft. #14 wire)	
24 hours, 25°C.	21.0
24 hours, 50°C.	4.1
1 week, 50°C.	6.5
12 weeks, 50°C.	4.3

MONS 080739

permanent plasticizer for wire, cable and electrical tape



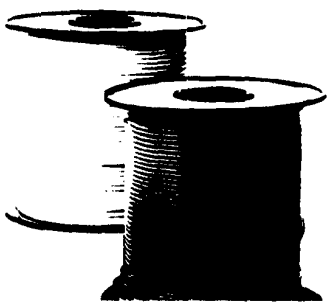
■ General Description

Santicizer 482 offers an unusually high degree of permanence in the three major areas of permanence — volatility, extractant resistance, and migration resistance. It is as low in volatility as other higher priced polymerics. It is excellent on extraction resistance to hexane and good resistance to caustic and soapy water. It has excellent migration resistance to natural and synthetic rubbers.

Santicizer 482 is ideally suited for primary vinyl insulation for 105° C. wire and cable. It has excellent electrical properties (high insulation resistance and volume resistivity). It has low odor and color for critical wire applications in appliances, i.e., refrigerators, washers, dryers, radios, etc. It exhibits low volatility and excellent retention of physical properties after extended heat and/or oil aging.

For electrical tapes it has a high degree of migration resistance to adhesive backings.

Detailed toxicity studies show that Santicizer 482 is relatively innocuous and can be handled safely.



■ Properties

• Acidity	1.1 meq./100 gm. max.
• Appearance	Clear, oily liquid
• Color	APHA 325 max.
• Moisture (KF in methanol)%	0.15 max.
• Odor	Slight characteristic
Refractive Index (at 25°C.)	1.4751
• Specific Gravity (25°/25°C.)	1.097 to 1.103
Density (lbs./gal. at 25°C.)	9.16
Pour Point (°C.)	18
Viscosity cks @ 25°C. @ 37.8°C. @ 98.9°C.	 6422. 2506. 140.
Flash Point °F.	525
Fire Point °F.	580
Solubility in water at 25°	Practically insoluble

• Specifications

MONS 080740

Performance in PVC (40%–67 PHR)

Volatility, % loss, 6 days	1.8
Low Temp. Flex. Tr	−10.8
Hardness, Shore "A"	79
Extraction Resistance	
5% Caustic, 96 hrs. @ 23°C.	0.2
1% Ivory Soap, 96 hrs. @ 50°C.	2.3
Hexane, 24 hrs. @ 23°C.	15.6
Humidity Comp. 80°C.	
Days to Exude	6
Loop Compatibility, 1 week	Very, very slight

Rubber Migration (40%–67 PHR)

	% wt.-change @ 23°C.
Natural	+1.15
GRS-100	+0.21
Neoprene WRT	+0.84
Butyl	+0.4
Hycar	+0.4

Electrical Properties

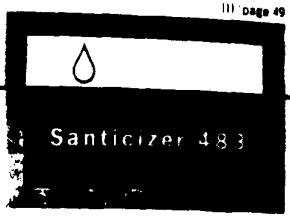
Dry-slab Volume Resistivity (ohm-cm. x 10¹⁴)	.99
Water-Immersion Resistivity (megohm/1000 ft. #14 wire)	
24 hours, 25°C.	210
24 hours, 50°C.	2.15
1 week, 50°C.	1.95
12 weeks, 50°C.	1.03

Retention of Physical Properties After Heat Aging of Vinyl Insulation Composition

	7 days at 136°C.
Elongation, %	
Original	322
Retention, %	99
Modulus (at 100% elongation), psi	
Original	2000
Retention, %	122
Tensile Strength, psi	
Original	3410
Retention	104

MONS 080741

permanent plasticizer for plastisols

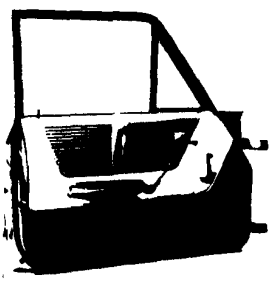


■ General Description

Santicizer 483 is specifically designed to impart permanence in finished products made by the plastisol technique. It exhibits low viscosity "per se" resulting in ease of handling and mixing. Initial viscosity of the plastisol is low, allowing easy processing and application. Plastisols formulated with Santicizer 483 have low viscosity build-up for long shelf life.

Even though Santicizer 483 show outstanding viscosity characteristics in plastisols, it has a fast fusion rate (better than most polymeric plasticizers). It has excellent soapy water resistance - comparable to that of diisodecyl phthalate. Santicizer 483 is highly efficient and Shore "A" hardness is in the same range as dioctyl phthalate. Compounds containing Santicizer 483 have excellent compatibility; at 80° C. and 100% relative humidity there was no measurable exudation after 126 days.

Toxicity studies show that Santicizer 483 can be handled as safely as other innocuous plasticizers.



■ Properties

• Acidity	0.24 meq./100 gm. max.
• Appearance	Clear, oily liquid
• Color, APHA	125 max.
• Moisture (KF in methanol)%	0.15 max.
Odor	Slight characteristic
Refractive Index (at 25°C.)	1.5015-1.5050
• Specific Gravity (25°/25°C.)	1.045 to 1.052
Density (lbs./gal. at 25°C.)	8.74
Pour Point (°C.)	−31
Viscosity cks	
@ 25°C.	156.
@ 37.8°C.	378.
@ 98.9°C.	7.9
Flash Point, °F.	485
Fire Point, °F.	525
Solubility in water at 25°	Practically insoluble

• Specifications

MONS 080742

Performance in PCV (40%—67 PHR)

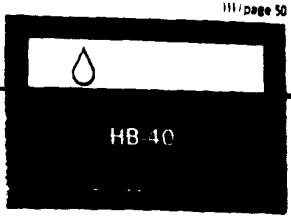
Volatility, % loss, 6 days	4.7
Low Temp. Flex., T_f	−25.7
Hardness, Shore "A"	68
Extraction Resistance	
5% Caustic, 96 hrs. @ 23°C.	0.2
1% Ivory Soap, 96 hrs. @ 50°C.	2.3
Hexane, 24 hours @ 23°C.	15.6
Humidity Comp., 80°C.	
Days to Exuda	126

Performance in Plastisol

Viscosity Stability, Poises 80 PHR, 50 RPM	
23°C.	
1 day	91
28 days	145
40°C.	
1 day	107
28 days	142
50°C.	
1 day	108
28 days	214

MONS 080743

low-cost, extender plasticizer for vinyls



General Description

HB-40 is recommended as a secondary plasticizer in polyvinyl chloride to replace up to 33⅓% of dioctyl phthalate. HB-40 is unique among secondary plasticizers in that it assumes the processing and fusion characteristics of the primary plasticizers used. Most secondary plasticizers adversely affect these properties. HB-40 maintains the composition's good color and heat stability. The use of HB-40 improves vinyl compositions' resistance to migration to nitrocellulose lacquers compared to dioctyl phthalate plasticized stocks. Its presence also improves the electrical properties of insulating compositions.

In plastisols, HB-40 functions as a viscosity-control agent without appreciable effect on the fusion characteristics compared to the unmodified formulation. It is recommended for plastisols for slush molding, fabric coating, and dip coating; for extruding compositions for profile moldings and wire coating; for floor tile; sheetings; and industrial coatings.

In asphaltic mixtures, HB-40 imparts a high gloss to high melting point molding compounds and makes an excellent plasticizer for maintenance paints, roofing and foundation coatings, linoleum cements, and undercoatings.

In ethyl cellulose, HB-40 performs in much the same manner as other compatible plasticizers and reduces the cost of molding compounds and strip coatings for metal.

HB-40 is compatible with polysulfide liquid polymers up to 40 PHR and is used to impart lower casting viscosity, higher filler levels, and reduced cost.

In many rubber compounds, HB-40 has a pronounced swelling action; greatly improves the miscibility of synthetic rubber latex with mineral oil. HB-40 has two special uses: it serves as a sizing agent for glass fibers and as a lubricant for hot stamping cellulose acetate.

HB-40 is virtually non-toxic.

Properties

Chemical type	Terphenyl
Appearance	Clear, oily liquid
• Color	APHA 100 max.
Odor	Faint, characteristic
• Refractive index @ 25°C.	1.5600 to 1.5750
• Specific gravity 25°/15.5°C.	1.001 to 1.007
• Water	125 ppm max.
Weight per gallon @ 25°C.	8.37 lb.
Distillation Range:	
First drop	340° to 349°C.
10%	345° to 358°C.
50%	353° to 360°C.
90%	362° to 389°C.
95%	371° to 396°C.
Boiling point, 760 mm Hg	345° to 396°C.
Pour Point	−26°C.
Flash Point (C.O.C.)	345°F.
Fire Point (C.O.C.)	385°F.
Vapor Pressure	
@ 150°C.	2 mm Hg
200°C.	15 mm Hg
300°C.	230 mm Hg
Viscosity, cks	
@ 25°C.	70.0
37.8°C.	29.0
98.9°C.	3.8
Evaporation Loss @ 100°C., 6 hrs.	0.033%
Surface tension @ 25°C.	40.1 dynes/cm.
General Solubility	Miscible with many solvents and oils.

• Specifications

Evaluation in PVC Plastisols

Viscosity, centipoises Brookfield # 4 spindle	DOP	HB-40 (20) DOP (60)
—23° C		
Initial	3,220	3,500
7 Days	8,400	4,660
28 Days	11,000	7,080
—40° C		
Initial	3,000	2,920
7 Days	14,760	7,000
28 Days	42,600	11,560
—50° C		
Initial	5,060	6,300
7 Days	GEL	GEL
28 Days		

Effect of secondary plasticizers on electrical properties of vinyl insulation

Plasticizer	Control	HB-40
	Parts by Weight	
Dioctyl Phthalate	50	35
HB-40	—	20
Properties		
Hardness, Shore "A"	88	89
Dry-Slab Resistance, ohm-cm x 10^{13}	8.3	21.4
Resistance, megohms/1000 ft. #14 wire (after water immersion)		
24 hours at 25° C.	643	1650
24 hours at 50° C.	50.7	187
1 week at 50° C.	81	314
6 weeks at 50° C.	109	396
12 weeks at 50° C.	98.8	342

Performance of HB-40 in PVC

Plasticizer	50 PHR			67 PHR		
	Control	1/5 HB-40	1/3 HB-40	Control	1/5 HB-40	1/3 HB-40
Dioctyl Phthalate	50	40	33	67	53.6	44.7
HB-40	—	10	17	—	13.4	22.3
Properties						
Low-Temp. Flexibility, T_f° C.	−26.1	−20.5	−18.5	−39.0	−34.0	−31.8
Hardness, Shore "A", 25° C.						
Original	83	86	85	73	75	77
Aged (6 days, 87° C.)	85	89	88	74	78	82
Tensile Strength, psi	2850	2950	3105	1960	2160	2440
Elongation, %	325	290	275	400	370	340
Modulus at 100% Elongation, psi	1750	2170	2320	830	1090	1210
Volatility, plasticizer lost, % (87° C., 24 hr., activated carbon)	4.7	13.4	17.0	5.3	18.1	23.8
Moisture Resistance (24 hr., 25° C.)						
Water absorbed, %	0.22	0.28	0.18	0.25	0.31	0.33
Solubles leached, %	0.01	0.05	0.01	0.03	0.09	0.10
Kerosene extraction, plasticizer lost, % (24 hr., 25° C.)	9.0	7.1	6.3	46	40	35

MONS 080745

unique modifier for non-aqueous coatings

Modaflow

General Description

Modaflow is a unique modifier for non-aqueous coatings and adhesives. Small concentrations in the range of 0.1-2.0% Modaflow based on resin solids improves flow and leveling significantly; eliminates pinholes and craters; results in a smooth, uniform build-up of film layers; improves recoating adhesion (Modaflow is not a silicone) and speeds up coating rate. Modaflow is included in the FDA list of substances regulated for resinous and polymeric coatings for lining food containers. Modaflow reduces foaming and air entrapment.

In epoxy coatings, 0.1% Modaflow improves leveling and flow-out significantly through surface tension modification and improved wetting of the substrate.

In alkyd varnishes and alkyd enamels, concentrations up to 2% Modaflow on the basis of vehicle solids improves leveling and flow-out without resulting in unsatisfactory sagging or curtaining. At concentrations up to 2%, Modaflow does not affect the physical properties, adhesion, or drying time.

In vinyl solution coatings, Modaflow provides optimum leveling, eliminates craters, ridges, pinholes, and entrapped air.

Modaflow is useful in epoxies, alkyds, acrylics, urethanes, melamines, phenolics, plastisols, and non-aqueous rubber for coatings, gel coats, silk screen inks, general inks, coil coatings, primers, container coatings, etc. Methods of application in which Modaflow improves the surface of finished product includes brushing, spraying, roll coating, knife coating, and dipping.

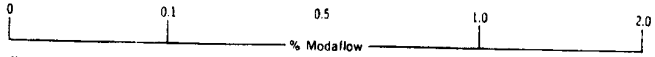
Properties

Appearance	Viscous light amber liquid
Color, ASTM	0.5
Viscosity, S.U.S. at 210°F	5000
Specific Gravity, 60/60°F	0.99
Refractive Index at 25°C (40% in 2,2,4 Trimethyl Pentane)	1.4130-1.4190
Solubility	Soluble in Benzene, Toluene, Xylene, Kerosene, Petroleum Ether, Carbon Tetrachloride, Mineral Oil; approximately 2-3% by weight in isopropyl alcohol and increasingly soluble in higher alcohols; insoluble in water.

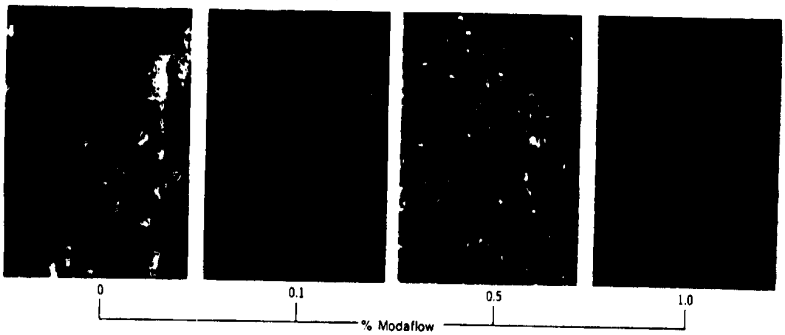
MONS 080746

Leveling effect of Modaflow* in 100% solids epoxy coatings (general purpose epoxy 50%, plus polyamide 50%).

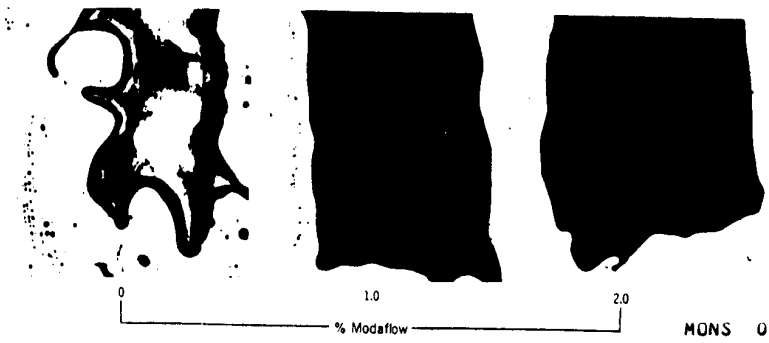




Leveling effect of Modaflow* in 100% solids epoxy coatings (general purpose epoxy, plus 20% aliphatic amine).



Epoxy resin coatings brushed on Teflon* film show how Modaflow* improves spread and coating dries in place.



MONS 080747

*DuPont Company Trademark

reactive diluent for epoxy resins

Mod Epox

General Description

Mod-Epox is a unique reactive modifier and working-properties-improver for epoxy resins. In liquid epoxy formulation, Mod-Epox addition can lower the viscosity as much as 75%, reducing bubble entrapment and minimizing rejects in finished potting on encapsulating operations. The lowered viscosity also permits use of a higher percentage of fillers.

Mod-Epox also acts in the epoxy formulation as a curing booster, permitting a reduction of up to one-third in the amount of amine curing agent normally required. Mod-Epox improves the adhesion; increases the dimensional stability under compressive load; and lowers the compound's power factor (thus reducing loss) and maintains the dielectric constant and specific resistivity.

Mod-Epox lowers epoxy resin formulating costs. Unlike other reactive modifiers, it costs much less than the epoxy resins themselves. In permitting a reduction of amine catalyst for curing and by enabling more filler to be used—the use of Mod-Epox creates a significant cost saving in a variety of epoxy formulations.

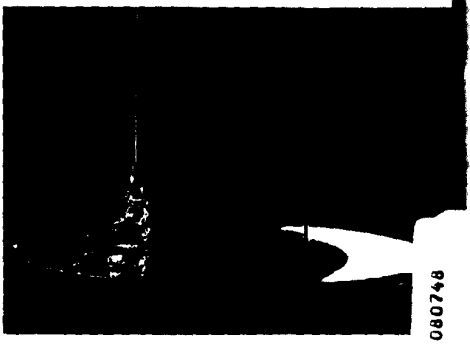
Like any reactive modifier, Mod-Epox tends to lower the heat distortion point; therefore it is not recommended where a high heat distortion point is essential. It crystallizes at 77°F. It is easily remelted by a slight warming, but excessive heating or localized high temperature heating must be avoided to prevent decomposition. Mod-Epox is hygroscopic. Containers should be tightly sealed. The use of 1 - 3% magnesium oxide based upon the Mod-Epox is an effective stabilizer against hydrolysis.

Mod-Epox is recommended for potting and encapsulation compounds, laminates, surface coatings, adhesives, and body solder compounds. It has a low order of toxicity; no special handling precautions are necessary.

Properties

• Appearance	Oily liquid or light yellow solid
• Neutralization number	0.08 mg. KOH/gm. max.
• Color	APHA 50 max.
• Hydrolyzable chlorine	0.010% max.
• Free phenol	0.05% max.
• Refractive index @ 25°C.	1.587 to 1.590
• Specific gravity 30°/15.5°C.	1.176 to 1.182
Weight per gallon @ 25°C.	9.83 lb.
Boiling point, 760 mm Hg	360°C.
Crystallizing point	25°C.
Flash point (C.O.C.)	375°F.
Fire point (C.O.C.)	525°F.
General solubility	Soluble in common solvents

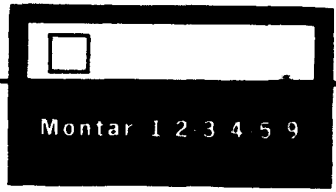
• Specifications



Room-temperature viscosity of a liquid epoxy-resin formulation can be lowered from 1800 centipoises (left) to 600 centipoises by the addition of 25 parts of Mod-Epox per hundred parts of resin (right).

MONS 080748

low-cost, specialty resin extenders



■ General Description

The Montar compounds are dark, high-melting solid resins. Montars 1, 2, 3, 4 and 5 are chlorinated polyphenyls; Montar 9 is a mixture of unchlorinated polyphenyls. Montars are used as extender plasticizers for polyvinyl chloride and a variety of other synthetic resins. The Montars are also useful for a variety of special properties—such as flame retardance — they impart to adhesives and asphaltic products.

In polyvinyl chloride compositions, all Montar compounds are compatible up to about 10 PHR. Used as extenders, their low cost reduces formulating costs. They can be blended with the resin by simple mixing.

In rubber-base adhesives, Montar 4 or Montar 5 gives good tack to paper adhesives. They are readily incorporated by first dissolving the Montar in a suitable solvent to a 50% solution and mixing the solution with a 60% solids rubber emulsion (1:1 ratio).

All Montars are effective as low-cost binders or tackifiers for adhesives, mastics, or hot-melt systems in which color is not objectionable.

As additives for asphalt, the chlorinated Montars create flame retardance in the asphalt compositions. All Montars are compatible up to 2 parts for each part of asphalt. Both softening point and brittleness of the asphalt blend are increased as the concentration of Montar is increased. Blending is easily accomplished by thorough mechanical mixing, using heat where necessary.

Except for avoidance of fumes and prolonged skin contact, the Montars can be handled as safely as roofing tar.

■ Properties

	MONTAR 1	MONTAR 2	MONTAR 3	MONTAR 4	MONTAR 5	MONTAR 9
• Appearance	Black solid	Black solid	Black solid	Black solid	Dark brown or black solid	Dark brown or black solid
Acidity	Slightly basic	Slightly basic	Slightly basic	Slightly basic	Slightly basic	0.1 to 0.3 mg KOH/gm.
Flash Point (C.O.C.)	500–620°F.	—	—	—	—	450–550°F.
Fire Point (C.O.C.)	—	—	—	—	—	530–630°F.
Vapor Pressure @ 150°C.	<1 mm Hg.	<1 mm Hg.	<1 mm Hg.	<1 mm Hg.	<1 mm Hg.	<1 mm Hg.
Softening Point (ASTM E28-51T)	54–160°C.	70–170°C.	86–168°C.	92–206°C.	155–195°C.	130–175°C.
Chlorine	36–42%	42–48%	50–52%	54–56%	53–55%	—
Calcium oxide	5 –15%	5 –15%	5 –10%	5 –10%	1 – 3%	—
Iron	0.5 to 1.0%	0.5 to 1.0%	0.3 to 0.6%	0.5 to 1.0%	0.1 to 0.2%	0.2 to 0.4%

• Specification

multipurpose flame-retardant organophosphorus polymer

Phosgard C-22-R

■ General Description

Phosgard C-22-R is a flame-retardant organophosphorus polymer for urethane foams, polymethylemethacrylate, phenolics, polyester resins, and epoxies.

Phosgard offers optimum performance properties for excellent flammability resistance in many critical polymer application: high efficiency through high phosphorus and chlorine content; essentially non-volatile for lasting flame retardant service life; excellent color stability on UV and heat exposure; ease of formulation and non-complicated handling; long storage stability "per se" and in formulation; and good hydrolytic stability.

Phosgard meets flame retardance requirements for rigid foams in construction, transportation, refrigeration and other industrial applications.

In flame penetrations tests, the high phosphorus content of Phosgard results in firm chars when foams are exposed to flame. In flame spread tests, the high chlorine content effectively quenches the flame spread.

