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INDUSTRIAL PROCESS PROFILES FOR ENVIRONMENTAL USE: Chapter 13. Plasticizers Industry

Industrial Environmental Research Laboratory
Office of Research and Development
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INDUSTRIAL PROCESS PROFILES

ENVIRONMENTAL USE

CHAPTER 13

PLASTICIZERS INDUSTRY

by

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SYNTHETIC PLASTICIZER INDUSTRY

INDUSTRY DESCRIPTION

The plasticizer industry includes manufacturers who produce primary synthetic organic plasticizers. Manufacturers who refine or otherwise upgrade natural plasticizers such as mineral oil or castor oil are not included. Plasticizers are materials which are added to organic polymers to facilitate processing, to modify the properties of the product, or both. In some cases the plasticizer serves primarily as a processing aid, facilitating the fabrication of the polymer into its final product but performing no function thereafter. In other cases the plasticizer determines the physical properties of the end product and is a critically important, functional component of the composite for the life of the end product. In general, workability, flexibility, extensibility and resilience are imparted to a polymer system by a plasticizer. Distinctions among plasticizers, extender oils, flame retardants, processing aids and lubricants are often blurred.

Amounts of plasticizer added vary from a few percent to amounts comparable to the amount of organic polymer in the finished product. Plasticizers compatible with one polymer may not be compatible with another. Primary plasticizers have a high degree of compatibility with the polymer at the projected use level. A second or extender plasticizer can be used safely only with substantial amounts of primary plasticizer for the polymer system to maintain satisfactory compatibility. Extenders are used to reduce costs. The plasticizer industry uses raw materials produced by the industrial organic chemicals industry (Chapter 6) and produces products which are used as raw materials by the plastics and resins industry (Chapter 10). There are more than 600 plasticizers commercially available but only about 150 of these have industrial significance. The bulk of plasticizers used currently in the United States is employed in the formulation of flexible vinyl plastics.

The major categories of synthetic plasticizers are carboxylic acid esters, phosphoric acid esters, linear polyesters and epoxidized esters. Most synthetic plasticizers are derived from some form of esterification.

Seventeen manufacturing facilities owned by 13 companies accounted for 93 percent of the 1974 plasticizers production capacity (980 Gg/yr). Numerous small firms are engaged in the production of plasticizers for specialty applications.

According to the Standard Industrial Classification System, the plasticizer industry is included in the group of industries which produces a wide range of synthetic organic chemicals. Since industry statistics for this group of manufacturers are combined, no information was found describing the approximate number of workers employed in the production of plasticizers.

The United States International Trade Commission (formerly U. S. Tariff Commission) reported total production of primary plasticizers in 1974 to be 858 Gg (1.89 billion pounds). Table 1 lists the production figures reported by the Tariff Commission. As indicated in Table 1 well

over half of U. S. synthetic plasticizer production is of phthalate esters. Production included 70 Gg of epoxidized esters (epoxidized soya oils and octylepoxytallates): 16 Gg of esters of natural fatty acids such as oleic, sebacic and stearic acids; and 56 Gg of other acrylic plasticizers. It is possible that some of the production by some of these categories does not refer to the synthetic plasticizer industry as it has been defined here.

Table 1. 1974 PRODUCTION OF PRIMARY PLASTICIZERS BY GROUPS

Plasticizer Type	Production (Gg)
Phthalic acid esters	548
Trimellitic acid esters	12
Other cyclic (non-phosphate plasticizers)	38
Adipic acid esters	29
Epoxidized esters	70
Esters of oleic, stearic, and sebacic acids	16
Other acyclic (non-phosphate) plasticizers	61
Cyclic phosphates	43
Acyclic phosphates	13
Complex linear polyesters	29
TOTAL	858

Source: United States International Trade Commission. Synthetic Organic Chemicals, United States Production and Sales of Plasticizers. 1974, Preliminary, December 1975.

Manufacturing plants, with several minor exceptions, are located east of the Mississippi River. The plants are evenly distributed north to south with some concentrations along the eastern seaboard. Appendix C gives plant site locations.

About 80 percent of all plasticizers are consumed in poly(vinyl chloride) (PVC) formulations; therefore, trends in the synthetic plasticizer industry generally follow those of flexible poly(vinyl chloride) production. Table 2 lists total U.S. production of plasticizers as reported

by the International Trade Commission.

Table 2. TOTAL U.S. PLASTICIZER PRODUCTION FOR 1965-1974

Year	Production (Gg/yr)
1965	587
1966	548
1967	573
1968	604
1969	627
1970	606
1971	678
1972	775
1973	850
1974	858

Source: U.S. Tarriff Commission Synthetic Organic Chemicals, United States Production and Sales. Plasticizers. 1965 TC Publication 206; 1966 TC Publication 248; 1967 Preliminary; 1968 Preliminary; 1969 Preliminary; 1970 TC Publication 479; 1971 TC Publication 614; 1972 TC Publication 681. United States International Trade Commission, Synthetic Organic Chemicals, United States Production and Sales. Plasticizers 1973 ITC Publication 728; 1974 Preliminary.

Production of poly(vinyl chloride) resins and products dropped approximately 25 percent from 1974 to 1975. Assuming plasticizer production followed the same trend, 1975 production would be estimated at about 645 Gg. This drop in production was brought on by greatly decreased demand from the automotive and housing industries. The only other annual decrease in plasticizer production in the past 10 years is correlated with the 1969-70 economic slowdown. Economic recovery is expected to return the growth rate for plasticizers to the 5-10 percent per year range.

Despite these optimistic predictions uncertainties exist in the long-range future of poly(vinyl chloride) based products and therefore in the future demand for synthetic plasticizers. These uncertainties arise from solid waste disposal problems and toxicity problems. Solid waste disposal problems include the nondegradability problems associated with plastics in

general when the landfill method of disposal is used. In addition, incineration of unplasticized poly(vinyl chloride) resin yields 0.6 kg of HCl, a corrosive and toxic gas, per kg of resin. (In a typical flexible [plasticized] product containing approximately 35 percent plasticizer the amount of HCl emitted would be proportionately reduced.) At low combustion temperatures the presence of chlorine retards combustion. Environmentally acceptable incineration of large amounts of poly(vinyl chloride) requires the use of specially designed incinerators to promote combustion, resist corrosion, and prevent hazardous emissions.

Toxicity questions associated with poly(vinyl chloride) revolve around the discovery of previously unknown toxic properties of vinyl chloride monomer in the early seventies. These discoveries resulted in stringent emission standards which have raised some doubts about the future of vinyl chloride. The toxicity of phthalate esters has been a matter of concern. However, possible effects on humans have not been clearly demonstrated. So far, concerns related to the environment and safety have not influenced the plasticizer market nearly so much as have economic factors.

Short-term estimates of raw materials supplies (phthalic annhydride, branched alcohols and linear alcohols) indicate adequate supplies in most cases for the next two to four years. The long-term outlook for feedstock supply and price (which impact product prices) is tied to the political and economic complexities associated with the increasing reliance of the United States on imported petroleum.