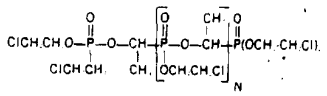
In flexible polyurethane foams, Phosgard C-22-R assures a high degree of flame retardant properties for cushioning in institutions, hospitals, and public places. Self-extinguishing foams (ASTM D-1692) are obtained with only 10 parts Phosgard C-22-R per 100 parts resin.

In flame-retardant polymethylmethacrylates Phosgard offers effective flame retardancy in cast acrylic sheet applications such as electrical sign facings, decorative building panels, luminous ceilings, and clear panels for doors or aircraft glazing. The flame retarded acrylic sheet offers excellent color stability on UV and heat exposure. Concentrations of 17.5 to 25% Phosgard C-22-R should be used depending on the desired flame resistance.

(continued)

■ Properties

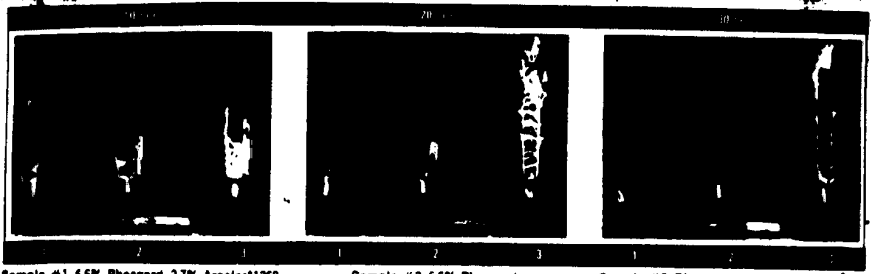
Structural Formula



• Appearance	Clear, viscous liquid
• Color, APHA	50 max.
• Ref. Index at 25°C.	1.492-1.494
• Specific gravity at 25°/25°C.	1.425-1.445
• Acidity, meq./gm	0.05 max.
• Viscosity, centipoise at 210°F.	55-85
• Chlorine	27%
• Phosphorus	15%
Odor	Essentially none
Boiling point	Not distillable
Crystallization point	None-glassy
Thermal stability	Stable for short times at 190-200°C.
Flash and fire points	Gas evolution at 300°C, no self-supporting combustion
Pour point	4°C.
Solubility	Soluble in all common organic solvents except aliphatic hydrocarbons. Insoluble in water.
Emulsification	Stable emulsions can be prepared.

• Monsanto Specifications

FLAMMABILITY TEST 18 x 2 x 2 inch vertical sample



Sample #1, 6.6% Phosgard, 2.7% Arocior*1260

Sample #2, 6.6% Phosgard

Sample #3, Rigid Foam, Without Retardant

In the tests shown, the rigid foam without Phosgard (#3) easily supports flame continuously, while there is very little actual flaming of the sample containing only 6.6% Phosgard (#2). For added flame retardance, Arocior 1260 may be added to the formulation as shown in the flame test sample with 2.7% Arocior/6.6% Phosgard (#1).

Phosgard C-22-R is also effective for electrical printed circuitry, counter tops, building panels, etc.

Phenolic paper laminated for use in electrical printed circuitry, counter tops, building panels, etc., are rendered flame retardant with Phosgard.

Phosgard is an effective synergist which strongly enhances the flame retardance of resins containing chlorine or bromine, such as certain polyesters and epoxy resins. Since the synergism is achieved at only 3-5% concentrations, better flame retardance can be obtained at lower cost.

Techniques to form stable oil-in-water emulsions of Phosgard C-22-R have been developed. Emulsification of the Phosgard flame retardants will permit more convenient use in applications such as cellulosic fibers, papers and pressure impregnation of wood. Further details on this are contained in Monsanto's Phosgard C-22-R technical bulletin.

Phosgard C-22-R is classified as slightly toxic by ingestion. Processing or handling at elevated temperatures requires adequate ventilation to prevent inhalation of vapors.

processing specialty color improver for alkyd resins

Triphenyl Phosphite

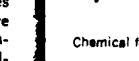
General Description

Triphenyl phosphite is widely used as a stabilizer in polyvinyl chloride compositions. It serves a dual function: (a) When cadmium compounds are part of the composition, triphenyl phosphite solubilizes and removes the haze developed by the cadmium chloride formation: (b) When chlorine ions are split from polyvinyl chloride, double-bonds susceptible to oxygen-darkening are left behind on the polymer; triphenyl phosphite acts as an antioxidant and contributes to better light stability. [This function, also valuable in other resins, is covered by U. S. Patents 2,572,571 (Monsanto) and 2,564,646 (Argus Chemical Company)].

In alkyd resins, triphenyl phosphite improves the color of the resins which tend to oxidize at the 400-540°F. processing temperatures due to presence of free peroxides or iron soluble salts. If calcium hydroxide is used as an alcoholysis catalyst, the presence of triphenyl phosphite will improve the finished resin's clarity by solubilizing the calcium phthalate precipitate which forms. *In polyester resin* manufacture, small amounts of triphenyl phosphite reduce the reaction time and improve the resin's color. The same color improvement is obtainable in the manufacture of bodied oils made by the treatment of soya, linseed, and tall oils with maleic anhydride or fumaric acid. *In phenolic resin* manufacture, triphenyl phosphite promotes the formation of permanently light colored liquid phenol formaldehyde compositions (U. S. Patent 2,816,876, Monsanto Co.).

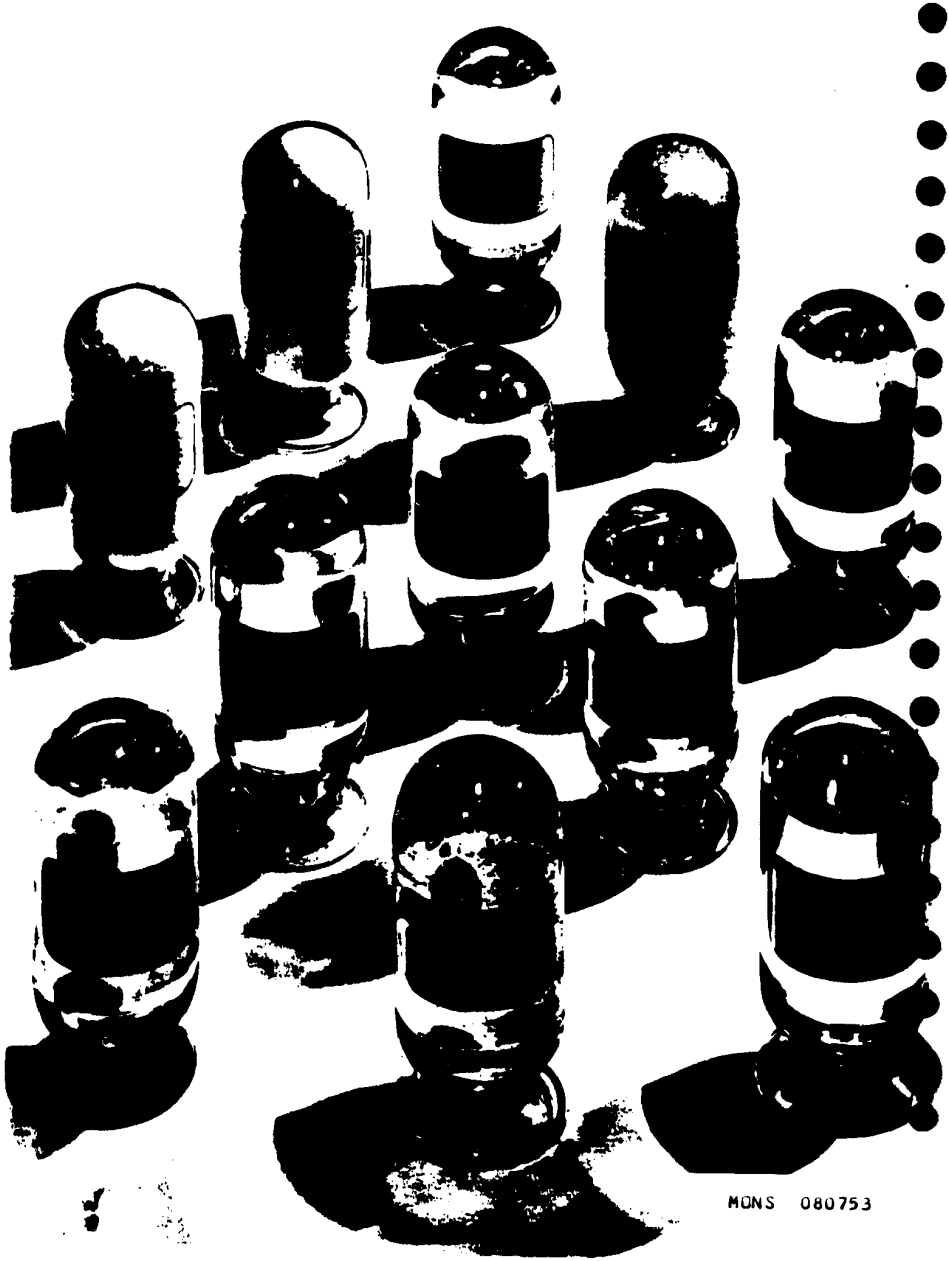
Triphenyl phosphite is considered only slightly toxic from the standpoint of oral ingestion and is not readily absorbed in lethal doses through the unbroken skin. Repeated or prolonged skin contact should be avoided, however, to prevent skin irritation. The material may cause irritation if there is accidental contact with eye tissues but no permanent damage should result. Prompt flushing of the eyes with water will reduce the degree of irritation. In laboratory studies, no deaths occurred among rats exposed for six hours to a saturated atmosphere of atomized triphenyl phosphite.

Properties

Chemical formula 

Molecular weight	310.28
• Appearance	Oily liquid or light yellow solid
• Neutralization number	0.08 mg. KOH/gm. max.
• Color	APHA 50 max.
• Hydrolyzable chlorine	0.010% max.
• Free phenol	0.5% max.
• Refractive index @ 25°C.	1.5875 — 1.5900
• Specific gravity 30°/15.5°C.	1.176 to 1.182
Weight per gallon @ 25°C.	9.83 lb.
Boiling point, 760 mm Hg	360°C.
Crystallizing point	25°C.
Flash point (C.O.C.)	375°F.
Fire point (C.O.C.)	525°F.
Vapor pressure @ 220°C.	11 mm Hg
Viscosity @ 25°C.	17.5 cks
Solubility in water @ 25°C.	Hygroscopic
General solubility	Soluble in common solvents

• Specifications



MONS 080753

AROCLOR PLASTICIZERS AND RESIN EXTENDERS

The Aroclor polychlorinated polyphenyls range in form and appearance from mobile oily liquids to fine white crystals and hard yellow transparent resins. The Aroclor products are useful as low-cost, efficient plasticizers and resin extenders for vinyls, cellulosics and rubber materials. The Aroclor compounds are compatible with most of the common plastic resins and numerous special resins.

These permanently thermoplastic materials are non-oxidizing; non-corrosive to metals; and not hydrolyzable by water, alkalies, or acids. They possess excellent electrical properties. The viscous liquids and resins will not support combustion when heated alone. The flexibility they impart to resins increases with the mobility of the particular Aroclor compound, while the degree of hardness imparted increases with the viscosity of the Aroclor selected.

In adhesives and surface coatings, the Aroclors impart outstanding adhesive qualities, good resistance to water and chemical action, and resistance to bacteria and fungi attack.

In vinyl resins, the Aroclors are used mainly as co-plasticizers with tricresyl phosphate, dioctyl phthalate, and others. They impart plasticizing action, chemical and corrosion resistance, flame resistance, and reduced migration to nitrocellulose lacquers.

Used with dioctyl phthalate and Santicizer 141, the Aroclors are efficient co-plasticizers for vinyl organosols, plastisols or pastes for free films, and textile and paper coatings. In these applications, the Aroclors impart valuable fire resistance and serve as excellent grinding and dispersing media for pigments.

In polyvinyl acetate, the liquid Aroclor compounds make excellent low-cost, quick-tack adhesives. The more viscous and solid Aroclor compounds are widely used in hot-melt adhesives.

The Aroclors are highly compatible with *ethyl cellulose*. The liquids impart great flexibility, and the resins impart great hardness. Aroclor 5460 contributes high gloss and exceptional weathering qualities to coatings for rigid surfaces.

In cellulose acetate-butyrate, the Aroclor compounds are useful in making flame-resistant, low-cost formulations for applications such as paper coatings, lacquers, and strippable coatings.

In nitrocellulose, the Aroclors function both as plasticizers and resins. They may be used alone or with other plasticizers and resins to impart weather resistance, luster, adhesion, and decreased burning rate. Because of their excellent electrical characteristics (high dielectric strength and resistivity and low power factor) and their property of retarding the passage of moisture and gases through nitrocellulose, chlorinated rubber, and other similar plastics films, they are especially useful in coatings for electrical insulating materials.

In chlorinated rubber (Parlon) and copolymers of styrene-butadiene (Pliolite S-5), Aroclor 1254 is an excellent plasticizer; and Aroclor 5460 acts as a film fortifier in protective and decorative coatings for concrete and masonry structures, steel structures, railway tank and gondola cars, wood, and metal maritime equipment. Aroclor in these types of coatings imparts excellent resistance to flame, corrosion, acids, alkalies, and water; as well as good electrical insulating properties.

The Aroclors are most useful in *natural* and *synthetic rubbers*. The liquid Aroclors 1221, 1232, 1242 and 1248 provide a strong plasticizing action. Small amounts of Aroclor 1260 plasticize hard rubber and reduce brittleness. Milled into rubber, Aroclor 1254 and 1260 impart permanent tackiness and adhesion. As a plasticizer for crepe-rubber resin (formulated into paints), Aroclor 1262 increases the gloss and alkali resistance of the film and its adhesiveness toward steel. Aroclor 1268 has excellent working qualities at 225-325°F. as a plasticizer in injection moldings. Ground into powder and milled into rubber at a temperature below its melting point, Aroclor 1268 can be dispersed through the rubber and acts as an efficient flame retardant.

In epoxy resin coatings, the Aroclor compounds with their excellent chemical resistance, oxidation resistance, and adhesion enable the formulator to reduce costs without detracting from the saleable features of the epoxy resins. In plastic applications, a combination of an Aroclor compound plus antimony oxide make low-cost non-burning formulations.

The Aroclor compounds are also useful with phenolic resins, polyester resins, polyisobutylene, waxes, and rosin.

MONS 080754

At ordinary temperatures, the Aroclor chlorinated polyphenyls have not presented industrial toxicological problems. When Aroclor compounds are used at elevated temperatures, engineering controls must be applied, either by the use of closed systems or by effective local-exhaust ventilation together with general workroom exhaust.

The threshold limits (maximum allowable concentration for an 8-hour working day) set by the American Conference of Government Hygienists are 1.0 milligram of the lower-chlorinated Aroclor compounds per cubic meter of air and 0.5 milligram of the more-highly-chlorinated compounds, such as Aroclor 1254, per cubic meter of air.

In skin patch tests, neither Aroclor 1254 alone or in a polyvinyl cloride film (11.5 per cent Aroclor) nor Aroclor 5460 in an alkyd resin coating (17 per cent Aroclor) on canvas irritated or sensitized the skin.

Continuous or repeated skin contact with the Aroclor compounds must be avoided because of the possible occurrence of chloracne.

Aroclor 1221

Properties

Appearance	Clear, mobile oil
• Acidity	0.014 mg. KOH/gm. max.
• Color	APHA 100 max.
Refractive index @ 20°C.	1.617 to 1.618
• Specific gravity 25°/15.5°C.	1.182 to 1.192
Chlorine, %	21.0 ± 0.5
Weight per gallon @ 25°C.	9.85 lbs.
Boiling point, 760 mm Hg	275-320°C.
Pour point (ASTM D-97)	Crystals at 1°C.
Flash point (C.O.C.)	286-302°F.
Fire point (C.O.C.)	349°F.
Viscosity @ 37.8°C.*	38 to 41 SUS
54.4°C.	35 to 37 SUS
98.9°C.	30 to 31 SUS

*Specifications

Aroclor 1248

Properties

• Appearance	Clear, mobile oil
• Acidity	0.010 mg. KOH/gm. max.
• Color	APHA 100 max.
• Moisture	50 ppm max.
Refractive index @ 20°C.	1.630 to 1.631
• Specific gravity 65°/15.5°C.	1.405 to 1.415
Weight per gallon @ 25°C.	12.04 lb.
Boiling point, 760 mm Hg	340 to 375°C.
Pour point, (ASTM D-97)	−7°C.
Flash point (C.O.C.)	379 to 384°F.
Fire Point (C.O.C.)	None to boiling point
Viscosity @ 37.8°C.	185 to 240 SUS
54.4°C.*	73 to 80 SUS
98.9°C.	36 to 37 SUS

*Specifications

Aroclor 1254

Properties

• Appearance	Light-yellow viscous liquid
• Acidity	0.010 mg. KOH/gm. max.
• Color	APHA 100 max.
• Moisture	50 ppm max.
Refractive index @ 20°C.	1.639 to 1.641
• Specific gravity 65°/15.5°C.	1.495 to 1.505
Weight per gallon @ 25°C.	12.82 lb.
Boiling point, 760 mm Hg	365 to 390°C.
Pour point, (ASTM D-97)	10°C.
Flash point (C.O.C.)	None to boiling point
Fire point (C.O.C.)	None to boiling point
Viscosity @ 37.8°C.	1800 to 2500 SUS
54.4°C.	260 to 340 SUS
98.9°C.	44 to 48 SUS

*Specifications

MONS 080755

Aroclor 1232

Properties

Appearance	Clear, mobile oil
• Acidity	0.014 mg. KOH gm. max.
• Color	APHA 100 max.
Refractive index @ 20°C.	1.620-1.622
• Specific gravity 25°/15.5°C.	1.270 to 1.280
Chlorine, %	32.0 ± 0.5
Weight per gallon @ 25°C.	10.55 lb.
Boiling point, 769 mm Hg	290 to 325°C.
Pour point, (ASTM D-97)	−35.5°C.
Flash point (C.O.C.)	305-310°F.
Fire point (C.O.C.)	460°F.
Viscosity @ 37.8°C.*	44 to 51 SUS
54.4°C.	39 to 41 SUS
98.9°C.	31 to 32 SUS

*Specifications

Aroclor 1242

Properties

• Appearance	Clear, mobile oil
• Acidity	.015 mg. KOH/gm. max.
• Color	APHA 100 max.
• Moisture	50 ppm max.
Refractive index @ 20°C.	1.627-1.629
• Specific gravity 25°/15.5°C.	1.381 to 1.392
Weight per gallon @ 25°C.	11.50 lb.
Boiling point, 760 mm Hg	325 to 366°C.
Pour point (ASTM D-97)	−19°C.
Flash point (C.O.C.)	348 to 356°F.
Fire point (C.O.C.)	None to boiling point
Viscosity @ 37.8°C.	82 to 92 SUS
54.4°C.	49 to 56 SUS
98.9°C.	34 to 35 SUS

*Specifications

Aroclor 1260

Properties

• Appearance	Light-yellow, soft, sticky resin
• Acidity	0.014 mg. KOH/gm. max.
• Color	APHA 150 max.
• Moisture	50 ppm max.
Refractive index @ 20°C.	1.647 to 1.649
• Specific gravity 90°/15.5°C.	1.555 to 1.566
Weight per gallon @ 25°C.	13.50 lb.
Boiling point, 760 mm Hg	385 to 420°C.
Pour point, (ASTM D-97)	31°C.
• Flash point (C.O.C.)	None to boiling point
• Fire point (C.O.C.)	None to boiling point
Viscosity @ 54.4°C.	3200 to 4500 SUS
98.9°C.*	72 to 78 SUS

*Specifications

Aroclor 1262

Properties

• Appearance	Light-yellow, sticky viscous resin
• Acidity	0.014 mg. KOH/gm. max.
• Color	APHA 150 max.
Chlorine, %	61.5 to 62.5
Refractive index @ 20°C.	1.6501 to 1.6517
• Specific gravity 90°/15.5°C.	1.572 to 1.583
Weight per gallon @ 25°C.	13.72 lb.
Boiling point, 760 mm Hg	390 to 425°C.
Pour point	35 to 38°C.
Flash point (C.O.C.)	None to boiling point
Fire point (C.O.C.)	None to boiling point
Viscosity @ 71.0°C.	600 to 850 SUS
98.9°C.*	86 to 100 SUS

*Specifications

MONS 080756

Aroclor 1268

Properties

• Appearance	White to off-white powder
• Acidity	0.05 mg. KOH/gm. max.
Color (molten)	1.5 NPA
Specific gravity 25°/25°C.	1.807
Weight per gallon @ 25°C.	15.09 lb.
Boiling point, 760 mm Hg	435 to 450°C.
• Softening point (ASTM E-28)	150 to 170°C.
Flash point (C.O.C.)	None to boiling point
Fire point (C.O.C.)	None to boiling point

*Specifications

Aroclor 4465

Properties

• Appearance	Clear, light-yellow resin
Acidity	0.05 mg. KOH/gm. max.
• Color (molten)	2 NPA max.
Refractive index @ 20°C.	1.664 to 1.667
Specific gravity 25°/25°C.	1.670
Weight per gallon @ 25°C.	13.91 lb.
Boiling point, 4 mm Hg	230 to 320°C.
• Softening point (ASTM E28-51T)	60 to 66°C.
Flash point (C.O.C.)	None to boiling point
Fire point (C.O.C.)	None to boiling point
Viscosity @ 130°C.	90 to 150 SUS

*Specifications

Aroclor 5442

Properties

• Appearance	Clear, yellow, sticky resin
Acidity	0.05 mg. KOH/gm. max.
• Color (molten)	2 NPA max.
Specific gravity 25°/25°C.	1.470
Weight per gallon @ 25°C.	12.24 lb.
• Softening point (ASTM E28-51T)	46 to 52°C.
Boiling point, 4 mm Hg	215 to 300°C.
Pour point, (ASTM D-97)	46°C.
Flash point (C.O.C.)	477°F.
Fire point (C.O.C.)	>662°F.
Viscosity @ 98.9°C.	300 to 400 SUS

*Specifications

Aroclor 5460

Properties

• Appearance	Clear, yellow to amber, brittle resin or flakes
Acidity	0.05 mg. KOH/gm. max.
• Color (molten)	2 NPA max.
Refractive index @ 20°C.	1.660 to 1.665
Specific gravity 25°/25°C.	1.670
Chlorine, %	59.5
Weight per gallon @ 25°C.	13.91
Boiling point, 5 mm Hg	280 to 335°C.
• Softening point (ASTM E28-51T)	98 to 105°C.
Flash point (C.O.C.)	None to boiling point
Fire point (C.O.C.)	None to boiling point

*Specifications









MONSANTO PLASTICIZERS:

Summary of Specifications and Typical Properties

For your convenience, the following chart lists Monsanto's Phthalate, Adipate, Phosphates and Glycollate plasticizers. If a specific property is ideally suited for a specific application simply find the optimum value of that property in the vertical column, the name of the plasticizer offering this value, may be read from the left hand listing.

MONS 080758

[illegible]	Molecular weight	Acidity (meq/gm) max	Appearance	Color (APHA) maximum	Moisture (in methanol) maximum	Odor	Refractive index at 20 °C
Dibutyl	278.34	* 0.12	* Clear, oily liquid	* 20	* 0.15	* Slight, characteristic	1.4895 to 1.4915
Dicyclohexyl	330.41	* 0.12	* White lumps or granules	* 100 (molten)	* 0.1	* Moderate, aromatic; slight phthalic; characteristic	
Diethyl	222.11	* 0.12	* Clear, oily liquid	* 10	* 0.15	* Slight, aromatic, max	1.4990 to 1.5010
Didodecyl	486.85	* 0.12	* Clear, oily liquid	* 50	* 0.10	* Slight, characteristic	1.4794 to 1.4864
Dioctyl	390.53	* 0.12	* Clear, oily liquid	* 35	* 0.10	* Slight, characteristic, max	1.4810 to 1.4880
Dimethyl	194.18	* 0.12	* Clear, oily liquid	* 10	* 0.20	* Slight, aromatic, max	1.5123 to 1.5141
Di(n-octyl,n-decyl)	418 Avg	* 0.01	* Clear, oily liquid	* 50	* 0.10	* Slight, characteristic	* 1.4810 to 1.4840
Diolyl	390.53	* 0.12	* Clear, oily liquid	* 25	* 0.10	* Slight, characteristic, max	1.4845 to 1.4858
Diphenyl	318.31	* 1.20	* Essentially white, fused solid with a slightly yellow or brown cast	* 160 (20ml: 50ml acetone)	0.25		1.572 (at 74 °C)
Ditridecyl	530	* 0.12	* Clear liquid	* 100	* 0.1	* Characteristic	* 1.4813 to 1.4850
Santicizer 160	312.75	* 0.12	* Clear, oily liquid	* 40	* 0.15	* Slight, characteristic, max	* 1.495 to 1.540
Santicizer 165		* 0.12	* Clear, oily liquid	* 40	* 0.12	* Slight (similar to DOP)	* 1.484 to 1.487
Santicizer 212		* 0.25	* Clear, oily liquid	* 75	* 0.15	Characteristic, very low	* 1.521 to 1.524
Santicizer 214		* 0.15	* Clear, oily liquid	* 100	* 0.15	Characteristic, very low	* 1.481 to 1.486
Santicizer 215		* 0.12	* Clear, oily liquid	* 100	* 0.10	Characteristic	* 1.508 to 1.516
Santicizer 262	996.5	* 0.37	* Clear, oily liquid	* 100	* 0.15		* 1.519 to 1.523
Santicizer 278	471	* 0.20	* Clear, oily liquid	100	* 0.15	Slight, characteristic	* 1.5170 to 1.5203
Santicizer 607		* 0.18	* Clear, oily liquid	* 50	* 0.10	* Characteristic, mild	* 1.482 to 1.486
Santicizer 608		* 0.12	* Clear, oily liquid	* 100	* 0.10	Characteristic	* 1.4825 to 1.4895
Santicizer 630		* 0.12	* Clear, oily liquid	* 70	* 0.10		* 1.5095 to 1.5160
Santicizer 631		* 0.12	* Clear, oily liquid	* 40	* 0.10		* 1.4990 to 1.5045
Santicizer 632		* 0.12	* Clear, oily liquid	* 100	* 0.15		* 1.484 to 1.487
Santicizer 636		* 0.12	* Clear, oily liquid	* 75	* 0.10		* 1.478 to 1.488
Santicizer 681		* 0.20	* Clear, oily liquid	* 40	* 0.10		* 1.472 to 1.479
Santicizer 683		* 0.12	* Clear, oily liquid	* 40	* 0.10		* 1.488 to 1.489
Dinodecyl	446.0	* 0.50	* Clear, oily liquid	* 50	* 0.10	* Mild	1.4485 to 1.4525
Di(n-octyl,n-decyl)	398 (average)	* 0.35	* Clear, oily liquid	* 50	* 0.10	Characteristic	* 1.444 to 1.448
Dioctyl	370.56	* 0.25	* Clear, oily liquid	* 25	* 0.10	* Mild	1.444 to 1.448
Santicizer 140	340.7	* 0.20	* Clear, oily liquid	* 40	* 0.15	* Essentially odorless	1.550 to 1.570
Santicizer 141	362.40	* 0.20	* Clear, oily liquid	* 60	* 0.10	* Slight, sweet	1.507 to 1.510
Tricresyl	368.18	* 0.20	* Clear, oily liquid	* 75	* 0.15	* No foreign odor	1.556
Triphenyl	326.31	* 0.06	* White flakes	20 (molten)		* Very faint, aromatic, max	1.590 (at 60 °C)
Tributoxyethyl	266.37	* 1.0	* Clear, oily liquid	* 25	* 0.20	* Characteristic	* 1.427 to 1.434
Tributyl		* 0.61	* Clear, oily liquid	* 75	* 0.20	* Characteristic, mild	* 1.434 to 1.438
Santicizer E 15	280.27	* 0.17	* Clear, oily liquid	* 20	* 0.15	* Slight, max	1.496 to 1.500
Santicizer H 16	336.37	* 0.33	* Clear, oily liquid	* 45	* 0.15	* Slight, characteristic	* 1.488 to 1.492
Santicizer M 17	266.74	* 0.33	* Clear, oily liquid	* 20	* 0.15	* Slight, characteristic, max	1.504

MONS 080759

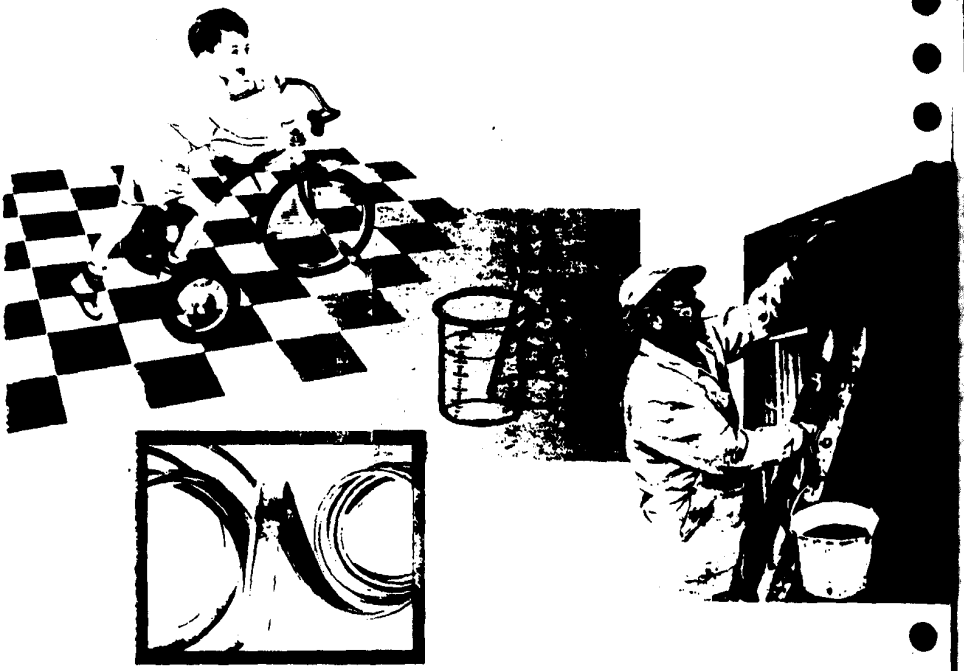
Specific Gravity (25°/25°C)	Density (at 25°C) (lb./gal.) (approx.)	Crystallizing Point (°C)	Pour Point (°C)	Boiling Point (at 760 mm. Hg) (°C)	Vapor Pressure mm. Hg at 150°C	at 200°C	at 300°C	at [illegible]	
* 1.044 to 1.048	8.72	< −35	−40	340.0	1	9	300	55.0	15
1.29	—	—	60	220 to 228 (4 mm. Hg)	0.09	1.1	—	—	
* 1.115 to 1.119	9.35	< −0.3	−40 (supercools readily)	298	8	50	—	31.0	9
* 0.963 to 0.969	8.05	−53 (stiff, clear gel)	−46	250 to 257 (4 mm. Hg)	0.015	0.35	—	642.0	1 91
* 0.980 to 0.985	8.21	−45	−46	228 to 237 (4 mm. Hg)	<0.05	1.0	—	322.0	55
* 1.188 to 1.192	9.92	0.0 (in −2°C bath)	−26 (supercools)	282	13	76	—	54.	11
* 0.9680 to 0.9770	8.1	−30	−35	232 to 267 (4 mm. Hg)	0.01	0.25	—	—	13
* 0.980 to 0.985	8.21	−55 (very stiff gel)	−47	386	0.06	1.2	—	148.0	58
1.28	—	—	—	405	0.15	1.7	55	—	
* 0.948 to 0.955	7.93	—	−37	285 (3.5 mm. Hg)	—	—	—	1500	1
* 1.115 to 1.123	9.3	< −35	−45	370	0.16	2	90	—	4
* 0.990 to 0.996	8.28	—	−51	—	0.14	1.8	—	250.0	4
* 1.040 to 1.045	8.68	—	−43	—	19.6	70.4	—	—	1
* 0.948 to 0.956	7.9	—	−43	—	15.0	53.1	—	—	2
* 0.974 to 0.980	8.14	—	−36	—	—	—	—	—	7
* 1.048 to 1.057	8.7	−27.8	−29	—	—	0.33	34	900	9
* 1.096 to 1.101		below −11	−6.5	—	—	0.20	80	above 1,000	8
0.971 to 0.977	8.1	—	−45	—	—	—	—	—	3
* 0.977 to 0.987	8.18	—	−51	—	—	—	—	400.0	6
* 0.987 to 0.994	8.25	—	−40	—	—	—	—	450.0	6
* 0.984 to 0.990	8.22	—	−45	—	—	—	—	250.0	5
* 0.976 to 0.982	8.15	—		—	—	—	—	—	
* 0.969 to 0.977	8.11	—		—	—	—	—	—	
* 0.963 to 0.970	8.05	—		—	—	—	—	—	
* 0.975 to 0.981	8.09	—		—	—	—	—	—	
* 0.962 to 0.973	7.65	< −50	−65	240 (4 mm. Hg)	0.02	0.58	—	—	1
* 0.914 to 0.922	7.63	−5	0	—	0.04	0.80	—	—	
* 0.921 to 0.927	7.72	< −70	−65	214 (5 mm. Hg)	<0.15	2.5	—	—	
* 1.203 to 1.213	10	< −35	−37	390	0.08	1	760 (390°C)	208.0	3
* 1.089 to 1.093	9.1	—	−54	375	0.095	1.3	—	61.0	16
* 1.157 to 1.173	9.7	< −35		420	—	0.5	29	1256.0	89
1.268 (60°/20°C)	10.5	49		370	0.15	1.9	—	—	7
* 0.973 to 0.978	8.14	< −80	< −80	137-145	7.3	>500	—	—	
* 1.017 to 1.023	8.50	< −70	< −70	215-228	<0.10	1.6	—	—	1
* 1.180 to 1.185	9.85	20 (supercools readily)		320	0.47	7	480	616.0	58
* 1.095 to 1.105	9.15	< −35	< −40	345	0.1	1.8	190	279.0	46
* 1.217 to 1.227	10.20	< −35	−26	310	0.5	8	600	1476.0	82

MONS 080760

* Specification

[illegible] at 25°C	at 98.9°C	Surface Tension at 20°C (dynes/cm)	Thermal Expansion Coefficient (at 10° to 40°C) (cc/cc/°C)	Flash Point (C.O.C.) (°F)	Fire Point (C.O.C.) (°F)	Assay (Ester Content) (%)	Sulfur (Copper strip test)	Solubility in water (at 25°C) (%)
15.6	2.4	35	0.00078	340	395	99 min.	—	0.001 (30°C)
—	—	36.4 (75°C ± 1°)	—	405	465		—	< 0.01
9.8	1.8	35.3 (20.5°C)	—	305	335	99 min.	Negative	0.1 (32°C)
91.0	5.6	29	0.00074	450	520	—	—	< 0.005
55.0	4.3	—	0.00073	430	480	99 min. to 101	Negative	< 0.01
11.4	1.6	32	0.00092 (0° to 30°C)	300	315	99 min.		0.4 (32°C)
138	34.0	31	0.00071	435	—	—	Negative	—
58.0	4.3	33 (25°C)	0.00074	425	480	99 to 101	Negative	< 0.005
—	—	—	—	435	—	—	—	< 0.01
160	8.0	—	—	450	—	—	—	—
41.5	—	39.9 (25°C)	0.00080	390	—	—	—	0.0003 (30°C)
45.0	3.9	—	—	390	—	—	Negative	< 0.005
17.0	—	33.6 (24°C)	—	315	335	—	—	Practically insoluble
29.6 (37.8°C)	4.5	31.0 (24°C)	0.00051	325	355	—	—	Practically insoluble
75	4.5	—	—	495	—	—	—	Practically insoluble
92	5.2	34.3 (25°C)	0.00059	420	515	—	—	—
860	11.7	34.8 (25°C)	0.00073	440	535	—	—	—
34.5 (37.8°C)	5.0	—	—	412	—	—	—	—
60.0	4.6	—	0.00076	395	—	—	—	—
61.0	4.3	—	0.00074	370	—	—	—	—
50.0	4.8	—	0.00074	385	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
14.5 (37.8°C)	3.6	30	0.00077	—	—	—		< 0.01
9.5 (37.8°C)	2.8	29	0.00076	401	480	—	Negative	< 0.01
8.2 (37.8°C)	2.4	29	0.00078	377	450	—	—	< 0.01
33.0	2.8	42	0.00067	450	none at 625	—	—	< 0.005
16.4	2.5	36.7 (23°C)	—	435	460	—	—	0.003
89.0	4.0	44.5	0.00067	470	695	—	—	< 0.002 9M/100 ml
7.8 (55°C)	2.9	—	—	437	—	—	—	0.001 (34°C)
3.8 (20°C)	—	29	0.00086	380	400	—	—	0.1
12.0 (20°C)	—	30	0.00081	435	485	—	—	0.11
58.0	2.9	—	—	386	—	—	Negative	0.0175 (30°C)
46.0	3.6	—	—	390	—	—	Negative	0.0012 (30°C)
82.0	2.8	43.6 (25°C)	—	380	—	—	Negative	0.09 (30°C)

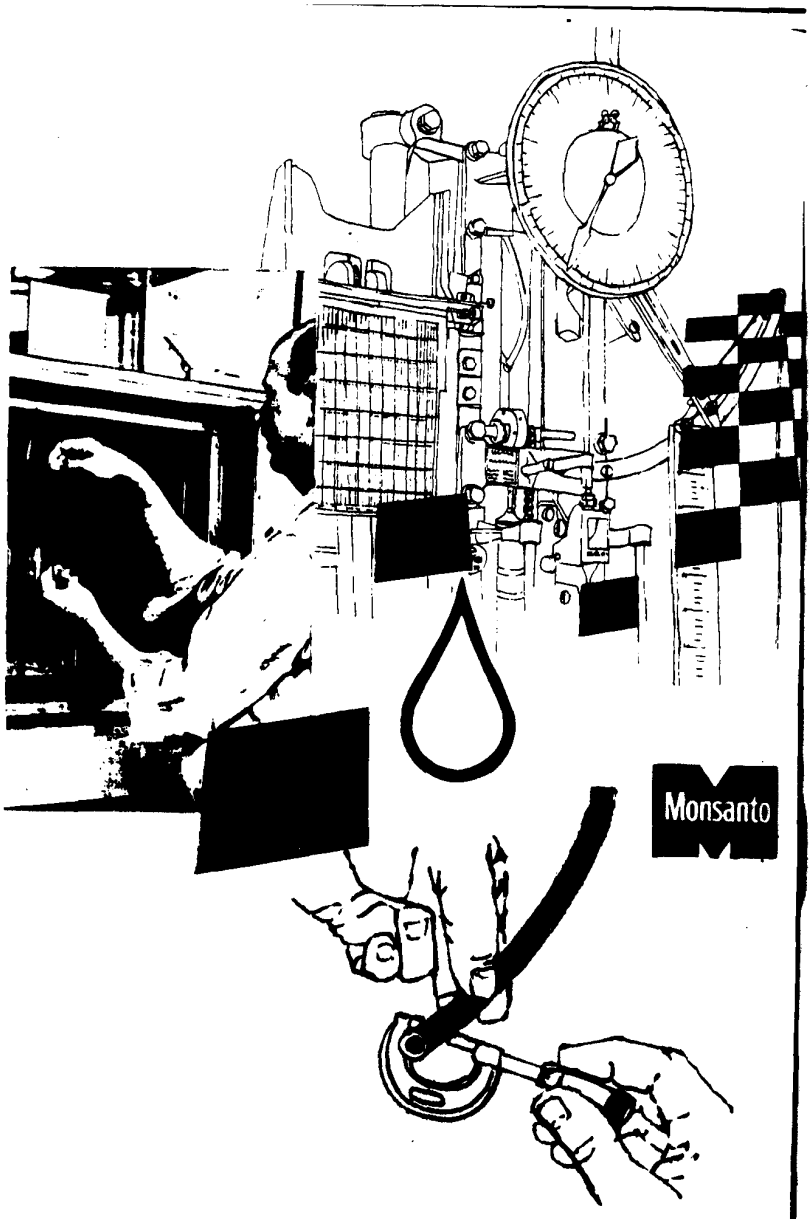
MONS 080761



There is a "BEST" plasticizer system for every formulation

Selection of a plasticizer or plasticizer combination blend is critical to the quality, the performance, and the cost of the finished product. But, in addition to end product performance, the processing characteristics of the compound may be vastly improved by selection of the optimum plasticizer system. Hidden costs, such as power consumption, heat requirements, milling time, curing speed can all be brought into a balance of maximum efficiency by proper choice of plasticizers.

MONS 080762

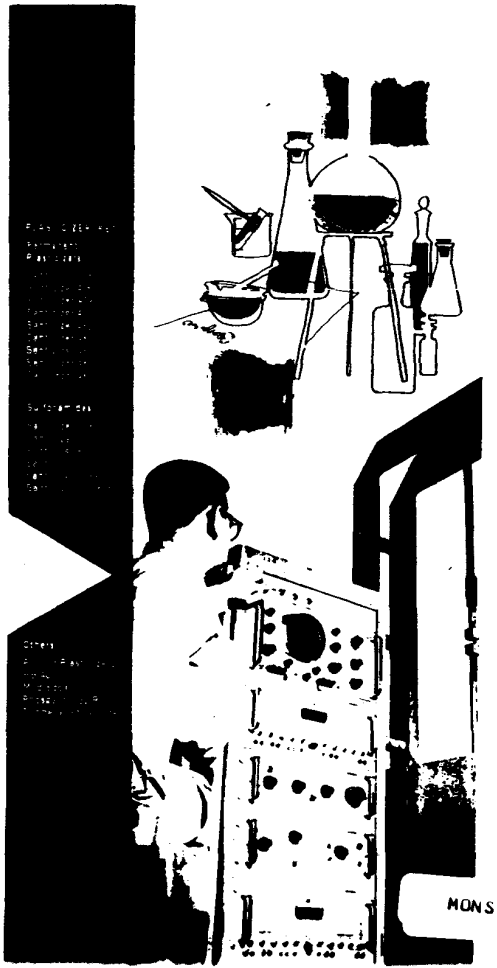


MONS 080763

	Molecular Weight	Acidity (max.) (30 gm maximum)	Appearance	Color (APHA) (max.maximum)	Moisture (KF in methanol) (% maximum)	Odor	Refractive Index at 25
Santicizer 405	—	* 1.0	* Clear, viscous liquid	* 250 (50ml.: 50ml.) 95% Ethanol	* 0.15	* Characteristic	1.476
Santicizer 406		* 1.0	* Clear, oily liquid	* 200 (50ml.: 50ml.) 95% Ethanol	* 0.15	* Very slight, characteristic	1.476
Santicizer 409	—	* 1.5	* Clear liquid	* 150 (50ml.: 50ml.) 95% Ethanol	* 0.15	Very faint, ester	1.4654
Santicizer 411	—	* 1.0	* Light yellow, viscous liquid some solids on standing	* 175 (50ml.: 50ml.) 95% Ethanol	* 0.15	* Slight, characteristic	1.4772
Santicizer 412	—	* 0.24	* Clear, oily liquid	* 150	* 0.15	Characteristic	1.508 to 1.510
Santicizer 430	—	* 0.60	* Clear, oily liquid	* 200	* 0.15	Slight, characteristic	1.4943
Santicizer 431	—	* 0.85	* Clear, oily liquid	* 300	* 0.15	Slight, characteristic	1.4795
Santicizer 432	—	* 1.1	Clear oily liquid	* 325	* 0.15	Slight, characteristic	1.4751
Santicizer 433	—	* 0.24	* Clear, oily liquid	* 125	* 0.15	Slight, characteristic	* 1.5015 to 1.5050
Santicizer 1-H	253.36	—	* Yellow-brown fused mass	* 300 (molten)	* 0.15	—	—
Santicizer 3	199.23	* 1.60	* Practically white solid	* 60 (molten)	* 0.25	—	1.512 to 1.537 (65°C)
Santicizer 8	199.22	* 0.80	* Light-yellow, viscous liquid	* 200 (molten)	—	* Slight, characteristic	1.540
Santicizer 9	171.1	pH 4.0 (min.)	* Fine, white to light cream granular particles	* 85 (33-1/3 wt. % in acetone)	* 1.0	Essentially none	
Santolite MHP	—	1.0 (mg KOH/g)	* Hard, practically colorless resin	* 50 (25g:75g butyl acetate)	—	Faint formaldehyde	1.4275 to 1.4325 (25g:75g butyl acetate)
Santolite MS 80%	—	—	* Light-colored, viscous liquid. Free flowing above 20°C	* 80 (25g:35g butyl acetate)	—	—	—
Aroclor 1221	—	* .014 (mg KOH/g)	Clear, mobile oil	* 100	—	—	1.617 to 1.618 (20°C)
Aroclor 1232	—	* .014 (mg KOH/g)	Clear, mobile oil	* 100			1.620 to 1.622 (20°C)
Aroclor 1242	—	* .015 (mg KOH/g)	* Clear, mobile oil	* 100	* 50 (ppm max.)		1.627 to 1.629 (20°C)
Aroclor 1248	—	* .018 (mg KOH/g)	* Clear, mobile oil	* 100	* 50 (ppm max.)		1.630 to 1.641 (20°C)
Aroclor 1254	—	* 0.10 (mg KOH/g)	Light yellow viscous liquid	* 100	* 50 (ppm max.)		1.639 to 1.641 (20°C)
Aroclor 1260	—	* 0.14 (mg KOH/g)	* Light yellow, soft, sticky resin	* 150	* 50 (ppm max.)		1.647 to 1.649 (20°C)
Aroclor 1267	—	* .014 (mg KOH/g)	* Light-yellow, sticky, viscous resin	* 150	—		1.6501 to 1.6517 (20°C)
Aroclor 1268	—	* .05 (mg KOH/g)	* White to off-white powder	* 1.5 NPA (molten)	—		
Aroclor 4465	—	0.5 (mg KOH/g)	* Clear, light-yellow resin	2 NPA max. (molten)	—		1.664 to 1.667 (20°C)
Aroclor 5442	—	* .05 (mg KOH/g)	* Clear, yellow, sticky resin	* 2 NPA max. (molten)	—	—	
Aroclor 5460	—	.05 (mg KOH/g)	* Clear, yellow-to amber brittle resin or flakes	* 2 NPA max. (molten)	—	—	1.660 to 1.665 (20°C)
HB-40	—	—	Clear, oily liquid	* 100	* 125 ppm	Faint characteristic	1.5600 to 1.5750
Mod Lpor	—	* 0.08 (mg KOH/g)	* Oily liquid or light yellow solid	* 50	—	—	* 1.587 to 1.590
Phosgard C 22-R	610.5	* 5.0	* Clear, viscous liquid	* 50	—	Essentially none	* 1.492 to 1.494
Triphenyl Phosphate	340.28	* 0.8 (mg. KOH/g)	* Oily liquid or light-yellow solid	* 50	—	—	* 1.5875 to 1.5900

MONS 080764





Summary of Specifications and Typical Properties

For your convenience the following chart lists Monsanto's Permanent, Sulfonamide, and Miscellaneous plasticizers. If a specific property is ideally suited for a specific application simply find the optimum value of that property in the vertical column, the name of the plasticizer offering this value may be read from the left hand listing.