The plasticizer industry, along with the entire petrochemical industry, has the flexibility to rapidly change the amount and type of materials produced, within wide limits, in response to raw materials shortages and market demands. This capacity and willingness to change production emphasis makes even moderate-term predictions about growth trends quite risky.

No specific information was found concerning on-site generation of steam or electricity. It is to be expected that steam, when required, will be generated on site. It is believed that electric power generally will be purchased from utility companies by contractual agreement, even for very large installations.

Raw Materials

Most plasticizers are products of esterification reactions between hydroxyl compounds such as alcohols or glycols and carboxylic or phosphoric acids. Commonly used catalysts are sulfuric acid and p-toluene-sulfonic acid for carboxylic acid esters and magnesium chloride for phosphoric acid esters. Appendix A contains a complete list of raw materials.

Raw materials for carboxylic acid esters are primarily aliphatic or aromatic dicarboxylic acids or anhydrides and C_6-C_{13} branched chain alcohols. The most important aromatic diacid derivatives are the phthalate esters. This group of plasticizers employs phthalic anhydride as the aromatic diacid precursor. Terephthalic acid and isophthalic acid are used to a much smaller extent. The major aliphatic dicarboxylic acid used in the production of dicarboxylic acid esters is adipic acid. Other less frequently used diacids are sebacic and azelaic acids. Mono- and tri-functional acid esters are also

produced to a small extent in the industry from mono- and tri-acids. Benzoic acid, citric acid and trimellitic anhydride are examples of acidic compounds used in the production of these less widely used plasticizers. The most important plasticizer alcohol for combination with carboxylic acids is 2-ethylhexanol (commonly referred to as octyl alcohol). Other important alcohols include isooctyl alcohol, isodecyl alcohol and butyl alcohol. In some cases mixtures of closely related alcohols rather than pure compounds are used.

Polyester plasticizers are usually of the linear variety and are made primarily from dicarboxylic acids and glycols. The acid and glycol are combined and polymerized to the required molecular weight range. Adipic acid is the most frequently used acid. Azelaic and sebacic acids are also used. The glycols vary and can be mixed.

Phosphate esters of phenolic compounds are the most important materials produced for fire-retardant plasticizers. The major acidic phosphorous compound used in the production of cyclic phosphate esters is phosphorous oxychloride, $POCl_3$, which is derived from phosphorous trichloride or phosphorous pentoxide and chlorine. Phenols are the hydroxyl bearing precursor. Tricresyl phosphate is produced by the reaction of $POCl_3$ with a mixture of meta and para cresols. Mixtures of cresols and phenol will yield esters such as cresyl diphenyl phosphate. Aryl-alkyl phosphates are produced in significant quantities from mixtures of aryl-alkyl alcohols. The most important ester of this type is 2-ethylhexyl diphenyl phosphate.

Epoxidized plasticizers are prepared from natural oils (esters) such as soybean oil or linseed oil or by epoxidation of synthetic esters such as the 2-ethylhexyl ester of tall oil or oleic acids. The most widely used natural oil is soybean oil and the most important synthetic is 2-ethylhexyl tallate.

Phthalic, trimellitic and adipic acids are derived primarily from petroleum with smaller amounts of raw materials coming from coal tar. Oleic, stearic, and palmitic acids are made from animal fats. Palmitic acid is also derived from cottonseed oil. Lauric acid comes from coconut oil and ricicionleic acid from castor oil. Azelaic acid is made by ozonolysis of oleic acid. Sebacic acid is obtained by hydrolysis of castor oil. Overall, the amounts of raw materials derived from petroleum and coal greatly exceed the amounts derived from non-fossil sources.

Plasticizer alcohols can be broadly categorized as branched chain alcohols in the C_6-C_{13} range and straight chain alcohols in the C_6-C_{11} range. These alcohols are prepared almost exclusively from olefins derived from petroleum by the "Oxo" process, by aldol condensation, by a combination of the "Oxo" process with aldol condensation or by the use of aluminum alkyls (Ziegler catalysts). These alcohols may be prepared by reduction of fatty acid esters derived from coconut oil or tallow, but currently only small amounts of alcohols are actually prepared this way. Branched-chain alcohols or mixed isomers of branches alcohols are commonly designated by the prefix iso even though this usage does not conform to the strict chemical definition of the term. In some cases mixtures of alcohols containing 7 to 11 carbon atoms are used.

Table 3 lists several toxicologican properties for a few alcohols which are used as raw materials for plasticizers.

Table 3. TOXICOLOGICAL PROPERTIES OF SOME ALCOHOLS

Alcohol	Single Oral LD50,[a] Rats, g/kg	Single Skin Penetration,[b] LD50 Rabbits ml/kg	Single Inhalation[c] Vapor Concentration ppm	Time Hours	No. Killed	Primary Skin Irritation,[d] Rabbits	Eye Injury, Rabbits
1-Butanol	4.36	4.2	145 145	1 4	none of 6	none	severe
Ethanol	21.3	20 (killed one of four)	16,000	8	none of 6	minor	moderate
Ethylene glycol	8.54[f]	9.53	16,000	8	none of 6	none	none
2-Ethylhexanol	7.1	2.38	16,000	8	none of 6	minor	moderate
Glycerol	27.5	>20	16,000	8	none of 6	none	none
Isobutyl alcohol	2.46	4.24	16,000	2	none of 6	none	severe
Isodecyl alcohol	9.80	3.56	16,000	8	none of 6	mild	minor
Propylene glycol	26.38	>20	8,000	8	none of 6	none	trace

FOOTNOTES:

[a]That quantity of undiluted chemical which kills 50% of exposed animals. Dosage is expressed as grams per kg of animal body weight.

[b]A 24 hour covered skin contact with the liquid chemical, or a solid in an acceptable vehicle.

[c]A single continuous breathing of the stated concentration of chemical in the stated period of time.

[d]The skin response 24 hours following application of 0.01 ml amounts to uncovered skin.

[e]Surface damage produced by the liquid or solid chemical or appropriate concentration thereof.

[f]Single dose oral toxicity to humans is greater.

Source: McClelland, C.P. Alcohols, Mono and Polyhydric. In: Encyclopedia of Polymer Science and Technology, Vol 1. H. F. Mark, ed. N.Y., Wiley, 1964.

Products

Classes of compounds used as primary plasticizers for poly(vinyl chloride) are listed in Table 4. This list does not include mineral oils and chlorinated hydrocarbons which are usually identified as secondary plasticizers or extenders although the chlorinated hydrocarbons impart some flame resistance and flexibility.