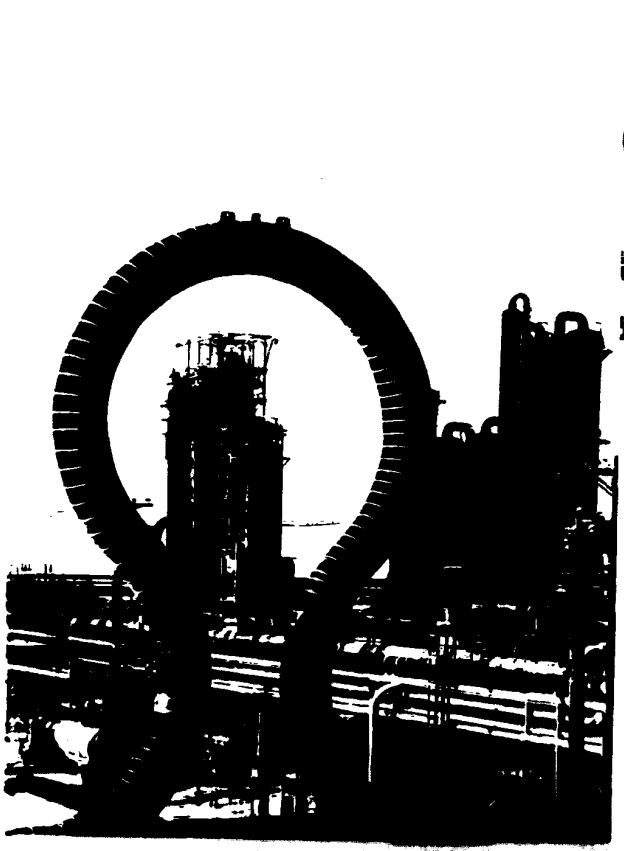
Monsanto

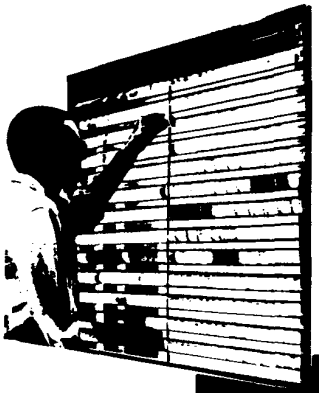
MONS 080765

* Specification

* 1.128 to 1.132	9.41	—	1 1	—	—	—	—	—	10000 to 13000	—	—	—	595	—	—	—	—	Practically insoluble
* 1.089 to 1.091	9.08	—	3 16	—	—	—	—	—	6000 to 9500	—	—	—	535	—	—	—	—	Practically insoluble
* 1.088 to 1.084	9.01	—	4	—	—	—	—	—	2900 to 3500	—	—	0.00071	530	570	—	—	—	Practically insoluble
* 1.104 to 1.110	9.20	—	4 21 1	—	—	—	—	—	9000 to 9900	—	—	—	540	—	—	—	—	Practically insoluble
* 1.077 to 1.077	8.95	—	28	—	—	—	—	—	291	—	—	—	—	—	—	—	—	Practically insoluble
* 1.039 to 1.046	8.72	—	1	—	—	—	—	—	586	—	—	—	475	535	—	—	—	Practically insoluble
* 1.072 to 1.078	8.96	—	28	—	—	—	—	—	3878	—	—	—	485	535	—	—	—	Practically insoluble
* 1.097 to 1.103	9.16	—	18	—	—	—	—	—	6422	—	—	—	525	580	—	—	—	Practically insoluble
* 1.045 to 1.052	8.74	—	31	—	—	—	—	—	156	—	—	—	485	525	—	—	—	Practically insoluble
1.125	—	(in vacuum jacket) * 82.5 mm	—	350	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00095 (20°C)
1.166 to 1.176 (65° / 65°C)	—	* 58.0 mm	398	—	0.8 (100°C)	—	—	—	—	—	—	—	371	—	—	—	—	Slight
1.190	9.92	< 40	—	340	0.95	5.5	—	10,000	350 0	6.0	44.5 (25°C)	—	345	—	—	—	—	0.13 (23°C)
1.353 (solid)	—	105	—	360 (approx.)	0.25	3.2	—	—	—	—	—	—	420	—	—	—	—	1 (20°C)
1.35	—	62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Practically insoluble
1.256	10.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Nil
1.182 to 1.192	9.85	—	Crystals 68 / °C (ASTM D-97)	275 to 320	—	—	—	* 38 to 41 SUS (37.8°C)	35 to 37 SUS (54.4°C)	30 to 31 SUS	—	0.00071 (15.48°C)	286 to 302	349	—	—	—	Practically insoluble
1.279 to 1.280	10.55	—	- 35 (ASTM D-97)	290 to 325	—	—	—	* 44 to 51 SUS (37.8°C)	39 to 41 SUS (54.4°C)	31 to 32 SUS	—	0.00073 (25-100°C)	305 to 310	460	—	—	—	Practically insoluble
* 1.281 to 1.292 (25° / 15.5°C)	11.50	—	- 19 (ASTM D-97)	325 to 366	—	—	—	82 to 92 SUS (37.8°C)	49 to 56 SUS (54.4°C)	36 to 36 SUS	—	0.00068 (25-65°C)	348 to 356	None to boiling point	—	—	—	Practically insoluble
* 1.405 to 1.415 (65° / 15.5°C)	12.04	—	- 7 (ASTM D-97)	360 to 375	—	—	—	185 to 240 SUS (37.8°C)	73 to 80 SUS (54.4°C)	36 to 37 SUS	—	0.00070 (25-65°C)	379 to 384	None to boiling point	—	—	—	Practically insoluble
* 1.495 to 1.505 (65° / 15.5°C)	12.82	—	10 (ASTM D-97)	365 to 390	—	—	—	1800 to 2500 SUS (37.8°C)	260 to 340 SUS (54.4°C)	44 to 48 SUS	—	0.00065 (25-65°C)	None to boiling point	None to boiling point	—	—	—	Practically insoluble
* 1.555 to 1.566 (90° / 15.5°C)	13.50	—	31 (ASTM D-97)	385 to 420	—	—	—	—	3200 to 4500 SUS (54.4°C)	* 72 to 78 SUS	—	0.00062 (25-100°C)	* None to boiling point	None to boiling point	—	—	—	Practically insoluble
1.572 to 1.583 (90° / 15.5°C)	13.72	—	35 to 38	390 to 425	—	—	—	—	600 to 850 SUS (71.0°C)	* 86 to 108 SUS	—	0.00064 (25-65°C)	None to boiling point	None to boiling point	—	—	—	Practically insoluble
1.807	15.09	—	—	435 to 450	—	—	—	—	—	—	—	0.00062 (20-100°C)	None to boiling point	None to boiling point	—	—	—	Practically insoluble
1.670	13.91	—	—	230 to 320 (4 mm Hg)	—	—	—	—	—	90 to 150 SUS (38°C)	—	0.00061 (25-65°C)	None to boiling point	None to boiling point	—	—	—	Practically insoluble
1.670	13.91	—	—	215 to 300 (4 mm Hg)	—	—	—	—	—	300 to 400 SUS	—	0.00123 (25-99°C)	477	> 662	—	—	—	Practically insoluble
1.670	13.91	—	—	280 to 335 (5 mm Hg)	—	—	—	—	—	—	—	0.00179 (25-125°C)	None to boiling point	None to boiling point	—	—	—	Practically insoluble
1.081 to 1.087 (25° / 15.5°C)	8.37	—	26	305 to 396	2	15 (20°C)	230	70 0	29.0 (37.8°C)	3.8	40.1 (25°C)	—	395	385	—	—	—	—
1.176 to 1.182 (38° / 15.5°C)	9.83	25	—	360	—	11 (220°C)	—	—	—	—	—	—	375	525	—	—	—	Hygroscopic
1.425 to 1.445	11.9	None glass	5	Not Distillable	—	—	—	—	—	* 60 to 68	—	—	No self supporting combustion		—	—	—	Nil
1.176 to 1.182 (38° 15.5°C)	9.83	25	—	360	—	11 (220°C)	—	—	17.5	—	—	—	375	525	—	—	—	Hygroscopic

MONS 080766











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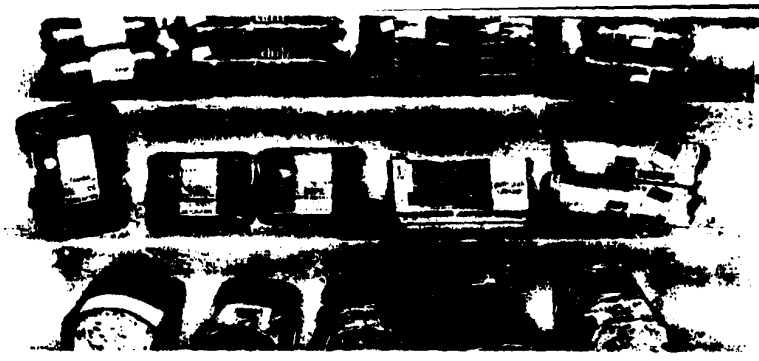


FDA REGULATED PLASTICIZERS

FDA regulated plasticizers have become increasingly important since March 6, 1960, the effective date of the 1958 Food Additives Amendment to the Federal Food, Drug and Cosmetics Act.

Monsanto offers more plasticizers regulated by the FDA than any other supplier. The following Monsanto plasticizers conform to the requirements of the 1958 Amendment and have been governed for uses relating to food packaging, handling, and fo rarticles in intimate contact with the human body.

Chemical Name	Monsanto Trademark
Di (2-ethylhexyl) Phthalate (Dioctyl Phthalate)*	——
Diisooctyl Phthalate*	——
Diethyl Phthalate	——
Di (2-ethylhexyl) Adipate (Dioctyl Adipate)	——
Diphenyl 2-ethylhexyl Phosphate	Santicizer 141
Ethyl Phthalyl Ethyl Glycolate	Santicizer E-15
Butyl Phthalyl Butyl Glycolate	Santicizer B-16
Butyl Benzyl Phthalate	Santicizer 160

*Approved for use in contact with foods of high water content only.

Performance Benefits of Monsanto's FDA Regulated Plasticizers

SANTICIZER 141

For improved processing through outstanding resin solvation. Imparts flame resistance, low temperature flexibility, added light stability, abrasion resistance, and resistance to extraction by oils and greases. Very low odor, low volatility.

SANTICIZER E-15

For excellence in plastic films. Active solvent for nitrocellulose, cellulose acetate, polyvinyl acetate and especially suited for polyvinylidene chloride. Gives clear, tough, flexible films with excellent water resistance. Light-fast, relatively nonvolatile. Widely used in nontoxic polyvinyl acetate adhesives.

SANTICIZER B-16

For plastic films for packaging all types of food, including those with high fat content. Lowest taste of any approved plasticizer. Useful for beverage tubing, food packaging and paper lacquers. Good heat and light stability with excellent general properties.

DIETHYL PHTHALATE

To improve low temperature coalescense and impart quick tack in polyvinyl acetate adhesives and coatings. Fast fusing and efficient. Industry standard for cellulose acetate applications.

DIOCTYL ADIPATE

For superior low-temperature flexibility and hand, low volatility, and excellent light stability.

DIOCTYL PHTHALATE–DIISOOCTYL PHTHALATE

For permanency, low-temperature flexibility, excellent electrical properties, good heat and light stability, and the general property balance that have made them the standard plasticizers for polyvinyl chloride and other resins. Monsanto's high specification standards guarantee a very high purity, low odor and minimum taste.

SANTICIZER 160

Santicizer 160 is regulated for use in food packaging film that may be in contact with red meat. It may be used as the sole plasticizer up to 16.7% based upon the total weight of the plasticizer article. In high water content packaging films, Santicizer 160 may be used up to 67 phr.



with DOP | with DOA | with SANTICIZER 141

FLAME-RETARDANT MODIFIERS

Fire retardant plastics materials are growing in favor in many end uses. Recent Underwriters Laboratories' rulings on air conditioners, the California fire laws on plastics film, and the specifications of end-product users mark a trend toward greater safety consciousness. This awareness for possible dangers will increasingly put a limit upon the flammability of materials of manufacture, construction, and decoration.

Monsanto supplies a variety of plasticizers which provide molecular structures with tightly linked chlorine and phosphorus, to impart fire resistance to compositions containing them. These plasticizers represent a range of properties, in addition to the imparting of fire resistance, that make them efficient plasticizers for a variety of resins for uses in a large number of diverse applications. These plasticizers offer a choice of price and compatibilities; many offer outstanding chemical resistance, extraction resistance, and good permanence. By selecting a one, two, or three component plasticizer system based on these products, the formulator can develop fire-resistant compositions using a number of resins, offer a variety of end product characteristics, in a range of costs.

The following are liquid and solid fire-retardant modifiers:

TRICRESYL PHOSPHATE

Tricresyl phosphate is a standard flame retarding liquid plasticizer for polyvinyl chloride, cellulose (excepting acetate), and synthetic rubber. It has low volatility and offers good permanence; it is especially recommended for electrical insulation applications. It is also compatible with phenolics, imparts a degree of flexibility to phenolic electrical laminates.

TRIPHENYL PHOSPHATE

Triphenyl phosphate is a solid plasticizer, particularly suited for producing flame retardant cellulosic compositions and coatings. It may also be used with synthetic rubber and with a variety of vinyl resins in conjunction with a solvating type plasticizer.

SANTICIZER 140

Santicizer 140 is a phosphate type liquid plasticizer. It makes an excellent general purpose plasticizer as well as a means of making flame resistant products. On a pound for pound basis it is more efficient than tricresyl phosphate in vinyl resins and imparts a superior flexibility.

SANTICIZER 141

Santicizer 141 is a liquid, phosphate-type general purpose plasticizer which is non-toxic. It imparts good low temperature flexibility, has low odor and improves the processing characteristics of most formulations because of its excellent resin solvating power.

AROCLOR PLASTICIZERS

The Aroclor polychlorinated biphenyls and terphenyls are particularly effective in reducing flameout time and the glow termed "punking." The Aroclor compounds are compatible in varying degrees with vinyls, cellulosics, rubbers, polyethylene, and epoxies.

MONTAR PLASTICIZERS

These polychlorinated polyphenyls are similar to Aroclors except for their dark color and lower cost. Although slightly compatible with vinyls (for use as low-cost, extender plasticizers where color can be tolerated), they are especially effective in asphalt, to which they impart instant flameout when present in concentrations of 25 to 30 per cent.

PHOSGARD C-22-R

Phosgard C-22-R is a flame-retardant organophosphorus polymer for urethane foams, polymethylmethacrylate, phenolics, polyester resins and epoxies with optimum performance properties: high efficiency through high phosphorus and chlorine content, essentially non-volatile for lasting flame-retardant service life, excellent color stability on UV and heat exposure, easy formulating and non-complicated handling, long storage stability ("per se" or in formulation), and good hydrolytic stability.

SOLID PLASTICIZERS

Solid plasticizers perform unusual functions in adhesives, coatings and lacquers, foams, rigid compositions and films. Many times solid plasticizers are overlooked in solving processing problems or in obtaining unique product properties. A solid plasticizer often transforms a deficient product into a completely different, high performance product.

HOT PROCESSING

Solid plasticizers offer processing advantages in hot processing applications. For example, in Banbury mixing, a solid plasticizer will melt at or below the processing temperature and function as a solvating or fluxing liquid; the lowered viscosity of the Banbury charge improves the flow resulting in faster and easier processing. Upon cooling, the plasticizer returns to a solid form producing a rigid or semi-rigid film or molded product. The solid plasticizer thus reduces processing costs as well as imparting unique properties to the finished product.

SOLVENT PROCESSING

Certain solid plasticizers enable successful formulation of higher solids content in lacquers. This means fewer coats to build a surface and, therefore, reduced application costs. As the lacquer dries, the presence of the solid plasticizer helps reduce blushing, sweating and separation.

Description of Monsanto Solid Plasticizers

Plasticizer	Description	Melting Point or Softening Range (°C)	
		Melting Point	Softening Range
Aroclor 5442	clear, yellow resin		46 to 52
Triphenyl Phosphate	white flakes	48.5	
Montar 1	black resin		54 to 160
Santicizer 3	practically white solid	58	
Aroclor 4465	clear, yellow resin		60 to 66
Santolite MHP	hard, colorless resin	62	
Dicyclohexyl Phthalate	white solid	63	
Diphenyl Phthalate	white solid	69	
Montar 2	black resin		70 to 170
Santicizer 1-H	yellow mass	82.5	
Montar 3	black solid		86 to 168
Montar 4	brown solid		92 to 206
Aroclor 5460	yellow-to-amber resin		98 to 105
Santicizer 9	white particles	105	
Montar 9	brown solid		130 to 175
Aroclor 1268	white flakes		150 to 170
Montar 5	brown solid		155 to 195

VERSATILITY IN APPLICATION

FOR ADHESIVES . . . unusual properties

Delayed-tack and heat-seal adhesives owe their existence to solid plasticizers, because it is the solid plasticizer that makes delayed-tack and heat sealing possible. Delayed-tack adhesives are activated by heat, and once activated, remain tacky long enough to permit handling before the adhesive cools and sets. The sharp melting point of solid plasticizers provides a sharp activation point for the adhesive. This activation temperature varies with different solid plasticizers, and special adhesives can be easily formulated to fit handling methods by selecting the proper solid plasticizer. Delayed-tack adhesives are covered by several U.S. Patents.

FOR FILMS . . . no blocking

Solid plasticizers can be used with other primary plasticizers to produce tough, clear films that feel dry and separate easily. Liquid plasticizers used alone often cause blocking due to a slight surface tackiness. Solid plasticizers also add resilience to films and impart exceptional resistance to extraction by kerosene, oils and grease.

FOR RIGID PRODUCTS . . . easier processing

Processing of rigid vinyl products can be made easier by using solid plasticizers . . . without changing present equipment or methods. With heating, the solid melts and acts as a solvating liquid plasticizer for the resin. Upon cooling, the article becomes rigid because the plasticizing effect of the solid plasticizer is slight at room temperature. Used strictly as a processing aid, the solid plasticizer pays its own way by lowering processing costs.

FOR HEAT-SEAL COATINGS . . . sharp activation temperature

Like adhesives, heat-seal coatings require the sharp melting points of solid plasticizers to give them the heat-seal property. By themselves, liquid plasticizers cannot endow coatings with a sharp activation temperature. Instead, the coatings tend to block and be tacky at temperatures beneath the activation temperature. In this type of coating, solid plasticizers can be chosen to provide an exact temperature at which the heat-seal property is activated. And beneath that critical temperature, the coating does not block or have tackiness.

FOR RIGID FOAMS . . . toughness

In the chemically-blown foams, solid plasticizers can be used to add toughness to the finished foam.

In the plastisol foam process, solid plasticizers thicken the starting formulation to make possible more uniform cell formation as the gas is released. A uniform cellular structure makes the foam tough and provides uniform dimensional stability.

In chemically-blown vinyl foams made by milling or Banburying, the solid plasticizer acts as a liquid solvating plasticizer at the process temperature to make possible easy processing. At room temperature, the solid plasticizer's inefficiency results in a higher compression-resistant foam.

FOR IMPREGNANTS . . . better flow

To get even dispersement of impregnating powders, solid plasticizers can be used as a flow aid for producing brake band linings. The flow aid property is also useful in certain types of adhesives, phenolic moldings, thermosetting ureas, and melamine coatings.

MONS 080774

APPLICATION RECOMMENDATIONS

Heat-sealing coatings
Dicyclohexyl phthalate (DCHP), Diphenyl phthalate, Santolite* MHP, Santicizer* 1-H, Santicizer 9

Rigid extrusions
Diphenyl phthalate, Aroclor* 5460, Triphenyl phosphate
Santicizer 1-H, DCHP

Moldings and rigid foams
Triphenyl phosphate, Diphenyl phthalate, Aroclor 5460 and 1268, DCHP

Break-away "glass"
Santolite MHP

Phenolic brake linings
Santicizer 9, Aroclor 1268

Surface coatings and composition wallboard

Cellulose acetate	Triphenyl phosphate
Nitrocellulose	DCHP, Diphenyl phthalate, Santolite MHP, Aroclor 5460
Melamine	Santicizer 9
Thermosetting resins	Santicizer 9, Santicizer 1-H, Triphenyl phosphate, Aroclor 5460 and 1268

Urea molding compounds
Santicizer 9

Melamine molding compounds
Santicizer 9

Fire-resistant cellulose acetate
Triphenyl phosphate

Crystallizing lacquers
Santicizer 1-H

Polyamides
Santicizer 9, Santicizer 1-H

Vinyl and other hot melts
Triphenyl phosphate, DCHP, Diphenyl phthalate, Aroclor 5460 and 1268, Montar* 4, 5, and 9

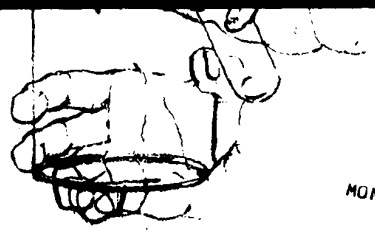
Delayed-tack adhesives
Diphenyl phthalate, Santicizer 1-H
DCHP

Book-binding adhesives
Triphenyl phosphate, DCHP, Diphenyl phthalate, Aroclor 5460 and 1268, Santolite MHP, Santicizer 1-H

*Registered U.S. Pat. Off., Monsanto Company

Guide to . . .

Plasticizer-Resin Compatibility	1
Plasticizer Performance In:	
Protective Coatings	2
Molding, Extrusions	3
Film and Sheeting	4
Adhesives	5
Plasticizer Evaluation:	
Polyvinyl Chloride Resin	6,a, b, c
PVC Plastisols	7
Other Resins	
Ethyl Cellulose	8
Nitrocellulose	8a
Cellulose Acetate	8a
Cellulose Acetate-Butyrate	8b
Epoxy Resins	8c
Polyvinyl Acetate-Emulsion Adhesives	8d



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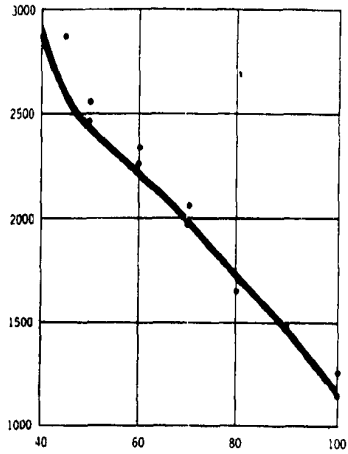
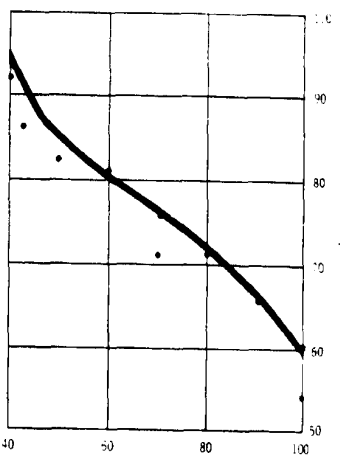
EFFECT OF DIOCTYL PHTHALATE CONCENTRATION

With filler
Without filler

. . . ON TENSILE STRENGTH

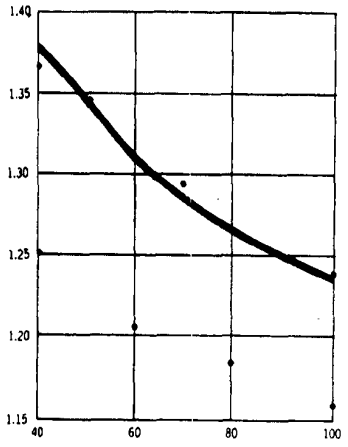


. . . ON HARDNESS in PVC

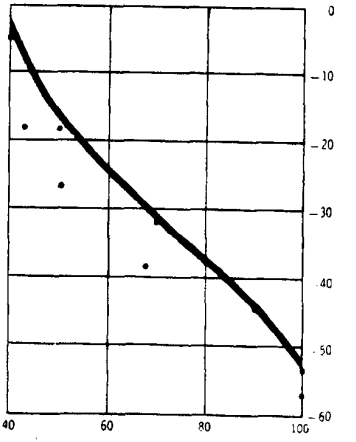


Dioctyl Phthalate Concentration, phr

. . . ON SPECIFIC GRAVITY



. . . ON LOW-TEMPERATURE FLEXIBILITY



Dioctyl Phthalate Concentration, phr

Formulations: Opalon 650, 100 parts; Calcium Carbonate, 25; Stabilizer, ½ phr

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PLASTICIZER-RESIN COMPATIBILITY GUIDE

The following table shows a close approximation of the upper limit of compatibility of each of Monsanto's plasticizers with a particular type of resin.

PHTHALATES

VINYL TYPE	Polyvinyl Chloride	100	30	I	100	100	I	100	100	80	100	100	100	100	100	100	100	100
	Polyvinyl Acetate	100	50	100	I	I	100	I	I	70	I	100	I	10	I	I	40	75
	Polyvinyl Butyral	100	50	50	25	15	50	15	15	50	25	100	10	50	20	30	20	75
	Polyvinylidene Chloride	75	20	75	10	25	50	25	25	20	10	75	50	25	10	15	25	50
	Polystyrene	100	20	100	100	100	100	100	50	70	100	100	100	75	75	100	50	75
CELLULOSIC	Nitrocellulose	100	50	100	100	100	60	100	100	80	100	100	100	40	40	40	100	100
	Ethyl Cellulose	100	50	100	100	100	100	100	100	30	100	100	100	75	75	100	100	75
	Cellulose Acetate	25	I	85	I	I	80	I	I	I	I	10	I	I	I	I	I	I
	Cellulose Acetate Butyrate	100	20	100	30	50	100	50	50	20	50	100	50	40	20	40	50	75
	Cellulose Acetate Propionate	30	10	100	15	20	100	20	20	10	15	80	50	20	5	1	25	50
MISCELLANEOUS THERMOPLASTIC	Chlorinated Rubber	100	20	25	100	100	25	50	33	20	100	80	100	25	25	100	30	50
	High Styrene-Butadiene	50	20	25	50	50	20	50	50	20	50	50	50	40	40	40	50	30
	Protein Compounds	20	I	20	I	I	20	I	I	I	I	10	I	I	I	I	I	I
	Shellac	I	I	5	I	I	5	I	I	I	I	I	I	I	I	I	I	I
	Acrylic Type Resins	70	25	100	25	25	100	25	25	25	25	70	25	15	1	20	70	50
	Polyamides	25	10	I	20	25	I	25	25	10	20	25	25	I	I	5	20	10
THERMOSETTING	Polyester	20	20	10	15	20	5	20	20	20	15	20	20	5	5	5	15	10
	Epoxy	25	10	10	I	I	I	I	I	10	I	25	10	I	I	I	15	15
	Phenolic	50	25	25	25	25	25	25	25	30	25	50	50	25	25	25	25	30
	Alkyd	70	25	25	25	25	25	25	25	25	25	50	50	25	25	20	25	30
	Melamine	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Polyurethane	25	10	15	25	25	15	25	25	10	25	25	25	20	20	20	25	15
	Nitrile & Neoprene Rubbers	100	50	100	33	100	100	100	50	50	33	100	50	50	50	40	70	60

MONS 080779

Plasticizer-Resin Compatibility Guide

ADIPATES | PHOSPHATES | SULFONAMIDES

100	100	100	100	100	100	90	100	50	75	75	100	100	60	100	20	1	1	1	1	15	15	25	1
1	1	1	1	1	1	1	1	1	1	1	40	50	40	40	80	50	50	100	50	50	50	100	1
25	25	25	25	20	25	5	20	1	25	1	100	100	50	100	50	50	50	100	50	50	50	100	1
15	20	25	25	10	25	20	10	10	15	15	75	75	50	75	20	20	25	50	20	25	25	75	
100	100	100	100	75	100	60	75	25	100	20	15	50	100	15	20	10	10	20	10	10	10	30	
100	100	50	60	40	100	70	40	35	35	35	100	100	100	100	75	75	80	80	50	100	100	100	1
100	100	100	100	75	100	80	75	100	100	50	70	100	50	70	30	80	60	60	75	75	75	75	
1	1	1	1	1	1	1	1	1	1	1	35	20	10	15	35	20	45	90	30	25	25	100	1
50	40	25	30	20	50	35	20	50	25	25	30	80	25	30	50	40	40	50	25	50	50	100	5
20	40	5	10	5	20	5	5	1	1	1	40	100	40	40	50	50	50	100	50	50	50	100	5
100	50	100	100	25	100	100	25	100	100	100	100	100	100	100	50	25	25	50	25	50	50	80	1
50	50	40	40	40	50	35	40	20	20	20	50	50	50	50	20	25	25	25	25	25	25	50	5
1	1	1	1	1	1	1	1	1	1	1	20	25	10	30	10	30	30	50	40	25	25	25	4
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25	25	40	60	25	25	10	1
25	25	10	10	1	25	1	1	1	1	1	25	100	25	25	25	25	25	25	25	25	25	50	1
20	20	1	1	1	20	25	1	25	25	25	25	25	15	25	10	50	50	50	25	50	50	1	2
10	15	5	5	5	10	5	5	1	1	1	20	20	20	20	10	5	5	10	5	20	20	5	
1	10	1	1	1	1	1	1	1	1	1	25	25	25	25	10	20	20	50	50	25	25	25	
25	25	25	25	25	25	25	25	25	25	25	50	50	50	50	50	50	50	50	50	50	50	50	
25	25	25	25	25	25	25	25	25	50	25	70	70	50	70	50	40	30	25	25	25	25	70	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25	25	50	80	25	25	1	
25	25	20	20	20	25	20	20	15	15	15	25	25	25	25	10	10	10	20	10	25	25	25	
50	50	50	50	50	50	65	50	33	20	33	33	40	50	55	50	50	50	50	50	50	50	50	

YI ATI S	PERMANENT									MISCELLANEOUS				
20	100	100	100	100	100	100	100	100	100	35	40	10	10	10
100	75	80	100	75	1	20	50	100	1	50	1	1	10	1
100	40	40	75	40	15	30	30	50	15	50	50	1	10	1
75	10	10	25	10	25	10	10	15	25	50	20	1	10	1
30	1	1	50	1	50	40	20	1	50	100	100	1	10	1
100	100	100	100	100	100	100	100	100	100	100	10	1	10	1
75	10	10	33	10	100	50	75	25	100	75	100	5	15	5
100	1	1	1	1	1	1	1	1	1	1	1	1	1	1
100	100	100	100	100	50	70	80	80	50	50	30	5	10	5
100	50	50	10	50	20	40	40	50	20	10	1	1	1	1
100	50	50	50	50	50	70	50	50	50	100	100	5	10	5
50	15	15	25	10	33	30	20	20	40	50	25	1	20	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1
60	1	1	1	1	70	10	10	10	50	10	20	1	1	1
1	1	1	1	1	25	20	15	1	25	25	1	1	10	1
5	5	5	10	5	20	15	20	10	20	25	1	5	10	1
25	1	1	1	1	1	1	1	1	1	50	1	100	25	100
50	15	15	25	15	25	25	15	15	25	25	25	25	25	25
70	20	20	25	20	25	20	25	20	25	25	15	5	25	0.5
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	10	10	15	10	25	25	15	10	25	25	15	1	10	1
50	25	25	50	25	50	25	25	30	50	50	50	25	50	25



Both monomeric and polymeric plasticizers that contain unsaturation often become incompatible because of chemical instability. Epoxy stabilizers accelerate this exudation so that tack and dirt pick-up are frequently observed in a month or two. Completely saturated polymeric plasticizers, such as Santicizer 409, remain tack free upon exposure to North indirect daylight for more than one year.



Absence of exudation under conditions of high humidity is important in many vinyl applications. Plasticizers with good humidity compatibility do not exude from film specimens in 18 weeks' exposure at 60°C and 100-per cent relative humidity.



Potential plasticizers are quickly screened for compatibility with polyvinyl chloride by compressing loops of plasticized vinyl specimens for one week at 23°C and 50 per cent relative humidity. The amount of plasticizer squeezed out, if any, is determined by wiping the inside of the fold with cigarette paper.

MONS 080782



guide to plasticizer performance

in PROTECTIVE COATINGS

for metal, wood, fabric, paper



MONS 080783

● *lift flap for chart*

The following table will assist formulators of coatings to select plasticizers for formulation evaluation on the basis of those properties most critical in the finished coating. The plasticizers shown provide the optimum effect for each designated property when used with the resin shown. When the same plasticizer appears under two or more of the properties desired in the finished coating — that plasticizer definitely merits evaluation.

Refer to Section IIIIpage 51 for complete information on Modaflow®, a unique Monsanto resin modifier for practically all organic surface coating systems.

By modifying surface tension, Modaflow eliminates foaming and air entrapment; improves flow and substrate wetting; results in faster, more uniform curing or drying; better spreading; improved adhesion to substrates; and better re-coating characteristics.

PLASTICIZER PERFORMANCE IN PROTECTIVE COATINGS *(continued)*

RESIN	PERFORMANCE			
	TENSILE STRENGTH	ELONGATION	ADHESION	
Cellulose Nitrate	Triphenyl Phosphate Santicizer 1-H Santicizer 160 Santicizer 262 Santolite MHP Diphenyl Phthalate	Santicizer 8 Santicizer 160 Santicizer 262 Tricresyl Phosphate Santicizer 165	Aroclor Santolite MHP Santicizer 8 Santicizer B-16	D D S S
Cellulose Acetate	Santicizer 1-H Santicizer 8 Santicizer M-17 Santolite MHP	Santicizer 8 Diethyl Phthalate Santicizer E-15	Santicizer 8 Santicizer M-17 Santolite MHP Santolite MS-80%	D S S
Cellulose Acetate-Butyrate	Santicizer 1-H Santicizer 8 Santicizer M-17 Dicyclohexyl Phthalate	Santicizer 8 Diethyl Phthalate Santicizer E-15	Santicizer 8 Santicizer M-17 Santolite MHP Aroclor	S D D
Cellulose Propionate	Santicizer 1-H Santicizer 8 Santicizer M-17	Santicizer 8 Diethyl Phthalate Santicizer E-15	Santicizer 8 Santicizer M-17 Santolite MHP Santolite MS-80%	Sa Sa
Ethyl Cellulose	Santicizer 1-H Santolite MHP Diphenyl Phthalate Dicyclohexyl Phthalate	Santicizer 9 Diphenyl Phthalate Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer 9 Santolite MHP Aroclor	Di Di Di
Acrylic	Dicyclohexyl Phthalate Santicizer 1-H Diphenyl Phthalate	Santicizer 160 Santicizer 141 Santicizer B-16 Santicizer 262	Santicizer 8 Santolite MHP Santicizer 160 Santicizer 262 Dicyclohexyl Phthalate	Sa Sa Sa Sa
Polystyrene	Diphenyl Phthalate Santicizer 9 Santolite MHP Aroclor	Santicizer B-16 Santicizer 160	Santicizer 8 Santicizer 9 Santolite MHP Aroclor	Di Sa
Polyvinyl Chloride	Diphenyl Phthalate Tricresyl Phosphate Santicizer 140 Santicizer 278 Santicizer 160 Santicizer 262	Santicizer 160 Santicizer 141 Dioctyl Adipate Di(n-octyl, n-decyl) Adipate	Santicizer 160 Aroclor Santolite MHP Santicizer 278 Santicizer 262	Di Di Di
Polyvinyl Butyral	Diphenyl Phthalate Dicyclohexyl Phthalate Tricresyl Phosphate Santicizer 140	Santicizer 160 Santicizer 141	Santicizer 160 Santicizer B-16	Sa Sa
Polyvinyl Acetate	Aroclor Tricresyl Phosphate Santicizer B-16	Santicizer 8 Tricresyl Phosphate Santicizer B-16	Santicizer 8 Aroclor Diethyl Phthalate Dimethyl Phthalate	Di Sa
Polyvinyl Alcohol	Santicizer 8 Santicizer 9 Santicizer M-17	Santicizer 8 Santicizer M-17	Santicizer 9	Sa Sa
Polyvinylidene Chloride	Aroclor	Santicizer B-16 Santicizer 160	Aroclor	Sa Di Sa Sa
Epoxy	Aroclor Mod-Epox Santicizer 8	Santicizer B-16	Mod-Epox Aroclor	Sa
Chlorinated Rubber (Parlon)	Triphenyl Phosphate Santicizer 140 Aroclor	Dibutyl Phthalate Santicizer 141 Santicizer 160	Aroclor Santicizer 160 Triphenyl Phosphate Tricresyl Phosphate	Sa Di Sa
Styrene-Butadiene Rubber (Pliolite and Marbon)	Tricresyl Phosphate Aroclor Dibutyl Phthalate	Santicizer M-17 Santicizer 160 Santicizer 141	Aroclor Tricresyl Phosphate Triphenyl Phosphate	Sa Sa Sa
Casein, Zein	Santicizer 9	Santicizer 8	Santicizer 8 Santicizer 9	S

water combined only

MONS 080785

PERFORMANC

	FLEXIBILITY	HARDNESS	LUSTER	FLAME RESISTANCE	HEAT [illegible]
utyl Phthalate ctyl Phthalate nticizer 160 nticizer 165 nticizer 262	Dibutyl Phthalate Santicizer 165 Santicizer 8 Triphenyl Phosphate	Dicyclohexyl Phthalate Diphenyl Phthalate Tricresyl Phosphate Santicizer 409 Santolite MHP	Santicizer B-16 Santicizer 8 Diphenyl Phthalate Santolite MHP	Aroclor Tricresyl Phosphate Santicizer 141 Triphenyl Phosphate	Dioctyl Phthalate Santicizer 165 Santicizer 160 Santicizer 262 Dibutyl Phthalate
thyl Phthalate nticizer 8 nticizer M-17	Triphenyl Phosphate Santicizer 8 Santicizer E-15	Santicizer 9 Santicizer 1-H Triphenyl Phosphate Santolite MHP	Santicizer 8 Santicizer M-17 Santicizer 3 Santicizer E-15 Santolite MHP	Triphenyl Phosphate Santicizer 141 Santicizer 140	Santicizer M-17 Santicizer E-15 Diethyl Phthalate Dimethyl Phthalate
nticizer 141 ctyl Phthalate utyl Phthalate	Triphenyl Phosphate Santicizer 140 Santicizer 8	Santicizer 1-H Triphenyl Phosphate Diphenyl Phthalate Aroclor	Santicizer 8 Santicizer M-17 Santicizer E-15 Santolite MHP	Santicizer 141 Tricresyl Phosphate Triphenyl Phosphate Aroclor	Santicizer M-17 Santicizer 409 Santicizer B-16 Dioctyl Phthalate
nticizer 8 nticizer M-17	Triphenyl Phosphate Santicizer 140 Santicizer 8		Santicizer 8 Santicizer M-17 Santicizer E-15 Santolite MHP	Triphenyl Phosphate Santicizer 140	Santicizer M-17 Santicizer E-15 Diethyl Phthalate
ctyl Adipate sodecyl Adipate n-octyl, n-decyl) dipate	Santicizer M-17 Diphenyl Phthalate Santicizer 8	Santicizer 1-H Diphenyl Phthalate	Santicizer 8 Diphenyl Phthalate	Tricresyl Phosphate Santicizer 141 Aroclor Triphenyl Phosphate	Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Dioctyl Phthalate
nticizer 160 nticizer 141 nticizer B-16 nticizer 262	Santicizer 160 Santicizer B-16 Santicizer 262	Dicycohexyl Phthalate Diphenyl Phthalate	Santicizer 8 Santicizer B-16 Santicizer 160 Santicizer 262 Dicyclohexyl Phthalate	Tricresyl Phosphate Santicizer 141 Santicizer 140 Phosgard C-22-R	Santicizer 160 Santicizer B-16 Santicizer 262
utyl Phthalate nticizer 141	Santicizer 141 Santicizer 160 Santicizer B-16	Diphenyl Phthalate Triphenyl Phosphate	Santicizer 8 Santicizer 9 Santicizer B-16	Aroclor Tricresyl Phosphate Santicizer 141	Dibutyl Phthalate Santicizer 160
ctyl Adipate n-octyl, n-decyl) dipate odecyl Adipate	Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Diisodecyl Adipate	Diphenyl Phthalate Santicizer 213 Aroclor Santicizer 409	Santicizer B-16 Santicizer 141 Santicizer 160	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 409
nticizer 141 nticizer B-16	Santicizer 141 Santicizer 160 Santicizer B-16	Diphenyl Phthalate Dicyclohexyl Phthalate Tricresyl Phosphate	Santicizer B-16 Santicizer 160	Tricresyl Phosphate Santicizer 141 Santicizer 140	Santicizer 160 Santicizer B-16 Dicyclohexyl Phthalate
utyl Phthalate nticizer 141	Santicizer 8 Triphenyl Phosphate Santicizer B-16 Dibutyl Phthalate	Diphenyl Phthalate Santicizer 1-H Triphenyl Phosphate Dicyclohexyl Phthalate	Santicizer 8 Dibutyl Phthalate Santicizer 160	Aroclor Tricresyl Phosphate Triphenyl Phosphate Santicizer 141	Dibutyl Phthalate Santicizer 160 Diethyl Phthalate Santicizer B-16
nticizer M-17 nticizer E-15	Santicizer M-17 Santicizer E-15	Santicizer 9 Triphenyl Phosphate	Santicizer 8 Santicizer 9	Triphenyl Phosphate Tricresyl Phosphate	Santicizer M-17 Santicizer E-15 Santicizer B-16
nticizer 141 utyl Phthalate nticizer B-16 nticizer 160	Dibutyl Phthalate Santicizer 160	Aroclor	Santicizer 160 Diethyl Phthalate	Aroclor Santicizer 141 Tricresyl Phosphate	Santicizer B-16 Santicizer E-15 Diethyl Phthalate
nticizer B-16	Santicizer B-16	Mod-Epox Santicizer 8 Aroclor	Santicizer B-16 Santicizer 160 Mod-Epox	Aroclor Mod-Epox Tricresyl Phosphate Santicizer 140	Santicizer B-16
nticizer 141 utyl Phthalate nticizer 160	Santicizer B-16 Dibutyl Phthalate Santicizer 141 Tricresyl Phosphate	Aroclor Triphenyl Phosphate Tricresyl Phosphate Santicizer 140	Dibutyl Phthalate Santicizer B-16 Santicizer M-17	Aroclor Tricresyl Phosphate Santicizer 141	Santicizer B-16 Santicizer 160 Dibutyl Phthalate
nticizer 160 nticizer 141 nticizer B-16	Santicizer 160 Santicizer 141 Santicizer B-16	Tricresyl Phosphate Santicizer 140 Triphenyl Phosphate Aroclor	Santicizer 160 Santicizer B-16 Santicizer 141	Aroclor Tricresyl Phosphate Santicizer 141	Santicizer 160 Santicizer B-16 Dibutyl Phthalate
nticizer 8	Santicizer 8	Santicizer 9	Santicizer 8 Santicizer 9		