Table 4. CLASSES OF COMPOUNDS USED AS PRIMARY PLASTICIZERS FOR POLY(VINYL CHLORIDE)

Monomeric esters of dicarboxylic acids or di- or polyhydric alcohols
dialkyl adipates
dialkyl azelates
glycol dibenzoate esters (some)
glycollates such as butyl phthalyl butyl glycollate
trialkyl mellitates
dialkyl and alkyl benzyl o-phthalates
pentaerythritol derivatives
Phosphoric acid esters
triaryl phosphates
aryl-alkyl phosphates
trialkyl phosphates
Polymeric plasticizers
Polyesters of
adipic acid
azelaic acid
phthalic acid
with various glycols terminated with
monofunctional groups
Epoxy compounds
epoxidized soybean oil
epoxidized tall oil
epoxy resins (some)
Miscellaneous
phenoxy compounds
sulfonamides

Source: Coaker, A. W. M. and E. Musclaick. Plasticizers. In: Modern Plastics Encyclopedia, Vol 51, No. 10A. Sidney Gross, ed. N.Y., McGraw-Hill, October 1974, p. 244-252.

Different plasticizers often are chosen to impart specific properties to the finished product. Phthalic esters find substantial general purpose use in PVC film, sheeting, extrusion products, and wire and cable coatings. Adipates are used to impart low temperature flexibility to PVC formulations (e.g., vinyl meat-wrapping films). Phosphate esters are added to PVC in order to restore the fire retardancy of the unplasticized polymer when this has been dimished by addition of other plasticizers not containing a fire-retardant element (P, Cl, B). Polyesters are more resistant to extraction and migration than monomeric esters.

Although the plasticizers listed in Table 4 are used principally in formulation of poly(vinyl chloride) products, many are compatible with other polymers. Appendix B contains a complete list of commercially available plasticizers and includes information on physical properties, compatibility with various polymers, and manufacturers.

Companies

The companies which dominate the industry are large, integrated chemical or petrochemical companies which also produce a number of other products. In several cases the companies produce the acids and/or the alcohols from which the plasticizers are made. Some manufacturers produce poly(vinyl chloride) monomer and resins as well. Thirteen companies which had approximately 93 percent of the synthetic plasticizer capacity for the United States in 1974 are listed in Table 5.

Table 5. PLASTICIZER PRODUCTION CAPACITIES 1974

Company	Gg/yr	%
Monsanto Company	225	23.0
Union Carbide Corporation*	147*	15.0
W. R. Grace & Co.	113	11.5
United States Steel Corporation	90	9.2
Eastman Kodak Company	64	6.5
Exxon Corporation	59	6.0
FMC Corporation	50	5.0
BASF Wyandotte Corporation	36	4.0
Rohm and Haas Company	41	4.0
Stauffer Chemical Company	27	2.8
Tenneco Inc.	27	2.8
Emery Industries, Inc.	18	1.8
B. F. Goodrich Company	16	1.6

*Union Carbide ceased production of phthalate esters in 1975. This shift significantly decreased Union Carbide's total plasticizer capacity, perhaps by as much as 100 Gg/yr.

Source: Monsanto Research Corporation. Work done under Contract 68-02-1320.

Appendix C lists companies engaged in the manufacture of materials used as plasticizers. Plant locations and materials produced are included. Capacities are listed if available. Some companies engaged in the manufacture of cosmetics, pharmaceuticals or industrial specialties also manufacture plasticizers.

Environmental Impact

The synthetic plasticizer industry produces gaseous, solid and liquid wastes. Waste water is the major environmental problem of this industry. Hydrochloric acid gas emissions, for example, are largely controlled in phosphate ester manufacture by gas scrubbers. Solid waste is a minor pollution source which results from ester purification processes. Solid wastes include spent activated carbon and insoluble sulfate salts.

A major source of waste water from esterification of carboxylic acids is the water from neutralization and washing operations and filter backwash. These types of plasticizers are normally washed and neutralized to remove traces of H_2SO_4 or other acid catalyst. Waste water can contain dilute caustic, additives, sulfates (from acid catalyst) and organics such as alcohols, monoester, and small amounts of product.

The waste water from one plant which produces diethylphthalate had very high values for biological oxygen demand, chemical oxygen demand, total organic carbon, sulfate, oil, total dissolved solids and copper. Exact values are given in Process Description 1. The waste water flow rate was 0.65 liter waste water per kg product. If these values are typical of processes involving esterification of carboxylic acids, the waste water problem lies not so much in the volume of water produced as in its poor quality. The copper concentration found for this plant is high enough to interfere with biological treatment of the water.

The waste load values from the diethylphthalate plant may be compared with those from a plant producing tricresylphosphate (TCP) (see Process 2). The comparison reveals that the TCP plant had a much higher waste water flow rate (28 liters per kg product) and much lower waste loadings for biochemical oxygen demand, chemical oxygen demand, total organic carbon, cyanide, oil, copper and total dissolved solids. Sulfate loads were comparable for the two processes. Waste loads were higher for the TCP process for all other contaminants listed. Chloride loads were quite high for the TCP process. Phenol levels are of potential concern. Although not listed in the table of contaminants, permanganate is added to phosphate esters during the purification process and manganese will be found in wash waters.

The contaminants listed are for untreated waste water and many of the potential problems with such wastes can be avoided by appropriate water treatment. Plasticizer production usually occurs at a plant at which other organic chemicals are manufactured. Pollutant emissions from the plant will depend on waste management practices, segregation or combination of waste streams, composition of wastes from other organic chemical processes conducted at the site, and waste treatment facilities.

The amount of solid waste (spent activated clay or activated charcoal) is not large. However, if the solids are disposed of by landfill, materials of unknown composition may be leached and might pose a threat of local groundwater contamination.

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INDUSTRY ANALYSIS

There are some inconsistencies in reported production data. Plasticizer production for 1974 was reported as 858 Gg by the U.S. International Trade Commission and as 745 Gg by Modern Plastics magazine. These figures contrast with a production capacity of 980 Gg/yr estimated by the Chemical Economics Handbook. Demand for plasticizers was very strong in 1974, exceeding production. Part of the gap between reported production and capacity figures can be attributed to raw materials shortages and normal plant down time.

Other factors impact reported capacity and production values for plasticizers. In many cases the distinction between plasticizers, extenders, fire retardants, etc. is not clear. Different authors may define primary plasticizers in different ways. Second, chemicals which are used primarily as plasticizers may have other uses, and some authors report only production which is to be used as plasticizers. Third, much of the equipment used to manufacture plasticizers can be used to make more than one plasticizer, or even materials with entirely different use patterns. The capacity of a given system can be expected to be different for each material produced.

The production figures used in this report represent total production of chemicals which are used mainly as primary plasticizers. Secondary plasticizers or extenders such as mineral oil or chlorinated hydrocarbons are not included.

Quantitative waste stream compositions reported in the process descriptions are the results of measurements made for processes producing one phthalate ester plasticizer and a typical phosphate ester plasticizer. These compositions are specific for the plant and product investigated and are not intended to represent raw waste loads for other processes. Specifically, diethyl phthalate (DEP), a plasticizer not used in PVC, is produced by a batch process in insignificant quantities. Since large scale production of plasticizers used in PVC such as di(2-ethylhexyl) phthalate (DOP), diisooctyl phthalate (DIOP) and diisodecyl phthalate (DIDP) generally involves continuous rather than batch processing, the waste streams resulting from the production of DOP, DIOP and DIDP can be expected to have little relationship to the data found for DEP. No information was found regarding waste stream composition associated with the production of epoxy-type plasticizers.