PERMANENCE

PLASTICIZED	LOW VOLATILITY	CHEMICAL RESISTANCE	SOLVENT RESISTANCE	WATER RESISTANCE	LIGHT [illegible]
Santicizer E-15 Santicizer B-16 Santicizer 141 Santicizer 160 Dioctyl Phthalate* Dioctyl Adipate	Tricresyl Phosphate Santicizer 140 Santicizer 141 Santicizer 262 Dioctyl Phthalate	Aroclor Tricresyl Phosphate Dioctyl Phthalate	Santicizer 160 Tricresyl Phosphate Santicizer 8 Santicizer 262 Santicizer M-17	Dioctyl Phthalate Santicizer 160 Santicizer 141 Santicizer 262 Santolite MHP Aroclor	Dibutyl Phthalate Santicizer 160 Dioctyl Phthalate Santicizer 165 Santicizer 262 Santolite MHP
Santicizer E-15 Diethyl Phthalate Santicizer 141	Santicizer 8 Santicizer M-17 Santicizer E-15	Diethyl Phthalate	Santicizer M-17 Santicizer E-15 Santicizer 8	Santicizer 8 Santicizer M-17 Santolite MHP	Santicizer E-15 Santicizer M-17 Santolite MHP
Santicizer E-15 Santicizer B-16 Santicizer 141 Dioctyl Phthalate* Dioctyl Adipate	Santicizer 140 Tricresyl Phosphate Santicizer 409	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer M-17 Santicizer 8 Triphenyl Phosphate Santicizer 409	Santicizer 140 Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer E-15
Santicizer E-15 Diethyl Phthalate Dioctyl Adipate	Santicizer 140 Santicizer 8 Santicizer M-17	Santicizer 140 Diethyl Phthalate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Santicizer 140 Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer E-15*
Santicizer B-16 Santicizer E-15 Santicizer 141 Dioctyl Phthalate*	Tricresyl Phosphate Dioctyl Phthalate Santicizer 409 Santicizer 141	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer M-17 Santicizer E-15 Triphenyl Phosphate Santicizer 8	Dioctyl Phthalate Santicizer 409 Diisooctyl Phthalate	Triphenyl Phosphate Santicizer 141 Santicizer 8
Santicizer B-16 Santicizer 141	Santicizer 160 Santicizer 141 Santicizer 262	Santicizer 160 Tricresyl Phosphate Santicizer 262	Santicizer M-17 Santicizer 8 Santicizer 160 Santicizer 262	Santicizer 160 Santicizer 141 Santicizer 262	Santicizer B-16 Santicizer 160 Dibutyl Phthalate Santicizer 262
Santicizer B-16 Santicizer 141 Dioctyl Adipate	Santicizer 141 Diphenyl Phthalate Santicizer 160	Aroclor Santicizer 141	Santicizer 9 Santicizer 160	Diphenyl Phthalate Dicyclohexyl Phthalate Santicizer 160	Santicizer 160 Santicizer B-16
Santicizer 141 Santicizer B-16 Santicizer 160 Dioctyl Phthalate* Diisooctyl Phthalate Dioctyl Adipate	Santicizer 409 Santicizer 262 Diisodecyl Phthalate Tricresyl Phosphate Santicizer 140	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer 160 Tricresyl Phosphate Santicizer 409 Santicizer 262	Diisodecyl Phthalate Santicizer 409 Dioctyl Phthalate Santicizer 262	Dioctyl Phthalate Santicizer 141 Santicizer B-16 Santicizer 165
Santicizer B-16 Santicizer 141 Dioctyl Adipate	Tricresyl Phosphate Santicizer 141 Santicizer 140 Santicizer 160	Tricresyl Phosphate Santicizer 160	Tricresyl Phosphate Santicizer 140 Santicizer B-16 Santicizer 141	Santicizer 141 Santicizer 160 Tricresyl Phosphate	Santicizer 160 Santicizer 141 Santicizer B-16
Diethyl Phthalate Santicizer B-16 Santicizer E-15 Santicizer 160	Tricresyl Phosphate Santicizer 141 Diphenyl Phthalate Triphenyl Phosphate	Aroclor Tricresyl Phosphate Diethyl Phthalate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Santicizer 8 Santicizer B-16 Triphenyl Phosphate	Dibutyl Phthalate Santicizer B-16 Santicizer 141
Santicizer E-15 Dioctyl Adipate	Santicizer B-16 Triphenyl Phosphate Tricresyl Phosphate	Santicizer E-15	Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer M-17	Santicizer B-16 Santicizer M-17
Diethyl Phthalate Santicizer E-15 Santicizer B-16 Dioctyl Adipate Santicizer 141 Santicizer 160	Tricresyl Phosphate Santicizer 141 Santicizer B-16	Aroclor Santicizer 141	Santicizer M-17 Santicizer E-15 Santicizer 160 Santicizer 141	Aroclor Santicizer 141	Santicizer 160 Santicizer E-15 Santicizer B-16
Santicizer B-16 Santicizer E-15	Mod-Epox Aroclor Santicizer 8	Aroclor Mod-Epox	Tricresyl Phosphate Santicizer E-15 Mod-Epox	Mod-Epox Aroclor	
Santicizer 141 Santicizer B-16 Dioctyl Adipate	Aroclor Tricresyl Phosphate Santicizer 140 Santicizer 141	Aroclor Tricresyl Phosphate Santicizer 141	Aroclor Santicizer M-17 Tricresyl Phosphate Santicizer 141	Tricresyl Phosphate Santicizer 140 Aroclor Santicizer 141	Santicizer B-16 Santicizer 160 Santicizer 141 Dibutyl Phthalate
Santicizer B-16 Santicizer 141 Dioctyl Adipate	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor	Aroclor Tricresyl Phosphate	Santicizer M-17 Santicizer 140 Aroclor	Tricresyl Phosphate Santicizer 141 Santicizer B-16 Aroclor	Santicizer B-16 Santicizer 160 Santicizer 140 Dibutyl Phthalate
	Santicizer 8 Santicizer 9	Santicizer 8	Santicizer 8	Santicizer 8 Santicizer 9	Santicizer 8

MONS 080787



Polyamides

Santicizer 8 imparts flexibility without adversely affecting tensile strength, abrasion resistance, or oil resistance. Santicizer 9, Santicizer 1-H and Santolite MHP each impart property improvements in particular applications.

Polyesters

Aroclor compounds impart flame resistance and improve adhesion, chemical and oxidation resistance.

Phenol-Formaldehyde

Santicizer 8 and Santicizer 9 improve flow and adhesion. Tricresyl Phosphate, Santicizer 160, Dibutyl Phthalate, Santicizer 140 and liquid Aroclor compounds improve punchability of laminates. Tricresyl Phosphate, Santicizer 140, Santicizer 141 and Aroclor compounds impart flame resistance.

Melamine-Formaldehyde

Santicizer 9 improves solution and color stability, gloss, flow, adhesion, and impact resistance of melamine coatings.

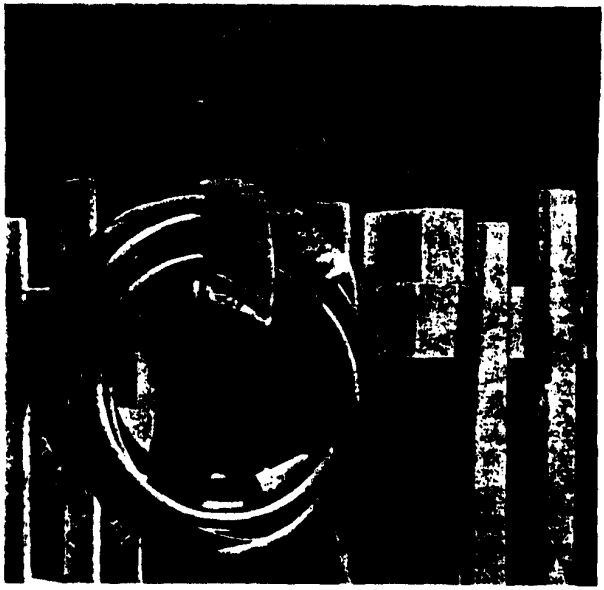
Urea-Formaldehyde

Santicizer 9 improves flow and acts as a hardening agent.

Alkyds

Aroclor plasticizers impart improved adhesion, chemical and oxidation resistance.

MONS 080788



PLASTICIZER PERFORMANCE IN MOLDING AND EXTRUDING

The following table will assist compounders select plasticizers for formulation evaluation on the basis of those properties most critical in the final molded part or extrusion. The plasticizers shown provide the optimum effect for each designated property when used with the resin shown. When the same plasticizer appears under two or more of the properties desired in the final product—that plasticizer definitely merits evaluation

MONS 080789

PLASTICIZER PERFORMANCE IN MOLDING AND EXTRUDING

RESIN	RAPID PROCESSING	LOW TEMP. FLEXIBILITY	TENSILE	[illegible]
Polyvinyl Chloride	Santicizer 160 Santicizer 141 Santicizer 140 Tricresyl Phosphate Santicizer 278	Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Diisodecyl Adipate	Diphenyl Phthalate Santicizer 160 Santicizer 409 Tricresyl Phosphate Santicizer 262	Santicizer 160 Santicizer 141 Dioctyl Adipate Santicizer 262
Polyvinylidene Chloride	Diethyl Phthalate Santicizer E-15	Santicizer 141 Dibutyl Phthalate Santicizer B-16	Aroclor	Santicizer 141 Santicizer B-16
Polyvinyl Alcohol	Santicizer 9 Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer E-15	Santicizer 9 Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer M-17
Polystyrene	Santicizer 160 Dibutyl Phthalate	Dibutyl Phthalate Santicizer 141	Diphenyl Phthalate	
Cellulose Acetate	Santicizer M-17 Diethyl Phthalate Santicizer E-15	Diethyl Phthalate Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer 1-H Triphenyl Phosphate Diphenyl Phthalate	Dimethyl Phthalate Diethyl Phthalate Santicizer E-15 Santicizer 8
Cellulose Acetate Butyrate	Santicizer 160 Santicizer 141 Santicizer E-15 Santicizer M-17 Santicizer 278 Santicizer 262	Santicizer 141 Dioctyl Phthalate Dibutyl Phthalate	Triphenyl Phosphate Santicizer 8 Diphenyl Phthalate Aroclor	Dibutyl Phthalate Tricresyl Phosphate Santicizer 140
Cellulose Nitrate	Dibutyl Phthalate Santicizer 160 Santicizer 165 Santicizer 278 Santicizer 262	Dibutyl Phthalate Dioctyl Phthalate Santicizer 165	Dicyclohexyl Phthalate Diphenyl Phthalate Tricresyl Phosphate Aroclor	Dioctyl Phthalate Dibutyl Phthalate Santicizer 165
Ethyl Cellulose	Santicizer 160 Dibutyl Phthalate Santicizer 278 Santicizer 262	Dioctyl Adipate Diisodecyl Adipate Di(n-octyl, n-decyl) Adipate	Santicizer 1-H Diphenyl Phthalate Dicyclohexyl Phthalate	Santicizer 8 Dioctyl Phthalate Santicizer 160
Styrene Butadiene Rubber (SRB)	Tricresyl Phosphate Dibutyl Phthalate Aroclor Santicizer 160 Santicizer 278 Santicizer 262	Dioctyl Phthalate Dioctyl Adipate Santicizer 141	Tricresyl Phosphate Dibutyl Phthalate	Santicizer 160 Santicizer 141
Butadiene Acrylonitrile Rubber (Buna N)	Santicizer 160 Tricresyl Phosphate Santicizer 141	Dioctyl Adipate Diisodecyl Adipate Di(n-octyl, n-decyl) Adipate	Triphenyl Phosphate Tricresyl Phosphate Diphenyl Phthalate	Santicizer 160 Santicizer 141 Santicizer B-16
Acrylic	Santicizer 160 Santicizer 141 Santicizer 262	Santicizer B-16 Santicizer 160 Santicizer 262	Dicyclohexyl Phthalate Santicizer 1-H Diphenyl Phthalate	Santicizer 160 Santicizer 141 Santicizer B-16 Santicizer 262
Casein	Santicizer 8 Santicizer 9	Santicizer 8	Santicizer 9	Santicizer 8
Phenol Formaldehyde	Santicizer 9 Santicizer 160			

MONS 080790

PERFORMANCE

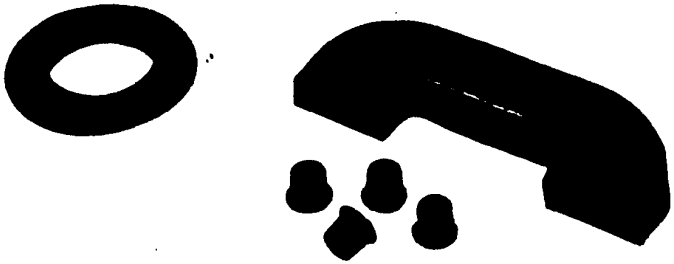
	FLAME RESISTANCE	ABRASION RESISTANCE	TEAR STRENGTH	HEAT STABILITY	[illegible]
Diphenyl Phthalate Aroclor Tricresyl Phosphate Santicizer 409 Santicizer 278	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor	Santicizer 160 Santicizer 141 Tricresyl Phosphate Santicizer 262 Santicizer 278	Santicizer 160 Santicizer 141 Santicizer 262 Santicizer 278	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 409	Dioctyl Phthalate* Diisooctyl Phthalate* Santicizer 141 Santicizer 160 Santicizer B-16 Dioctyl Adipate
Aroclor	Aroclor Santicizer 141 Tricresyl Phosphate			Santicizer B-16 Santicizer E-15 Diethyl Phthalate	Diethyl Phthalate Santicizer E-15 Santicizer B-16 Santicizer 141 Dioctyl Adipate
Santicizer 9 Triphenyl Phosphate	Triphenyl Phosphate Tricresyl Phosphate			Santicizer M-17 Santicizer E-15 Santicizer B-16	Santicizer E-15 Santicizer B-16 Dioctyl Adipate
Diphenyl Phthalate Triphenyl Phosphate	Aroclor Tricresyl Phosphate Santicizer 141			Dibutyl Phthalate Santicizer 160	Santicizer 141 Santicizer B-16 Santicizer E-15 Diethyl Phthalate Dioctyl Adipate
Santicizer 9 Santicizer 1-H Triphenyl Phosphate	Triphenyl Phosphate Santicizer 141 Santicizer 140	Triphenyl Phosphate Diethyl Phthalate		Santicizer M-17 Santicizer E-15 Diethyl Phthalate Dimethyl Phthalate	Santicizer E-15 Diethyl Phthalate Santicizer 141
Santicizer 9 Santicizer 1-H Diphenyl Phthalate Aroclor	Santicizer 141 Tricresyl Phosphate Triphenyl Phosphate Aroclor	Triphenyl Phosphate Diphenyl Phthalate Santicizer 160 Santicizer 278		Santicizer M-17 Santicizer 409 Santicizer B-16 Dioctyl Phthalate	Santicizer B-16 Santicizer 141 Dioctyl Phthalate* Diisooctyl Phthalate* Dioctyl Adipate
Dicyclohexyl Phthalate Diphenyl Phthalate Tricresyl Phosphate Santicizer 409	Aroclor Tricresyl Phosphate Santicizer 140 Santicizer 141	Diphenyl Phthalate Dicyclohexyl Phthalate Santicizer 160 Santicizer 278	Santicizer 160 Dibutyl Phthalate	Dioctyl Phthalate Santicizer 165 Santicizer 160 Dibutyl Phthalate	Santicizer 141 Dioctyl Phthalate* Diisooctyl Phthalate* Santicizer B-16 Dioctyl Adipate
Santicizer 1-H Diphenyl Phthalate	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor			Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Dioctyl Phthalate	Santicizer 141 Santicizer B-16 Dioctyl Phthalate* Diisooctyl Phthalate*
Tricresyl Phosphate Triphenyl Phosphate Diphenyl Phthalate Aroclor	Tricresyl Phosphate Triphenyl Phosphate Santicizer 141 Aroclor			Dioctyl Phthalate Santicizer 160	Santicizer 141 Dioctyl Phthalate* Santicizer B-16 Diisooctyl Phthalate* Dioctyl Adipate
Diphenyl Phthalate Dicyclohexyl Phthalate Triphenyl Phosphate Santicizer 409	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor			Dioctyl Phthalate Santicizer B-16 Santicizer 409	Santicizer 141 Santicizer B-16 Dioctyl Phthalate* Diisooctyl Phthalate*
Dicyclohexyl Phthalate Diphenyl Phthalate	Tricresyl Phosphate Santicizer 141 Santicizer 140	Dicyclohexyl Phthalate		Santicizer 160 Santicizer 262	Santicizer 141 Santicizer B-16
Santicizer 9					Santicizer 141 Santicizer B-16
Santicizer 9 Aroclor	Aroclor Tricresyl Phosphate Santicizer 140 Santicizer 141				

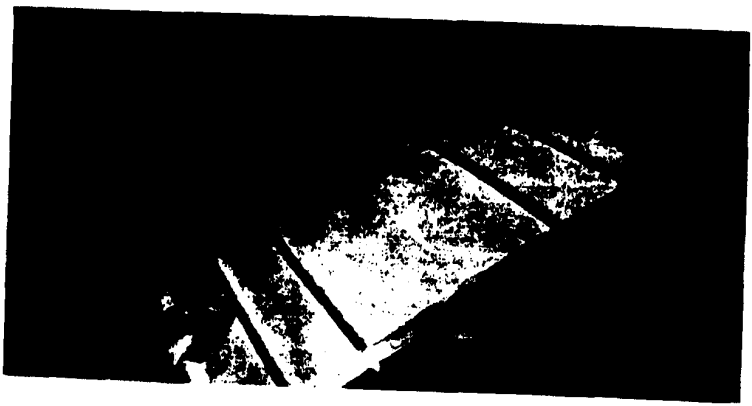
MONS 080791

PERMA

[illegible]	SOLVENT RESISTANCE	CHEMICAL RESISTANCE	WATER RESISTANCE	
Santicizer 262 Santicizer 409 Tricresyl Phosphate Diisodecyl Phthalate Santicizer 278	Santicizer 262 Santicizer 409 Tricresyl Phosphate Santicizer 160 Santicizer 278	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer 262 Diisodecyl Phthalate Santicizer 409 Dioctyl Phthalate Aroclor	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 141
Santicizer 141 Santicizer B-16	Santicizer M-17 Santicizer E-15	Aroclor	Santicizer 141 Aroclor	Santicizer B-16 Santicizer E-15 Santicizer M-17 Santicizer 141
Santicizer E-15 Santicizer B-16 Triphenyl Phosphate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Tricresyl Phosphate Santicizer B-16	Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer B-16 Santicizer E-15
Tricresyl Phosphate Santicizer 141 Santicizer 160	Santicizer M-17 Santicizer E-15	Aroclor Tricresyl Phosphate	Tricresyl Phosphate Santicizer 141	Santicizer B-16 Dibutyl Phthalate
Santicizer 141 Triphenyl Phosphate Santicizer E-15 Santicizer 8	Santicizer 8 Santicizer M-17 Santicizer 1-H	Diethyl Phthalate Santicizer 141	Santicizer E-15 Santicizer M-17 Diethyl Phthalate Santicizer 1-H	Santicizer M-17 Santicizer E-15 Diethyl Phthalate
Santicizer 409 Tricresyl Phosphate Santicizer 140 Santicizer 141	Santicizer 278 Santicizer 8 Santicizer M-17 Santicizer 160 Santicizer 1-H Santicizer 262	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer 262 Dioctyl Phthalate Tricresyl Phosphate Santicizer 141 Santicizer 160 Santicizer 278	Dioctyl Phthalate Dibutyl Phthalate Santicizer 141 Santicizer B-16
Santicizer 409 Tricresyl Phosphate Dioctyl Phthalate Santicizer 140	Santicizer 409 Santicizer 8 Santicizer M-17 Diethyl Phthalate	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Tricresyl Phosphate Aroclor	Dioctyl Phthalate Dibutyl Phthalate Santicizer 141 Santicizer 165
Santicizer 409 Tricresyl Phosphate Diisodecyl Phthalate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 165 Santicizer 160 Santicizer 278	Dioctyl Phthalate Dioctyl Adipate Di(n-octyl, n-decyl) Adipate
Santicizer 409 Tricresyl Phosphate	Santicizer M-17 Santicizer 141 Tricresyl Phosphate	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Santicizer 141 Santicizer 165 Santicizer 160 Santicizer 278	Santicizer B-16 Dioctyl Phthalate Santicizer 141
Santicizer 409 Tricresyl Phosphate Dioctyl Phthalate Santicizer 141	Santicizer M-17 Tricresyl Phosphate Santicizer 140	Aroclor Tricresyl Phosphate Dioctyl Phthalate	Dioctyl Phthalate Tricresyl Phosphate Santicizer 141	Diooctyl Phthalate Santicizer 165 Santicizer 141
Santicizer 141 Santicizer 160 Santicizer 262	Santicizer M-17 Santicizer 8 Santicizer 160 Santicizer 262	Tricresyl Phosphate Santicizer 160 Santicizer 262	Santicizer 141 Santicizer 160 Santicizer 262	Santicizer 160 Santicizer 262
Santicizer 8 Santicizer 9	Santicizer 8	Santicizer 8	Santicizer 8 Santicizer 9	
Aroclor Tricresyl Phosphate Santicizer 141		Aroclor Tricresyl Phosphate	Aroclor	

MONS 080792





MONS 080793

PLASTICIZER PERFORMANCE IN MOLDING AND EXTRUDING (continued)

● *lift flap for chart*

[illegible]	[illegible]	[illegible]
Santicizer 8 is the most efficient plasticizer. Santicizer 1-H, Santicizer 9 and Santolite MHP are also useful.	Santicizer 9 useful for improving gloss, flow characteristics, and as a hardener.	Santicizer 9 used for improving flow characteristics and as a hardener.