Synthetic Plasticizer Processes

Esterification of dicarboxylic acids and fatty acids with monohydric alcohols and the production of polyesters by esterification/polymerization of dicarboxylic acids with glycols are chemically similar processes. They are treated by Process Description No. 1. Esterification of phosphoric acid (phosphorous oxychloride) requires special equipment and techniques because of the corrosive nature of the reactants and products and is treated in Process No. 2. Epoxidation is described in Process No. 3. Figures 1,2 and 3 are flow sheets describing their respective processes. Production of ester and epoxidized ester plasticizers is a relatively simple industrial process and the flow sheets reflect this simplicity.

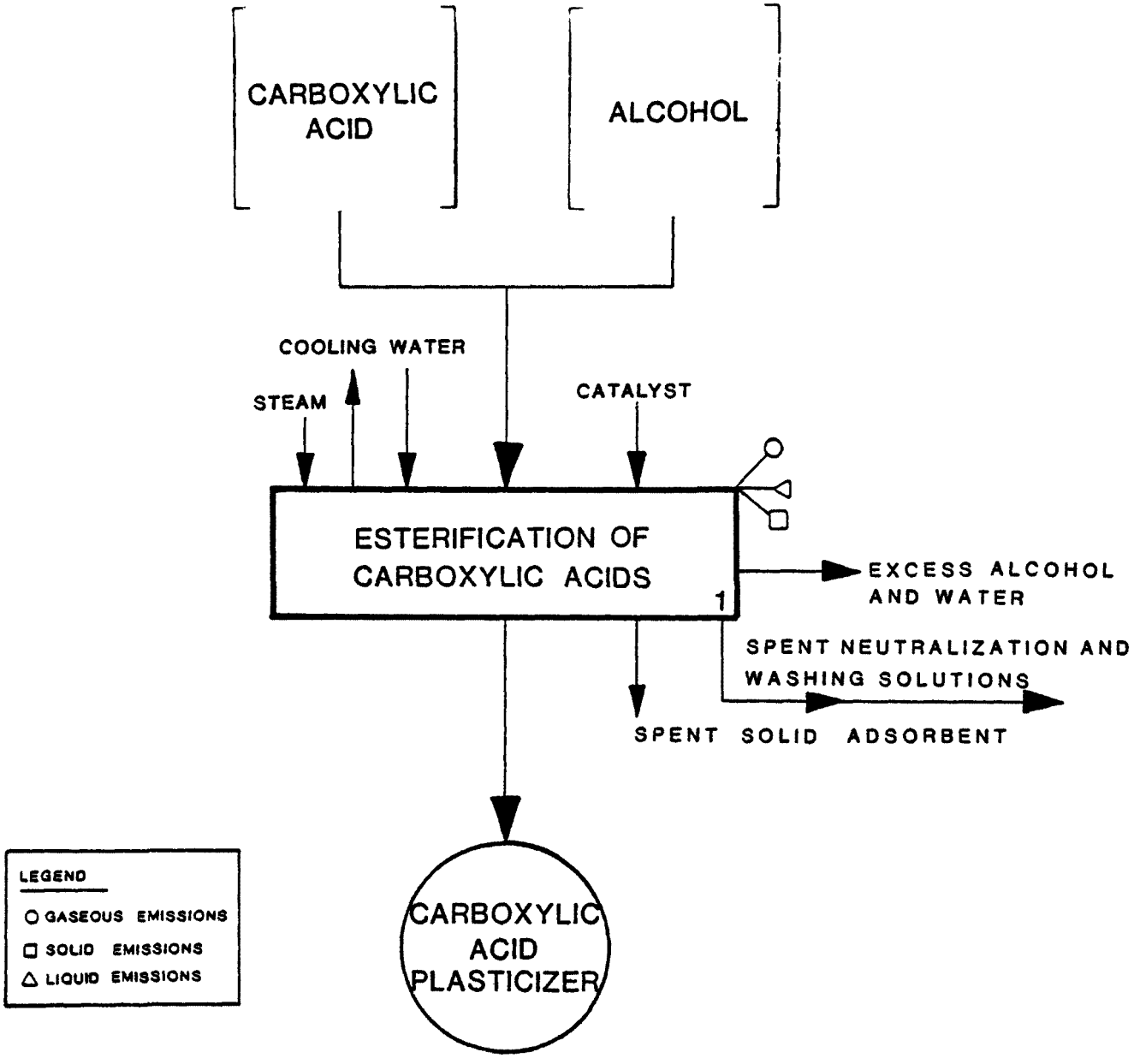
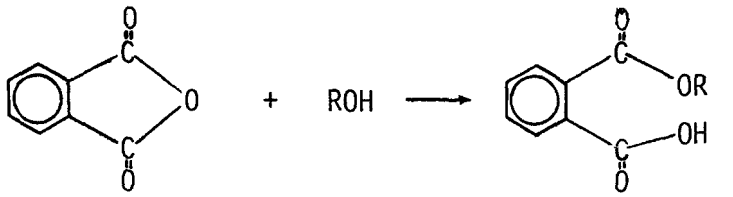


Figure 1. PROCESS FLOW SHEET FOR ESTERIFICATION OF CARBOXYLIC ACIDS

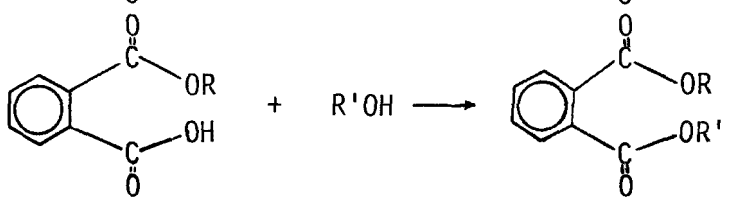
Esterification of Carboxylic Acids

1. Function - In this process an acid or an acid anhydride combines with an alcohol to produce an ester. Most plasticizers are synthesized in simple esterification reactions, which can be carried out in the liquid phase in heated kettles with stirring and water take-off provisions. Many plants still produce plasticizers by batch methods, but newer plants operate on a continuous basis. Esterification catalysts such as sulfuric acid or p-toluene sulfonic acid are removed in a washing step. The crude product is purified by distillation, steam stripping, filtration, and treatment with activated clay or activated charcoal.

Reactions of dicarboxylic acids (or anhydrides) may be typified those of phthalic anhydride. The general reactons for their formation are shown in equations (1-1) and (1-2) where R and R^1 are alkyl groups.