MONS 080794



PLASTICIZER PERFORMANCE IN FILM AND SHEETING

The following table will assist resin compounders select plasticizers for formulation evaluation on the basis of those properties most critical in the finished film or heavy sheeting. The plasticizers shown provide the optimum effect for each designated property when used with the resin shown. When the same plasticizer appears under two or more of the properties desired in the finished film or sheeting—that plasticizer definitely merits evaluation.

PLASTICIZER PERFORMANCE IN FILM AND SHEETING

RESIN	PERFORMANCE			
	RAPID PROCESSING	LOW TEMP FLEXIBILITY	TENSILE	ELONGATION
Polyvinyl Chloride	Santicizer 278 Santicizer 160 Santicizer 141 Santicizer 140 Tricresyl Phosphate	Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Diisodecyl Adipate	Santicizer 262 Diphenyl Phthalate Santicizer 160 Santicizer 409 Tricresyl Phosphate Santicizer 278	Santicizer 160 Santicizer 141 Dioctyl Adipate Santicizer 262
Polyvinylidene Chloride	Diethyl Phthalate Santicizer E-15	Santicizer 141 Dibutyl Phthalate Santicizer B-16	Aroclor	Santicizer 141 Santicizer B-16
Polyvinyl Alcohol	Santicizer 9 Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer E-15	Santicizer 9 Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer M-17
Polystyrene	Santicizer 160 Dibutyl Phthalate	Dibutyl Phthalate Santicizer 141	Diphenyl Phthalate	
Cellulose Acetate	Santicizer M-17 Diethyl Phthalate Santicizer E-15	Diethyl Phthalate Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer 1-H Triphenyl Phosphate Diphenyl Phthalate	Dimethyl Phthalate Diethyl Phthalate Santicizer E-15 Santicizer 8
Cellulose Acetate-Butyrate	Santicizer 160 Santicizer 141 Santicizer E-15 Santicizer M-17	Santicizer 141 Dioctyl Phthalate Dibutyl Phthalate	Triphenyl Phosphate Santicizer 8 Diphenyl Phthalate Aroclor	Dibutyl Phthalate Tricresyl Phosphate Santicizer 140
Cellulose Nitrate	Dibutyl Phthalate Santicizer 160 Santicizer 165	Dibutyl Phthalate Dioctyl Phthalate Santicizer 165	Dicylohexyl Phthalate Diphenyl Phthalate Tricresyl Phosphate Aroclor	Dioctyl Phthalate Dibutyl Phthalate Santicizer 165
Ethyl Cellulose	Santicizer 160 Dibutyl Phthalate	Dioctyl Adipate Diisodecyl Adipate Di(n-octyl, n-decyl) Adipate	Santicizer 1-H Diphenyl Phthalate Dicylohexyl Phthalate	Santicizer 8 Dioctyl Phthalate Santicizer 160
Styrene-Butadiene Rubber (GRS)	Tricresyl Phosphate Dibutyl Phthalate Aroclor Santicizer 160	Dioctyl Phthalate Dioctyl Adipate Santicizer 141	Tricresyl Phosphate Dibutyl Phthalate	Santicizer 140 Santicizer 141
Butadiene-Acrylonitrile Rubber (Buna N)	Santicizer 160 Tricresyl Phosphate Santicizer 141	Dioctyl Adipate Diisodecyl Adipate Di(n-octyl, n-decyl) Adipate	Triphenyl Phosphate Tricresyl Phosphate Diphenyl Phthalate	Santicizer 160 Santicizer 141 Santicizer B-16
Polyemide	Santicizer 8 is the most efficient plasticizer. Santicizer 1-H, Santicizer 9 and Santolite MHP are also useful.			

MONS 080796

PERFORMANCE

[illegible]	FLAME RESISTANCE	ABRASION RESISTANCE	TEAR STRENGTH	HEAT STABILITY	[illegible]
Diphenyl Phthalate Aroclor Tricresyl Phosphate Santicizer 409	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor	Santicizer 262 Santicizer 160 Santicizer 141 Tricresyl Phosphate Santicizer 278	Santicizer 262 Santicizer 160 Santicizer 141 Santicizer 278	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 409	Dioctyl Phthalate* Diisooctyl Phthalate* Santicizer 141 Santicizer B-16 Santicizer 160
Aroclor	Aroclor Santicizer 141 Tricresyl Phosphate			Santicizer B-16 Santicizer E-15 Diethyl Phthalate	Diethyl Phthalate Santicizer E-15 Santicizer B-16 Santicizer 141
Santicizer 9 Triphenyl Phosphate	Triphenyl Phosphate Tricresyl Phosphate			Santicizer M-17 Santicizer E-15 Santicizer B-16	Santicizer E-15 Santicizer B-16
Diphenyl Phthalate Triphenyl Phosphate	Aroclor Tricresyl Phosphate Santicizer 141			Dibutyl Phthalate Santicizer 160	Santicizer 141 Santicizer B-16 Santicizer E-15 Diethyl Phthalate
Santicizer 9 Santicizer 1-H Triphenyl Phosphate	Triphenyl Phosphate Santicizer 141 Santicizer 140	Triphenyl Phosphate Diethyl Phthalate		Santicizer M-17 Santicizer E-15 Diethyl Phthalate Dimethyl Phthalate	Santicizer E-15 Diethyl Phthalate Santicizer 141
Santicizer 9 Santicizer 1-H Diphenyl Phthalate Aroclor	Santicizer 141 Tricresyl Phosphate Triphenyl Phosphate Aroclor	Triphenyl Phosphate Diphenyl Phthalate Santicizer 160		Santicizer M-17 Santicizer 409 Santicizer B-16 Dioctyl Phthelate	Santicizer B-16 Santicizer 141 Dioctyl Phthalate* Diisooctyl Phthalate*
Dicyclohexyl Phthalate Diphenyl Phthalate Tricresyl Phosphate Santicizer 409	Aroclor Tricresyl Phosphate Santicizer 140 Santicizer 141	Diphenyl Phthalate Dicyclohexyl Phthalate Santicizer 160	Santicizer 160 Dibutyl Phthalate	Dioctyl Phthalate Santicizer 165 Santicizer 160 Dibutyl Phthalate	Santicizer 141 Dioctyl Phthalate* Diisooctyl Phthalate* Santicizer B-16
Santicizer 1-H Diphenyl Phthalate	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor			Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Dioctyl Phthalate	Santicizer 141 Santicizer B-16 Dioctyl Phthalate* Diisooctyl Phthalate*
Tricresyl Phosphate Triphenyl Phosphate Diphenyl Phthalate Aroclor	Tricresyl Phosphate Triphenyl Phosphate Santicizer 141 Aroclor			Dioctyl Phthalate Santicizer 160	Santicizer 141 Dioctyl Phthalate* Santicizer B-16 Diisooctyl Phthalate*
Diphenyl Phthalate Dicyclonexyl Phthalate Triphenyl Phosphate Santicizer 409	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor			Dioctyl Phthalate Santicizer B-16 Santicizer 409	Santicizer 141 Santicizer B-16 Dioctyl Phthalate* Diisooctyl Phthalate*

MONS 080797

PERMANENCE

[illegible]	SOLVENT RESISTANCE	CHEMICAL RESISTANCE	WATER RESISTANCE	LIGHT STABILITY
Santicizer 278 Santicizer 409 Santicizer 262 Tricresyl Phosphate Diisodecyl Phthalate Santicizer 406 Santicizer 411	Santicizer 278 Santicizer 409 Tricresyl Phosphate Santicizer 160 Santicizer 406 Santicizer 411 Santicizer 262	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer 262 Diisodecyl Phthalate Santicizer 409 Dioctyl Phthalate Aroclor Santicizer 406	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 141
Santicizer 141 Santicizer B-16	Santicizer M-17 Santicizer E-15	Aroclor	Santicizer 141 Aroclor	Santicizer B-16 Santicizer E-15 Santicizer M-17 Santicizer 141
Santicizer E-15 Santicizer B-16 Triphenyl Phosphate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Tricresyl Phosphate Santicizer B-16	Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer B-16 Santicizer E-15
Tricresyl Phosphate Santicizer 141 Santicizer 160	Santicizer M-17 Santicizer E-15	Aroclor Tricresyl Phosphate	Tricresyl Phosphate Santicizer 141	Santicizer B-16 Dibutyl Phthalate
Santicizer 141 Triphenyl Phosphate Santicizer E-15 Santicizer 8	Santicizer 8 Santicizer M-17 Santicizer 1-H	Diethyl Phthalate Santicizer 141	Santicizer E-15 Santicizer M-17 Diethyl Phthalate Santicizer 1-H	Santicizer M-17 Santicizer E-15 Diethyl Phthalate
Santicizer 409 Tricresyl Phosphate Santicizer 140 Santicizer 141	Santicizer 8 Santicizer M-17 Santicizer 160 Santicizer 1-H	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Tricresyl Phosphate Santicizer 141 Santicizer 160	Dioctyl Phthalate Dibutyl Phthalate Santicizer 141 Santicizer B-16
Santicizer 409 Tricresyl Phosphate Dioctyl Phthalate Santicizer 140 Santicizer 411	Santicizer 409 Santicizer 8 Santicizer M-17 Diethyl Phthalate Santicizer 411	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Tricresyl Phosphate Aroclor	Dioctyl Phthalate Dibutyl Phthalate Santicizer 141 Santicizer 165
Santicizer 409 Tricresyl Phosphate Diisodecyl Phthalate Santicizer 411	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Diisodecyl Phthalate Santicizer 165 Santicizer 160	Dioctyl Phthalate Dioctyl Adipate Di(n-octyl, n-decyl) Adipate
Santicizer 409 Tricresyl Phosphate	Santicizer M-17 Santicizer 141 Tricresyl Phosphate	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Dioctyl Phthalate Santicizer 141 Santicizer 165 Santicizer 160	Santicizer B-16 Dioctyl Phthalate Santicizer 141
Santicizer 409 Tricresyl Phosphate Dioctyl Phthalate Santicizer 141	Santicizer M-17 Tricresyl Phosphate Santicizer 140	Aroclor Tricresyl Phosphate Dioctyl Phthalate	Dioctyl Phthalate Tricresyl Phosphate Santicizer 141	Dioctyl Phthalate Santicizer 165 Santicizer 141



Diisodecyl Phthalate is widely used in shower curtains, baby pants, and similar articles because of its superior resistance to hot soapy water.



Santicizer 160 is unrivaled for rapid processing on the calender and for high tear-strength.

MONS 080799

● *lift flap for chart*

MONS 080800



PLASTICIZER PERFORMANCE IN ADHESIVES

The following table will assist formulators of adhesives select plasticizers for evaluation on the basis of those properties most critical in the finished formulation. The plasticizers shown provide the optimum effect for each property when used with the particular resin shown. When the same plasticizer appears under two or more of the desired properties important to the finished adhesive—that plasticizer definitely merits evaluation.

PLASTICIZER PERFORMANCE IN ADHESIVES

RESIN	PERFORMANCE			
	TENSILE STRENGTH	ELONGATION	FLEXIBILITY	ADHESION
Cellulose Nitrate	Triphenyl Phosphate Santicizer 1-H Santicizer 160 Diphenyl Phthalate	Santicizer 8 Santicizer 160 Tricresyl Phosphate Santicizer 165	Dibutyl Phthalate Santicizer 165 Santicizer 8 Triphenyl Phosphate	Aroclor Santolite MHP Santicizer 8 Santicizer B-16
Cellulose Acetate	Santicizer 1-H Santicizer 8 Santicizer M-17 Santolite MHP	Santicizer 8 Diethyl Phthalate Santicizer E-15	Triphenyl Phosphate Santicizer 8 Santicizer E-15	Santicizer 8 Santicizer M-17 Santolite MHP Santolite MS-80%
Cellulose Acetate-Butyrate	Santicizer 1-H Santicizer 8 Santicizer M-17 Dicyclohexyl Phthalate	Santicizer 8 Diethyl Phthalate Santicizer E-15	Triphenyl Phosphate Santicizer 140 Santicizer 8	Santicizer 8 Santicizer M-17 Santolite MHP Aroclor
Cellulose Propionate	Santicizer 1-H Santicizer 8 Santicizer M-17	Santicizer 8 Diethyl Phthalate Santicizer E-15	Triphenyl Phosphate Santicizer 140 Santicizer 8	Santicizer 8 Santicizer M-17 Santolite MHP Santolite MS-80%
Ethyl Cellulose	Santicizer 1-H Santolite MHP Diphenyl Phthalate Dicyclohexyl Phthalate	Santicizer 9 Diphenyl Phthalate Santicizer 8 Santicizer M-17	Santicizer M-17 Diphenyl Phthalate Santicizer 8	Santicizer 8 Santicizer 9 Santolite MHP Aroclor
Acrylic	Dicyclohexyl Phthalate Santicizer 1-H Diphenyl Phthalate	Santicizer 160 Santicizer 141 Santicizer B-16	Santicizer 160 Santicizer B-16	Santicizer 8 Santolite MHP Santicizer 160
Polystyrene	Diphenyl Phthalate Santicizer 9 Santolite MHP Aroclor	Santicizer B-16 Santicizer 160	Santicizer 141 Santicizer 160 Santicizer B-16	Santicizer 8 Santicizer 9 Santolite MHP Aroclor
Polyvinyl Chloride	Diphenyl Phthalate Dicyclohexyl Phthalate Tricresyl Phosphate Santicizer 160	Santicizer 160 Santicizer 141 Dioctyl Adipate Di(n-octyl, n-decyl) Adipate	Dioctyl Adipate Di(n-octyl, n-decyl) Adipate Diisodecyl Adipate	Santicizer 160 Aroclor Santolite MHP
Polyvinyl Butyral	Diphenyl Phthalate Dicyclohexyl Phthalate Tricresyl Phosphate Santicizer 140	Santicizer 160 Santicizer 141	Santicizer 141 Santicizer 160 Santicizer B-16	Santicizer 160 Santicizer B-16
Polyvinyl Acetate	Aroclor Tricresyl Phosphate Santicizer B-16 Santicizer 160	Santicizer 8 Tricresyl Phosphate Santicizer B-16 Santicizer 160	Santicizer 8 Triphenyl Phosphate Santicizer B-16 Dibutyl Phthalate Santicizer 160	Santicizer 8 Aroclor Diethyl Phthalate Dimethyl Phthalate Santicizer 160
Polyvinyl Alcohol	Santicizer 8 Santicizer 9 Santicizer M-17	Santicizer 8 Santicizer M-17	Santicizer M-17 Santicizer E-15	Santicizer 9
Polyvinylidene Chloride	Aroclor Santicizer 160	Santicizer B-16 Santicizer 160	Dibutyl Phthalate Santicizer 160	Aroclor
Epoxy	Aroclor Mod-Epox Santicizer 8	Santicizer B-16	Santicizer B-16	Mod-Epox Aroclor
Chlorinated-Rubber (Parlan)	Triphenyl Phosphate Santicizer 140 Aroclor	Dibutyl Phthalate Santicizer 141 Santicizer 160	Santicizer B-16 Dibutyl Phthalate Santicizer 141 Tricresyl Phosphate	Aroclor Santicizer 160 Triphenyl Phosphate Tricresyl Phosphate
Styrene-Butadiene Rubber (Pliolite and Marbon)	Tricresyl Phosphate Aroclor Dibutyl Phthalate	Santicizer M-17 Santicizer 160 Santicizer 141	Santicizer 160 Santicizer 141 Santicizer B-16	Aroclor Tricresyl Phosphate Triphenyl Phosphate
Casein, Zein	Santicizer 9	Santicizer 8	Santicizer 8	Santicizer 8 Santicizer 9

MONS 080802

PERMANENCE

FDA REGULATED	CHEMICAL RESISTANCE	SOLVENT/GREASE RESISTANCE	WATER RESISTANCE	LOW VOLATILITY
Santicizer E-15 Santicizer B-16 Santicizer 141 Dioctyl Phthalate*	Aroclor Tricresyl Phosphate Dioctyl Phthalate	Santicizer 160 Tricresyl Phosphate Santicizer 8 Santicizer M-17	Dioctyl Phthalate Santicizer 160 Santicizer 141 Aroclor	Tricresyl Phosphate Santicizer 160 Santicizer 141 Dioctyl Phthalate
Santicizer E-15 Diethyl Phthalate Santicizer 141	Diethyl Phthalate	Santicizer M-17 Santicizer E-15 Santicizer 8 Santolite MHP	Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer M-17 Santicizer E-15
Santicizer E-15 Santicizer B-16 Santicizer 141 Dioctyl Phthalate*	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer M-17 Santicizer 8 Triphenyl Phosphate Santicizer 409	Santicizer 140 Santicizer 8 Santicizer M-17	Santicizer 140 Tricresyl Phosphate Santicizer 409
Santicizer E-15 Diethyl Phthalate	Santicizer 140 Diethyl Phthalate	Santicizer 8 Santicizer M-17 Triphenyl Phosphate	Santicizer 140 Santicizer 8 Santicizer M-17	Santicizer 140 Santicizer 8 Santicizer M-17
Santicizer B-16 Santicizer E-15 Santicizer 141 Dioctyl Phthalate*	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer M-17 Santicizer E-15 Triphenyl Phosphate Santicizer 8	Dioctyl Phthalate Santicizer 409 Diisooctyl Phthalate	Tricresyl Phosphate Dioctyl Phthalate Santicizer 409 Santicizer 141
Santicizer B-16 Santicizer 141	Tricresyl Phosphate Santicizer 160	Santicizer M-17 Santicizer 8 Santicizer 160	Santicizer 160 Santicizer 141	Santicizer 141 Santicizer 160
Santicizer 141 Santicizer B-16	Aroclor Santicizer 141	Santicizer 9 Santicizer 160	Diphenyl Phthalate Dicyclohexyl Phthalate Santicizer 160	Santicizer 141 Diphenyl Phthalate
Santicizer 141 Santicizer B-16 Dioctyl Phthalate* Diisooctyl Phthalate*	Aroclor Dioctyl Phthalate Tricresyl Phosphate	Santicizer 160 Tricresyl Phosphate Santicizer 409	Diisodecyl Phthalate Santicizer 409 Dioctyl Phthalate	Santicizer 409 Diisodecyl Phthalate Tricresyl Phosphate Santicizer 140
Santicizer B-16 Santicizer 141	Tricresyl Phosphate Santicizer 160	Tricresyl Phosphate Santicizer 140 Santicizer B-16 Santicizer 141	Santicizer 141 Santicizer 160 Tricresyl Phosphate	Tricresyl Phosphate Santicizer 141 Santicizer 140 Santicizer 160
Diethyl Phthalate Santicizer B-16 Santicizer E-15 Santicizer 141 Santicizer 160	Aroclor Tricresyl Phosphate Diethyl Phthalate Santicizer 160	Santicizer 8 Santicizar M-17 Triphanyl Phosphate Santicizer 160	Santicizer 8 Santicizer B-16 Triphenyl Phosphate Santicizer 160	Tricresyl Phosphate Santicizer 141 Diphenyl Phthalate Triphenyl Phosphate
Santicizer E-15	Santicizer E-15	Santicizer 8 Santicizer M-17	Santicizer 8 Santicizer M-17	Santicizer B-16 Triphenyl Phosphate Tricresyl Phosphate
Diethyl Phthalate Santicizer E-15 Santicizer B-16 Santicizer 141	Aroclor Santicizer 141	Santicizer M-17 Santicizer E-15 Santicizer 141	Aroclor Santicizer 141	Tricresyl Phosphate Santicizer 141 Santicizer B-16
Santicizer B-16 Santicizer E-15	Mod-Epox Aroclor	Tricresyl Phosphate Santicizer E-15 Mod-Epox	Mod-Epox Aroclor	Mod-Epox Aroclor Santicizer 8
Santicizer 141 Santicizer B-16	Aroclor Tricresyl Phosphate Santicizer 141	Aroclor Santicizer M-17 Tricresyl Phosphate Santicizer 141	Tricresyl Phosphate Santicizer 140 Aroclor Santicizer 141	Aroclor Tricresyl Phosphate Santicizer 140 Santicizer 141
Santicizer B-16 Santicizer 141	Aroclor Tricresyl Phosphate	Santicizer M-17 Santicizer 140 Aroclor	Tricresyl Phosphate Santicizer 141 Santicizer B-16	Tricresyl Phosphate Santicizer 140 Santicizer 141 Aroclor
	Santicizer 8	Santicizer 8	Santicizer 8 Santicizer 9	Santicizer 8 Santicizer 9

MONS 080803



Diethyl Phthalate imparts quick tack to polyvinyl acetate—emulsion adhesives, including nontoxic ones.