(1-1)



(1-2)

Reaction of the anhydride (1-1) proceeds under much milder conditions than does the esterification of the remaining carboxyl group (1-2). Often the anhydride is reacted with an alcohol under relatively mild conditions to produce the monoester which is then transferred to another vessel for conversion to the diester. If a diester with R and R' the same is desired, the same alcohol will be used in both reaction steps. If a mixed diester is desired, remnants of the first alcohol will be removed from the monoester before reaction of the second carboxylic acid group with a second alcohol. Usually an excess of alcohol is used and the unreacted portion recycled. Water formed by the second esterification is removed from the system to drive the reaction to completion.

The synthesis of 2-ethylhexyl tallate proceeds according to the typical esterification reaction shown in equation 1-3. The reaction may be catalyzed by sulfuric acid or hydrogen chloride:

$$RCOOH + R^1OH \rightleftarrows RCOOR^1 + H_2O \qquad (1\text{-}3)$$

The equilibrium reaction may be driven toward completion by several methods. With alcohols of intermediate chain length (such as 2-ethylhexanol) which are insoluble in water, stoichiometric quantities of the reactants are used and the water is removed by azeotropic distillation. With short chain alcohols, molar ratios of alcohol to fatty acid in the order of 10 or 20 to 1 are used. At such high ratios the reaction equilibrium is shifted in accordance with the law of mass action, giving yields of 95 percent or better.

Polymeric plasticizers are linear polyesters produced by the polymerization/esterification of an aliphatic dicarboxylic acid (usually adipic acid) with either pure or mixed glycols, e.g.:

$$X\left[HOOC\text{-}(CH_2)_4\text{-}COOH\right] + X\left[HOCH_2\text{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}OH\right] \xrightarrow[R^1COOH]{ROH} R\left[O\text{-}\overset{O}{\overset{\|}{C}}\text{-}(CH_2)_4\text{-}\overset{O}{\overset{\|}{C}}\text{-}OCH_2\text{-}\underset{\displaystyle CH_3}{\underset{|}{CH}}\text{-}\right]_x OR^1 \quad (1\text{-}4)$$

R and R^1 are monofunctional reactants which are introduced at a suitable stage in the reaction to control the molecular weight and residual functionality. Typically, the average molecular weight of these esters is about 2000, but weights of from 800 to well over 6000 are produced for specialty applications.

2. Input Materials - The feed to the esterification unit will include an acid (or acid anhydride), an alcohol, and a catalyst. The reaction vessel may be sparged with an inert gas (CO_2 or N_2) to suppress unwanted side reactions. In some cases an inert solvent will be added. Besides phthalic anhydride, other dibasic acids commonly used include adipic, sebacic, azelaic and fatty acids such as oleic and stearic.

Esters most commonly used as plasticizers include those produced by combining dicarboxylic acids with aliphatic alcohols containing one to thirteen carbon atoms and polyesters from the combination of dicarboxylic acids with polyhydric alcohols. The specific alcohol (or alcohols) and acid used to prepare any given ester can be determined from the name of the ester. For example, di(2-ethylhexyl) phthalate is prepared by reacting two moles of 2-ethylhexyl alcohol with each mole of phthalic acid (phthalic anhydride). One process using a "non-acidic" catalyst is reported to require 66.9 kg 2-ethylhexanol and 38.2 kg phthalic anhydride per 100 kg of di(2-ethylhexyl) phthalate (alternate terminology: dioctylphthalate, DOP) product. High efficiency is claimed for the process, so processes using other catalysts may require more input materials for the same amount of product.

3. Operating Parameters - Temperatures ranging from 35 to 180°C have been reported for esterification processes. In most cases, heat is required. Temperatures of 150-160°C have been listed for the production of di(2-ethylhexyl phthalate. Reported pressures range from atmospheric to 170 kPa. Batch reaction times of 6 to 20 hours have been given.

Catalysts for esterification of carboxylic acids are acids (Lewis acids, species having an electron deficit in the outer shell, may be used). Sulfuric acid and toluenesulfonic acid are the catalysts most often used. Acidic cation exchange resins may be used as catalysts, particularly in large-scale continuous processes.

4. Utilities - One process for the preparation of di(2-ethylhexyl) phthalate lists a requirement of 75 kg steam per kg of product. It is not clear whether this value is representative of other processes. Electricity will be required for pumping and stirring and cooling water will be needed; no quantitative information was available in the references consulted.

5. Waste Streams - Atmospheric emissions consist primarily of fugitive emissions from processing equipment and evaporation of volatile components from liquid wastes. In general, the most volatile compounds associated with plasticizer esters prepared from carboxylic acids and alcohols are the alcohols used as raw materials. Unreacted alcohols are present in process streams and wastewater.

Wastewater comes from distillation of crude products, from condensate from steam stripping, from catalyst neutralization and crude product washing operations, and from filter backwash. Some equipment is used for the production of more than one ester. Equipment washdown which is required when changing from production of one ester to another generates wastewater. The wash water contains dilute caustic (from catalyst neutralization), sulfates (assuming sulfuric acid catalyst), unreacted alcohol, monoester, and relatively small amounts of other organic contaminants.

Table 6 lists pollutants in wastewater from a facility producing diethyl phthalate.

6. EPA Source Classification Code: None exists.

7. References -

(1) Anon. Adipic Acid and Its Derivatives. E. I. DuPont de Nemours & Company, Wilmington, Delaware, 1957.

(2) Environmental Protection Agency. Development Document for Interim Final Effluent Limitations Guidelines and New Source Performance Standards for the Significant Organic Products Segment of the Organic Chemical Manufacturing Point Source Category. EPA-440/1-75/045, Group I Phase II. September 1975, p. 217, 273-4.

(3) Fedor, Walter S. Plasticizers. The Competitive Struggle Grows Keener. Chemical & Engineering News, 13 November 1961, 118.

(4) Mark, H. F. and N. G. Gaylord, eds. Encyclopedia of Polymer Science and Technology. Vol 1. N.Y., Wiley, 1964.

(5) Phthalate Plasticizer--Chisso Corp. Hydrocarbon Processing, 54:174, November 1975.

(6) Reid, Emmet, Marvin L. Peterson and John W. Way. Esterification. In: Unit Processes in Organic Synthesis, 5th Ed. Philip H. Groggins, ed. N.Y., McGraw-Hill, 1958, p. 694-749.

(7) Shreve, R. N. Chemical Process Industries, 3rd E. N.Y., McGraw-Hill, 1967.

Table 6. RAW WASTE CONCENTRATIONS AND LOADS FOR FACILITY PRODUCING DIETHYL PHTHALATE[a]

Contaminant	Concentration[b] (mg/liter)	Load[c] (kg/1000 kg product)
BOD5	82,600	53.9
COD	127,000	82.6
TOC	51,200	33.4
Phenol	.01	.00001
NH_3 - Nitrogen	1.1	.00073
Total Kjeldahl Nitrogen	3.9	.00258
Cyanide	.04	.00003
Sulfate	2,030	1.33
Oil	12,500	8.17
Total Phosphorous	3.29	.00215
Zn	3.95	.00258
Cu	97.9	.0640
Fe	4.49	.00293
Total Cr	.076	.00005
Cd	.151	.0001
Total Suspended Solids	101	.0661
Total Dissolved Solids	94,800	61.9
Chloride	160	.104

[a] Process flow of 653 liters per 1000 kg product was reported.