POLYAMIDES

Santicizer 8 imparts additional flexibility; compositions containing it maintain high tensile strength, good abrasion and oil resistance. Santicizer 1H, Santicizer 9 and Santolite MHP also impart a plasticizing action with specific values for compositions in particular applications.

MELAMINE-FORMALDEHYDE

Santicizer 9 improves solution and color stability, flow, and adhesion.

PHENOL-FORMALDEHYDE

Santicizer 8 and Santicizer 9 improve flow characteristics.

UREA-FORMALDEHYDE

Santicizer 9 improves flow and acts as a hardening agent.

MONS 080804

PLASTICIZER EVALUATION IN POLYVINYL CHLORIDE RESIN

In formulating vinyl compounds for film and sheeting, a plasticizer system must be selected on the basis of processing efficiency, the optimum end properties required, and the cost of the formulation. The plasticizer selection is critical to each of these three criteria.

The following tabulations show the performance of Monsanto plasticizers in a polyvinyl chloride formulation at 30, 40, and 50% The figures also provide a guide to their processing efficiency. In addition to the performance data shown, several of the plasticizers impart special properties, such as non-toxicity, flame resistance, abrasion resistance, permanence, and low temperature flexibility.

Monsanto's Plasticizer Council can recommend specific plasticizers or blends to provide you optimum results in the processing characteristics and compound performance.

PERFORMANCE IN PVC

Volatility (% Plasticizer Lost) (Activated Carbon) 24 hrs. @ 87°C	4.2	1.5	4.0	1.6	1.4	7.0	9.4	13.5	8.8	17.7
Low-Temperature Flex, Tf°C	−17	−15	−16	−20	−16	−3.8	−17	−1.7	−12	−9
Water Immersion (24 hours):										
% Soluble Matter Lost	0.01	0.01	0.01	0.02	0.06	0.02	0.02	0.29	0.14	0.80
% Water Absorbed	0.22	0.15	0.19	0.31	0.74	0.25	0.24	0.46	1.2	0.24
Kerosene Extraction (% Plasticizer Lost)	8.3	10.3	6.7	42	43.7	2.0	4.0	2.4	11	8.7
Shore "A" Hardness	87	91	88	87	91	86	86	92	92	86
Migration, Linde Silica:										
1 Day (% Plasticizer Lost)	0.57	0.55	0.53	2.37	—	0.25	0.35	0.29	0.23	0.51
3 Days	1.02	0.88	0.80	4.37	—	0.46	1.00	0.51	0.27	0.95
7 Days	1.45	1.53	1.42	8.01	—	0.74	1.79	0.95	1.67	2.17
Tensile, p.s.i.	2890	3010	2850	3108	3010	3090	2980	3010	2810	2850
Elongation, %	320	300	320	340	320	320	290	320	350	320
Modulus @ 100% Elongation	1780	1820	1810	2040	1940	1720	1880	1950	2070	1760
Flame Retardant	No	No	No	No	No	No	No	No	No	No
Heat Stability	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent	Good
Migration Resistance to Nitrocellulose	Good	Excellent	Good	Good	Excellent	Good	Poor	Excellent	Excellent	Excellent
Fluxing Rate	Good	Fair	Good	Good	Poor	Excellent	Good	Excellent	Poor	Fair
Electrical Properties	Excellent	Excellent	Good-Exc.	Good	Fair	Good	Good	Good	Excellent	Excellent

@ 38% (43 PHR)

IV page 6B

PERFORMANCE IN PVC

Volatility (% Plasticizer Lost) (Activated Carbon) 24 hrs @ 87°C	4.5	2.2	4.3	2.8	1.4	7.7	10.3	18.1	10.0
Low Temperature Flex, T/°C	39	37	37	47	35	24	41	21	36
Water Immersion (24 hours):									
% Soluble Matter Lost	0.03	0.02	0.03	0.16	0.11	0.05	0.04	0.56	0.22
% Water Absorbed	0.25	0.24	0.25	0.45	1.05	0.30	0.28	0.88	1.8
Kerosene Extraction (% Plasticizer Lost)	34	>70	28	>70	>70	5.2	27	6.3	>70
Shore "A" Hardness	70	78	74	73	79	66	72	76	75
Migration, Linde Silica:									
1 Day (% Plasticizer Lost)	1.08	1.51	1.17	5.13		1.27	0.93	1.2	1.06
3 Days	2.13	2.93	2.11	10.14	—	2.56	1.56	2.7	3.27
7 Days	3.98	4.76	4.73	18.05	—	4.15	5.23	4.4	5.84
Tensile, p.s.i.	1960	2300	1920	2476	2520	2240	2015	2200	2150
Elongation, %	400	390	390	375	370	400	360	430	410
Modulus @ 100% Elongation	830	1140	860	1040	1010	830	910	890	1150
Flame Retardant	No	No	No	No	No	No	No	No	No
Heat Stability	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Excellent	Fair	Good	Excellent	Poor	Poor	Excellent	Excellent
Fluxing Rate	Good	Fair	Good	Good	Poor	Excellent	Good	Excellent	Poor
Electrical Properties	Excellent	Excellent	Good-Exc	Good	Fair	Good	Good	Good	Excellent

MONS 080807

(40 mil sheet) @ 30% (43 PHR)

2	0.7	2.8	11.7	14.3	13.7	2.9	0.8	3.4	6.8	13.7	3.2	7.8	14.9	1 Day -0.4 2 Days-0.8 6 Days-1.4	1 Day -0.5 2 Days-0.7 6 Days-1.3	1 Day -0.8 2 Days-1.2 6 Days-2.0	7 Day 0.5 2 Days-0.8 6 Days-1.4	— — — — 6 Days-4.9	— — — — 6 Days-6.9	— — — — 6 Days-6.2	— — — — 6 Days-2.8	— — — — 6 Days-1.9	— — — — 6 Days-5.5
−2	+19	−16	−16	−11.7	−13	−16	+10.5	+5.4	−17	−46	−43.1	−47.9	−8.3	−1.4	+1.9	−9.3	+3.0	−7.3	+8.1	−9.6	−3.3	−9.6	−13.5
0.05 0.24	0.01 0.20	0.01 0.18	0.03 0.23	0.05 0.30	0.05 0.20	0.01 0.18	0.01 0.24	0.03 0.27	0.02 0.24	0.05 0.40	0.02 0.28	0.07 0.61	0.08 0.27	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
1.1	0.3	9.0	9.0	6.1	6.9	9.0	0.4	0.4	3.0	19.5	63.5	51.9	1.1	0.3	0.3	1.2	0.4	—	0.7	—	—	—	—
90	97	90	90	93	91	89	100	93	86	83	90	86	87	93	92	92	92	95	95	87	87	89	82
0.06 0.33 0.42	0.9 0.04 0.05	0.75 0.90 1.60	0.51 1.13 1.88	0.38 0.67 1.14	0.44 0.87 1.34	0.22 0.77 1.64	0.08 0.76 0.28	0.0 0.08 0.21	0.34 1.18 2.30	5.1 9.5 14.6	6.4 18.2 16.4	5.1 15.1 27.2	0.20 0.55 0.93	0.15 0.20 0.25	0.1 0.4 0.3	0.4 0.7 1.0	0.03 0.2 0.3	0.11 0.24 0.46	0.00 0.01 0.19	0.25 0.48 0.77	0.13 0.34 0.55	0.12 0.27 0.40	0.68 1.16 2.12
3123	3180	2980	2830	3120	2970	2920	3120	3170	2930	2360	2490	2620	3090	2760	2715	3100	2800	3470	3220	2900	3050	2995	3200
311	258	330	280	270	280	360	250	290	320	390	370	410	310	250	320	370	340	290	350	360	365	355	360
2365	3144	1920	2080	2340	2200	1910	2540	2020	1500	1150	1390	1290	1880	2410	2330	2500	2760	3045	2980	2470	2780	2750	2420
No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
Good	Good	Excellent	Excellent	Good	Good	Excellent	Fair	Fair	Fair	Good	Good	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Fair	Good	Excellent	Excellent	Excellent	Good
Good	Good	Excellent	Good	Excellent	Excellent	Good	Poor	Fair	Poor	Poor	Poor	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Good	Good	Fair	Good	Good	Good	Good	Excellent	Excellent	Excellent	Fair	Poor	Fair	Excellent	Poor	Poor	Fair	Poor	Good	Fair	Good	Good	Poor	Good
—	—	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Fair	Fair	Fair	Poor	Fair	—	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair

MONS 080808

(40 mil sheet) @ 40% (67 PHR)

29.3	2.9	0.7	3.5	12.8	18.8	16.2	3.6	1.0	3.6	7.4	13.9	3.4	8.1	12.8	1 Day -8.5 2 Days-1.0 6 Days-1.6	1 Day -8.6 2 Days-0.8 6 Days-1.5	1 Day -1.8 2 Days-1.5 6 Days-2.2	1 Day -8.6 2 Days-0.9 6 Days-1.5	— — — — 6 Days-4.8	— — 6 Days-7.8	— — 6 Days-3.5	— — 6 Days-2.9	— — 6 Days-1.8	— — 6 Days-4.7
-28	-20	-4.2	-36	-36	-33	-35	-37	-10	-15	-39	-66	-63	-66	-35	-11.9	-9.5	-21.6	9.1	-19.6	-8.2	-22.0	-15.0	-10.8	-25.7
0.94 0.31	0.97 0.27	0.02 0.33	0.03 0.25	0.05 0.27	0.10 0.33	0.09 0.31	0.02 0.24	0.02 0.26	0.04 0.30	0.06 0.35	0.10 0.66	0.07 0.36	0.08 0.53	0.12 0.39	—	—	—	—	—	—	—	—	—	—
34.9	3.3	0.5	6.3	4.5	3.5	4.0	6.5	2.4	2.1	7.3	>70	>70	>70	3.8	0.4	0.5	1.1	0.5	1.8	0.5	1.7	0.7	0.6	1.6
76	73	85	73	77	76	74	72	76	76	65	65	74	68	68	76	78	75	81	74	78	72	78	79	68
1.44 2.99 6.75	0.30 0.48 0.86	0.0 0.08 0.14	1.05 2.58 4.22	0.96 3.14 5.82	0.89 2.32 4.22	0.97 2.57 4.60	0.55 2.18 4.75	0.4 0.8 1.6	0.63 1.63 2.70	1.55 4.6 9.0	7.5 135 21.0	9.0 117 27.4	7.8 22.8 35.9	0.76 2.9 5.34	—	0.06 4.3 0.5	0.5 1.2 2.0	0.23 0.4 0.6	0.33 0.82 1.56	0.13 0.34 0.76	0.93 1.81 2.91	0.49 0.90 1.43	0.28 0.60 0.95	1.53 3.15 5.68
2140	2950	2600	2180	2700	2640	2160	2190	2490	2700	1960	1710	1840	1940	2180	2560	2385	2510	2575	2830	2510	2525	2630	2590	2600
425	405	341	390	350	340	370	400	360	380	440	430	400	430	370	380	390	450	400	370	400	435	410	430	445
1140	1142	1855	1080	1070	1210	1090	1100	1000	1080	700	630	890	800	830	1610	1530	1305	1680	1685	1630	1400	1710	1685	1195
No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Good	Good	Good	Excellent	Excellent	Good	Good	Excellent	Fair	Fair	Fair	Good	Good	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Fair	Good	Excellent	Excellent	Excellent	Good
Excellent	Good	Good	Good	Good	Excellent	Excellent	Good	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Fair	Good	Good	Fair	Good	Good	Good	Good	Excellent	Excellent	Excellent	Fair	Poor	Fair	Excellent	Poor	Poor	Fair	Poor	Good	Fair	Good	Good	Poor	Good
Excellent	—	—	Excellent	Good	Excellent	Excellent	Excellent	Good	Fair	Fair	Fair	Poor	Fair	—	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair

MONS 080809

IV (page 6C

PERFORMANCE IN PVC

Volatility (% Plasticizer Lost) (Activated Carbon) 24 hrs @ 87 C	5.0	7.2	4.7	3.2	1.5	9.1	12.3	19.5	11.0
Low Temperature Flex, Tf C	55	53	54	70	48	39	57	37	54
Water Immersion (24 hours):									
% Soluble Matter Lost	0.04	0.03	0.04	0.28	0.13	0.25	0.05	0.09	0.28
% Water Absorbed	0.57	0.75	0.78	0.57	1.19	0.43	0.30	1.30	1.9
Kerosene Extraction (% Plasticizer Lost)	>70	>70	>70	>70	770	13.3	>70	15.4	>70
Shore "A" Hardness	70	58	53	51	54	45	54	76	58
Migration, Linde Silica:									
1 Day (% Plasticizer Lost)	2.18	2.55	2.59	8.07		4.03	2.18	2.8	2.02
3 Days	4.75	5.79	5.53	18.33	—	7.8	6.05	5.9	6.57
7 Days	8.04	9.30	9.79	28.31	—	11.4	10.9	10.0	11.45
Tensile, p.s.i.	1360	1540	1310	1650	1770	1360	1220	1480	1500
Elongation, %	470	440	460	415	410	460	440	470	460
Modulus @ 300% Elongation	420	590	430	448	560	410	410	460	560
Flame Retardant	—	—	—	No	No	—	—	—	—
Heat Stability	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Excellent
Migration Resistance to Nitrocellulose	Good	Good Exc.	Poor	Good	Excellent	Poor	Poor	Poor	Excellent
Fluxing Rate	Good	Fair	Good	Good	Poor	Excellent	Good	Excellent	Poor
Electrical Properties	—	—	—	Good	Fair	—	—	—	—

MONS 080810

(40 mil sheet) @ 50% (100 PHR)

[redacted]

29.8	1.6	0.7	3.5	14.5	19.9	17.9	3.6	1.6	4.8	8.4	14.8	3.5	9.0	14.0
−53	−35	−14	−54	−54	−51	−52	−54	−29	−36	−58	<−70	<−70	<−70	−49
1.12 0.39	0.10 0.32	0.04 0.36	0.01 0.24	0.07 0.30	0.10 0.51	0.09 0.35	0.03 0.26	0.03 0.35	0.07 0.30	0.25 0.50	0.07 0.82	0.38 0.46	0.12 0.45	0.28 0.56
>70	7.5	1.3	>70	>70	>70	>70	>70	4.4	7.6	24	>70	>70	>70	11.4
58	56	65	56	57	57	56	54	76	65	50	48	56	49	53
2.47 5.34 11.08	0.36 1.4 2.2	0.02 0.35 0.51	2.81 6.70 8.94	1.86 5.37 9.87	1.68 4.7 9.2	1.69 4.8 8.6	1.12 3.60 7.70	0.65 2.51 4.39	2.91 7.47 11.8	4.2 12.3 22.4	11.5 22.0 28.7	16.2 28.9 38.7	12.7 31.1 47.0	2.22 7.27 13.9
1360	1530	2039	1340	1380	1530	1430	1350	1560	1680	1280	1090	1280	1280	790
460	428	413	430	450	420	430	440	460	440	510	460	430	460	450
610	556	895	520	510	540	510	520	470	540	380	350	440	440	440
—	No	No	—	—	—	—	—	—	—	—	—	—	—	—
Good	Good	Good	Excellent	Excellent	Good	Good	Excellent	Fair	Fair	Fair	Good	Good	Excellent	Good
Excellent	Good	Good	Good	Good	Excellent	Excellent	Good	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Fair	Good	Good	Fair	Good	Good	Good	Good	Excellent	Excellent	Excellent	Fair	Poor	Fair	Excellent
Excellent	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MONS 080812



PLASTICIZER PERFORMANCE IN PLASTISOL FORMULATIONS (65 PHR)

In formulating plastisols for various kinds of coatings, slush molding, rotational casting—the selection of the plasticizer system is critical. Storage life, speed of cure, the hardness and tensile strength of the cured compound can all be developed to the optimum values through selection of the right plasticizer or plasticizer blend.

The following chart shows, for quick comparison purposes, the characteristics of a "standard" 65 PHR plastisol formulated with the various Monsanto plasticizers, using Opalon® 410 resin without stabilizer. These values can be used as a guide to the performance of a particular-type plasticizer. However, closer values to the particular property most important to you may be obtainable by a blended plasticizer system...which can be recommended to you by Monsanto's Plasticizer Council.

MONS 080813

Viscosity, centipoises Brookfield HAT #6 Spindle 50 RPM											
23°C											
Initial	7,700	9,600	8,200	3,600	14,000	2,400	3,500	6,200	13,000(4)‡	164,000(7)‡	
7 Days	10,700	12,700	11,700	5,400	17,000	4,400	7,700	9,900	16,000(4)‡	198,000(7)‡	
28 Days	13,000	12,000	10,900	6,000	26,500	5,100	8,900	8,500	18,000(5)‡	292,000(7)‡	
40°C											
Initial	5,000	6,200	6,000	3,200	10,400	1,900	3,400	4,000	7,400(4)‡	36,000(6)‡	
7 Days	11,800	9,300	10,900	6,200	170,900	7,800	17,600	6,200	17,500(4)‡	62,000(6)‡	
28 Days	13,300	9,600	14,100	7,800	Gel	13,000	37,800	6,600	20,600(5)‡	84,000(6)‡	
50°C											
Initial	4,500	5,500	6,200	2,800	20,000	2,200	9,100	3,700	7,700(4)‡	22,000(6)‡	
7 Days	20,600	11,300	20,400	12,500	Gel	37,300	Gel	7,000	74,000(6)‡	69,000(6)‡	
28 Days	32,300	11,700	33,100	15,400	—	Gel	—	7,500	258,000(7)‡	111,000(7)‡	
Severs, centipoises											
10 psi	9,200	10,500	8,800	3,300	20,900	4,800	5,500	8,200	22,000	304,000	
50 psi	7,600	8,000	8,000	3,100	31,400	4,900	6,300	6,800	22,700	249,000	
100 psi	5,900	6,300	6,000	2,400	29,000	4,000	5,200	5,100	16,600	145,000	
*Flow Index	1.0	0.8	1.0	0.9	2.2	2.0	1.8	1.1	1.7	1.5	
Yield Value, dynes/cm²	64	465	370	100	32	40	16	255	95	9	
Fusion Point, °C	127	138	127	—	89	119	105	146	90	122	
***Air-Release Time, minutes	9	11	10	—	30	20	14	7	—	—	
***Resilience, inches rebound (Standard steel ball dropped 40" onto 0.5" thick specimen @ 23°C)	4.5	5.4	4.6	—	2.8	5.1	4.4	6.4	—	—	
***Ball Resilience, inches rebound (4" vinyl ball dropped 90" to constant-hardness surface)	18	18	—	—	15	—	—	20	—	—	

MONS 080814

8,200 12,500 11,400	6,100 9,100 10,100	9,100 10,600 12,300	9,000 10,900 12,000	3,440 4,480 4,400	24,000 27,500 33,600	30,800 38,600 42,900	5,600 11,200 15,400	4,400 5,200 6,400	5,000 5,600 5,600	2,300 3,000 3,400	10,300 16,300 23,000	97,000 93,000 92,600
5,800 9,600 10,900	4,700 11,100 14,500	6,400 11,400 13,300	6,400 11,300 13,800	3,080 4,600 6,000	15,000 54,400 103,200	19,200 78,600 Gel	7,100 250,900 Gel	3,800 6,000 6,600	4,000 4,000 4,200	2,100 4,000 4,600	9,600 159,200 Gel	42,400 41,000 40,000
5,200 14,100 17,300	5,200 32,600 69,400	6,100 21,400 39,200	6,100 26,600 44,000	3,160 10,120 18,800	20,200 Gel —	25,600 Gel —	15,900 Gel —	4,200 8,100 12,000	3,300 5,200 5,600	2,700 5,200 6,200	26,100 Gel —	35,200 32,000 39,800
11,400 9,500 7,600	7,500 6,300 5,100	11,100 9,300 6,400	9,700 8,100 6,200	6,130 6,280 4,630	40,000 72,700 73,600	53,300 119,100 139,900	5,800 6,400 5,800	1,000 900 700	2,500 2,000 1,500	15,100 14,000 11,700	16,500 21,400 18,200	98,500 85,000 80,500
1.2	1.0	1.0	0.9	1.8	3.0	3.9	1.1	0.2	0.4	6.1	2.1	0.9
240	80	320	464	90	224	440	72	705	640	240	48	160
132	129	132	130	132	92	100	105	139	156	148	100	—
10	18	6	6	10	25	24	15	7	7	7	—	—
5	5.1	4.5	4.5	4.9	1.7	2.7	5.8	10.9	10.4	9.2	—	—
—	—	—	—	—	—	—	27	34	26	—	—	—

MONS 080815

84,600 73,000 63,400	31,400 20,200 24,600	113,600 99,400 82,400	9,900 11,900 11,800	22,900 28,800 29,600	113,600 117,600 136,000	185,000 178,000 216,000	6,000 11,400 14,500	3,500 4,500 4,700	7,500 10,000 20,000	12,000 20,000 35,000	
33,000 30,400 32,200	15,200 21,200 15,100	32,800 27,200 20,800	5,200 12,600 10,800	12,800 17,100 20,200	44,000 54,000 48,000	90,800 67,200 72,900	6,600 13,200 14,200	3,000 4,900 6,000	6,000 12,000 35,000	8,000 16,000 42,000	
31,200 17,200 27,600	11,000 13,800 11,800	27,000 23,000 27,800	4,600 112,100 10,100	11,200 17,800 21,000	313,600 37,200 36,900	44,600 45,500 54,600	6,400 17,800 21,400	2,900 30,000 >100,000	10,000 >100,000 Gel	20,000 >100,000 Gel	
105,000 77,000 72,500	31,110 29,460 27,300	114,000 85,000 74,000	38,800 49,400 40,800	— — —	— — —	— — —	— — —	6,300 6,750 4,800	— — —	— — —	
0.9	0.8	0.7	1.5	—	—	—	—	2.3	—	—	
320	160	640	40	120	0	0	80	60	—	—	
—	148	—	—	—	—	—	—	135	—	—	
—	60	—	—	—	—	—	—	6	4	—	
—	3.1	—	—	—	—	—	—	4.5	4.5	—	
—	—	—	—	—	—	—	—	—	—	—	

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