[b] Raw waste concentrations are based on unit weight of pollutant per unit volume of process waste waters.

[c] Raw waste loadings are based on unit weight of pollutant per 1000 unit weights of product.

Source: Environmental Protection Agency, Effluent Guidelines Division. Development Document for Interim Final Effluent Limitations and New Source Performance Standards for the Significant Organic Products Segment of the Organic Chemicals Manufacturing Point Source Category. EPA-440/1-75/045. Washington, D.C., Sept. 1975.

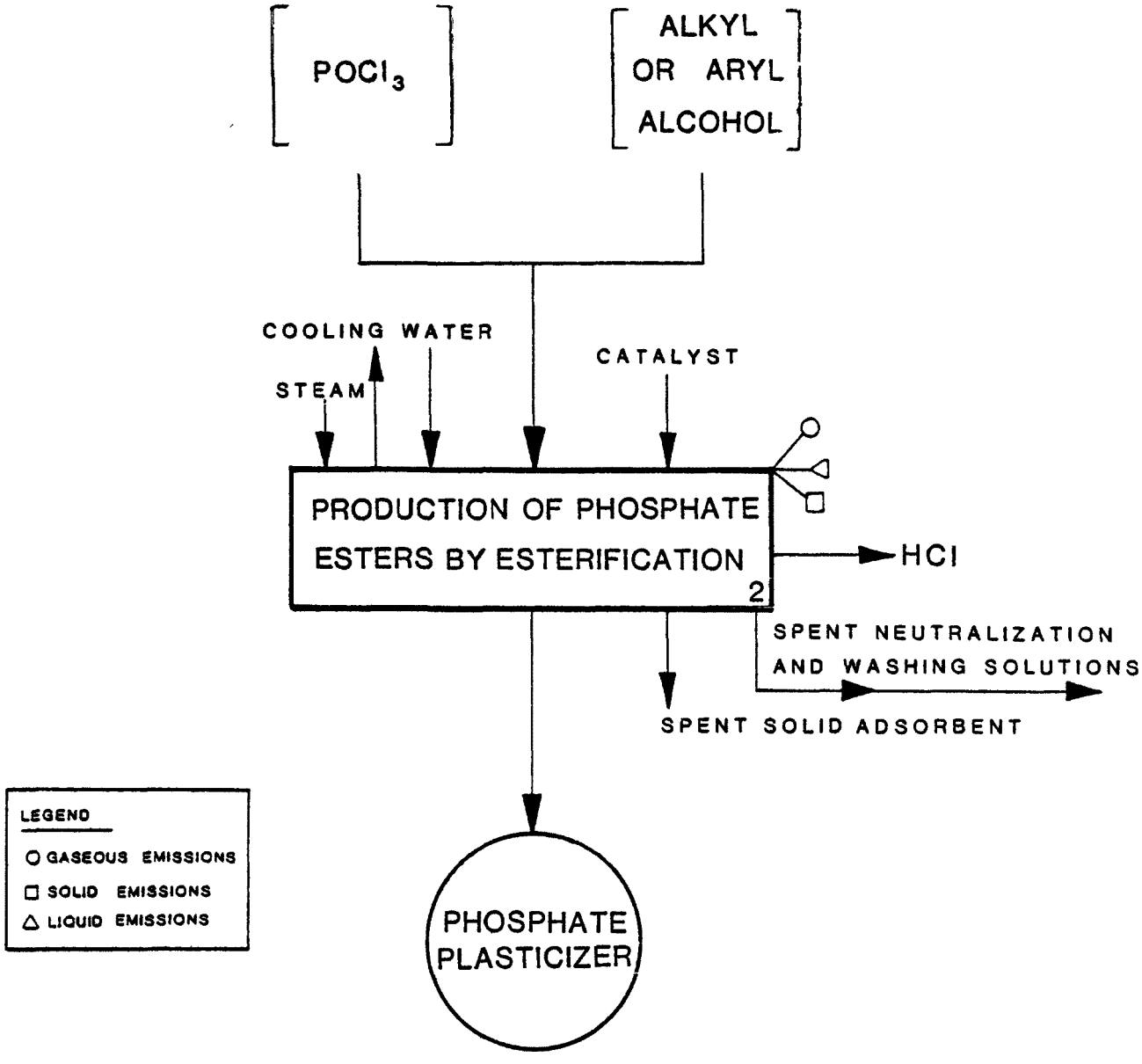


Figure 2. PROCESS FLOW SHEET
FOR PRODUCTION OF PHOSPHATE ESTERS

Production of Phosphate Esters by Esterification

1. Function - Phosphate plasticizers are prepared by condensation of $POCl_3$ (phosphorous oxychloride) with an alcohol or a mixture of alcohols. Cresols, phenols or xylenols are most commonly used. Mixed alkyl-aryl esters may be prepared by successive reaction with appropriate alcohols. The reaction for cresols may be written:

$$3m\text{-, } p\text{-}C_6H_4(CH_3)OH + POCl_3 \longrightarrow [C_6H_4(CH_3)O]_3\ PO + 3HCl \qquad (2\text{-}1)$$

The production of HCl causes some processing problems. Hydrogen chloride can be removed by a current of air or neutralized by the addition of alkali. Glass-lined or alloy kettles are used because the reaction mixture is highly corrosive. The process may employ a distillation column for preliminary purification of the alcohol feed, a reactor, an ester refining column (for washing), a stripping column, and a filter. Steam ejector jets and barometric condensors may be employed for providing reduced pressures.

Although variations may exist in the sequence of operations and the amount of purification required for different applications, standard purification techniques are used. Preliminary purification typically involves direct flash distillation of the crude reaction mixture and washing with dilute caustic. The dilute caustic neutralizes residual HCl, hydrolyzes and extracts traces of partial esterification products, and extracts unreacted cresylic compounds. Addition of lime to the crude reaction mixture before distillation has been reported as a means of reducing corrosion. Final purification of plasticizer-grade products employs further washing with dilute caustic and water, steam stripping, treatment with dilute permanganate solution, dehydration by heating under reduced pressure, bleaching with activated carbon and filtration. The use of an amphoteric metal in conjunction with an alkaline wash has been reported to improve the color of the product.

2. Input Materials - The most common phosphate ester used as a plasticizer is tricresyl phosphate. Phosphorous oxychloride ($POCl_3$) and a mixture of m- and p-cresols, which may contain as much as 30 to 40 percent xylenols, are input materials for plasticizer-grade tricresylphosphate. The ortho form of tricresyl phosphate is considerably more toxic than esters derived from other isomers. Therefore, the o-cresol content of the cresol feed is usually less than three percent.

3. Operating Parameters - Condensation of cresols and phosphorous oxychloride is carried out at elevated temperatures. Depending on the catalyst used, temperatures range from 150 to 300°C. A slight excess of cresol favors complete esterification. Condensation times of 6 to 9 hours at 200°C are typical when metal halide catalysts such as $MgCl_2$ are used. Condensation may be carried out under moderate pressure to minimize loss of phosphorous oxychloride in the HCl off-gas; otherwise, each process step is carried out under reduced pressure.

4. Utilities - No information was found in the literature consulted for this study. Steam, cooling water and process heaters will be required.

5. Waste Streams - Emissions of cresols (and/or other aromatic alcohols) to the atmosphere can be expected from barometric condensers.

Waste water comes from barometric condensers, from HCl scrubbers and from preliminary and final purification steps. Caustic washing produces waste water containing dilute caustic, unreacted phenols and partial esters. Waste water from final purification contains additives washed from the product such as permanganate or permanganate reduction products. Table 7 lists pollutants from one facility producing tricresylphosphate.

The major solid waste from the production of phosphate esters is spent activated carbon from the final purification step.

6. EPA Source Classification Code - None exists.

7. References -

(1) Billmeyer, Fred W., Jr. Textbook of Polymer Science, 2nd Ed. N. Y., Wiley, 1971.

(2) Environmental Protection Agency, Effluent Guidelines Division. Development Document for Interim Final Effluent Limitations and New Source Performance Standards for the Significant Organic Products Segment of the Organic Chemicals Manufacturing Point Source Category. EPA-440/1-75/045. Washington, D. C., Sept. 1975, p. 217, 273-4.

(3) Pratt, Christopher J. PHOSPHORUS. In: Chemical and Process Technology Encyclopedia. Douglas M. Considine, ed. N.Y., McGraw-Hill, 1974, p. 874.

(4) Reid, Emmet, Marvin L. Peterson and John W. Way. Esterification. In: Unit Processes in Organic Synthesis, 5th Ed. Philip H. Groggins, ed. N.Y., McGraw-Hill, 1958, p. 694-749.

(5) Van Wazer, John R. Phosphoric Acid and Phosphates. In: Kirk-Othmer Encyclopedia of Chemical Technology, Vol 15. Anthony Standen, ed. N.Y., Wiley, 1968, p. 324-6.

Table 7. RAW WASTE CONCENTRATIONS AND LOADS FOR FACILITY PRODUCING TRICRESYL PHOSPHATE [a]

Contaminant	Concentration [b] (mg/liter)	Load [c] kg/1000 kg product
BOD	40.	1.12
COD	408.	11.4
TOC	70.	1.96
Phenol	10.8	.304
NH_3-N	3.65	.102
Total Kjeldahl N	11.8	.344
Sulfate	54.	1.513
Oil	10.5	.297
Total Phosphorous	1.19	.0335
Zn	.327	.0914
Cu	.07	.00197
Fe	1.31	.0366
Total Cr	.041	.00115
Cd	.041	.00115
Total Suspended Solids	4.	.110
Total Dissolved Solids	615.	17.2
Chloride	2,560.	71.5

[a] Process flow of 28 m^3 per 1000 kilograms product was reported. These data are for a plant using steam ejectors and barometric condensers for each process step.

[b] Raw waste concentrations are based on unit weight of pollutant per unit volume of process waste waters.

[c] Raw waste loadings are based on unit weight of pollutant per 1000 unit weights of product.

Source: Environmental Protection Agency, Effluent Guidelines Division. Development Document for Interim Final Effluent Limitations and New Source Performance Standards for the Significant Organic Products Segment of the Organic Chemicals Manufacturing Point Source Category. EPA-440/1-75/045. Washington, D. C., Sept. 1975, p. 217, 273-4.

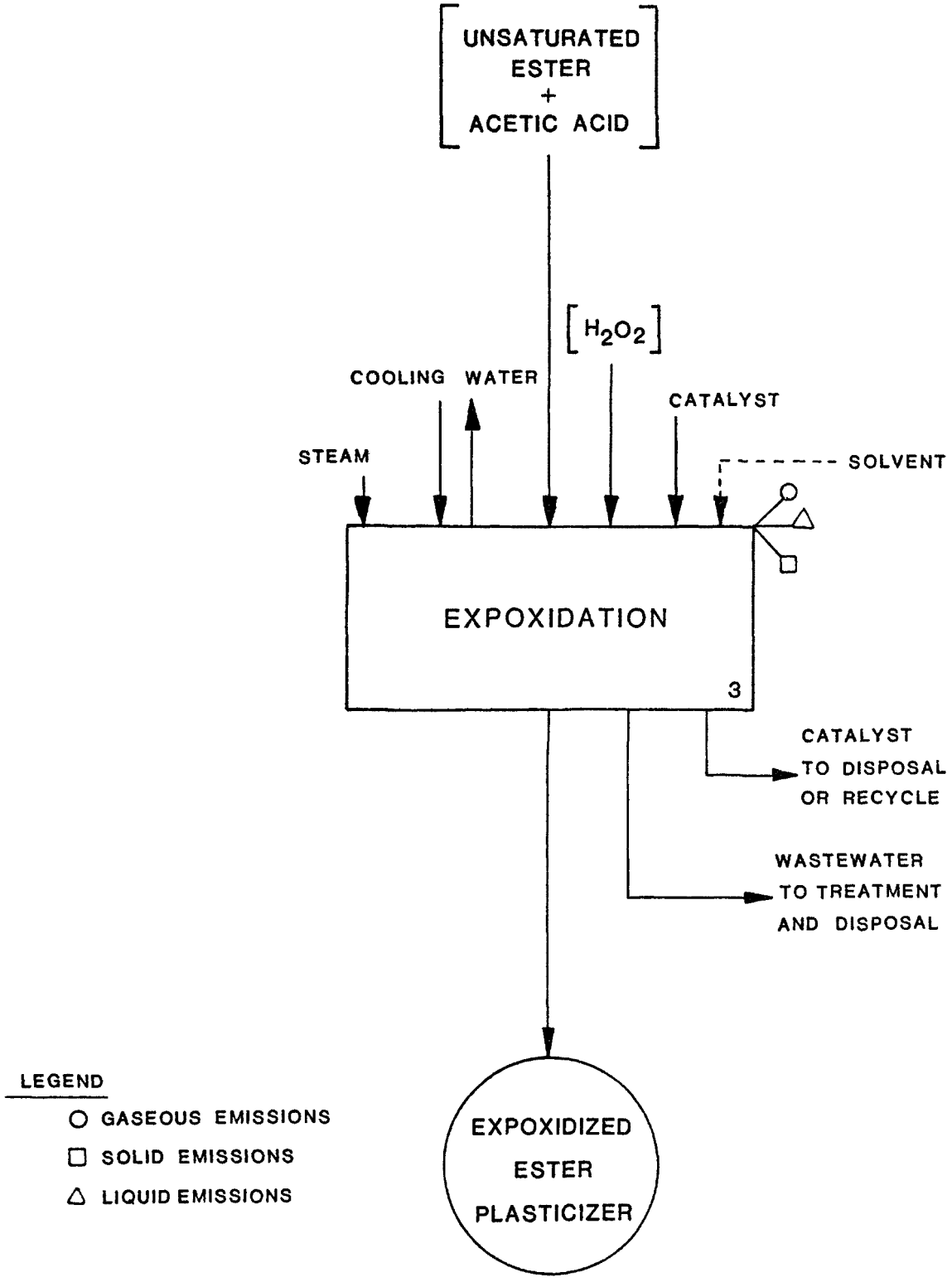
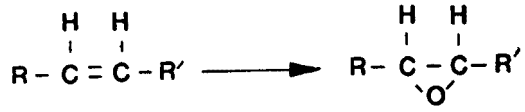


FIGURE 3. PROCESS FLOW SHEET FOR PRODUCTION OF EPOXIDIZED ESTERS

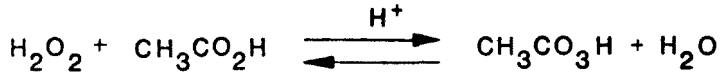
Epoxidation

1. Function - Epoxidation is defined as the reaction in which double bonds in unsaturated (olefinic) esters are converted to cyclic three-membered ethers by an active oxygen agent, as in equation 3-1.

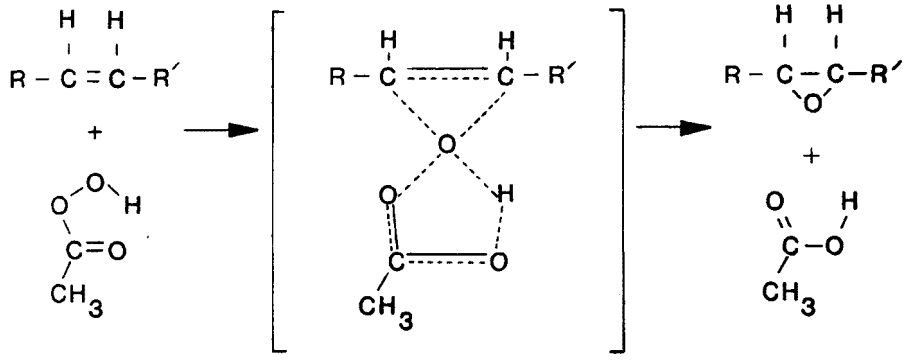


(3-1)

Hydrogen peroxide is the principal oxygen source for this conversion but it must be transformed into a more active form for effective use in commercial epoxidation. Most production systems involve the preparation of peroxyacetic acid (Equation 3-2) which is then thought to interact with this double bond according to Equation 3-3.



(3-2)



(3-3)

Where possible, epoxidation reactions are carried out with peroxyacetic acid formed in situ. A one step reaction is employed in which the peroxyacetic acid is formed and used in the presence of the material to be epoxidized. The hydrogen peroxide is charged to the reaction vessel or the unsaturated ester, a catalyst, and glacial acetic acid. Reaction conditions must be controlled to minimize subsequent opening of the epoxy ring and formation of unwanted by-products.

In the widely used Archer-Daniels-Midland process, epoxy ring opening by the sulfuric acid catalyst is retarded because the system is heterogeneous, consisting of an oil phase and an aqueous phase containing the hydrogen peroxide and acetic acid. In another process based on sulfuric acid catalyses (FMC Corporation) an inert solvent such as benzene or hexane is used to reduce the effect of sulfuric acid in catalyzing epoxy ring opening. Epoxidation may be catalyzed also by the addition of poly(styrenesulfonic acid) resin.

Resin catalyzed systems are characterized by high epoxy yields, little by-product formation, nearly complete elimination of olefinic structure, low reaction temperatures and short reaction times. Because of the relative expense of the resin catalyst, conservation measures are mandatory. These involve either recycle of the resin or the use of minimal quantities of resin with corresponding increases in reaction temperature and time.

Batch production methods are used for epoxidation reactions, but considerable work on development of continuous production systems has been completed. Such methods have been found to offer promise and might be adopted if demand for epoxidized products continues to grow.

In the FMC process described above, the reaction is carried out in a stainless steel reaction vessel fitted with an agitator, cooling coils, reflux condenser, vent, rupture disc, sample line, direct and recording thermometers, feed lines and a manhole. The vessel is equipped with a system for automatically flooding the reaction with water in emergencies.

The Archer-Daniels-Midland system is apparently a two-step epoxidation process in which fresh unsaturated ester is partially epoxidized by continuous agitation with a semi-spent acid containing 1 to 2 percent sulfuric acid, 25 to 30 percent acetic acid and 5 to 6 percent unused active oxygen. The partially epoxidized ester is then separated from the aqueous (acid) phase and reacted with a fresh acid (hydrogen peroxide and acetic acid with sulfuric acid as a catalyst) to complete its epoxidation. The acid from this final epoxidation is then used to partially epoxidize fresh unsaturated ester as described above.

2. Input Materials - The unsaturated ester may be a natural oil such as soybean oil or linseed oil or it may be one of a number of synthetics such as the n-butyl or 2-ethylhexyl esters of tall oil acid or oleic acid. Peroxyacetic acid may be preformed and added in a solvent or it may be formed in situ from hydrogen peroxide and acetic acid in the presence of a catalyst and the unsaturated ester. Table 8 lists quantities of input materials for sulfuric acid catalyzed batch epoxidation of soybean oil by the FMC process.

TABLE 8. INPUT MATERIALS FOR BATCH EPOXIDATION OF SOYBEAN OIL (FMC PROCESS)

Material	Quantity (kg)	Quantity (lbs)
Soybean Oil	907	2,000
Hexane	181	400
Acetic Acid (glacial)	145	320
Sulfuric Acid (50%)	361	796
Hydrogen Peroxide (50%)	347	765

Source: Wallace, John G. Epoxidation. In:Kirk-Othmer Encyclopedia of Chemical Technology, Vol. 8. Anthony Standen, ed., New York, Wiley, 1968, p. 254.

In processes using poly(styrenesulfonic acid) resin as a catalyst, almost complete epoxidation occurs when relatively large amounts of the resin are used. In a typical reaction, a quantity of fatty oil or ester containing 1.0 mole of unsaturation is mixed with 0.55 moles of glacial acetic acid and 12 percent dry resin based on the weight of epoxidizable material. Hydrogen peroxide (1.1 moles) is added slowly to facilitate control of the reaction temperature. After the reaction has reached completion the liquid is decanted or filtered, leaving the resin catalyst in the reactor for succeeding runs.

Specific data relating to reaction efficiency of the various methods for epoxidation of unsaturated esters were not found in the sources consulted for this study. A typical materials list for the epoxidation of soybean oil (iodine value of 130) using the repeated resin process is shown in Table 9.

TABLE 9. INPUT MATERIALS FOR RESIN CATALYZED EPOXIDATION OF SOYBEAN OIL

Material	Amount Used (mg/kg final product)
Soybean Oil	935
Hydrogen Peroxide (70%)	252
Acetic Acid (glacial)	95
Resin	10

Source: Wallace, John G. Epoxidation. In:Kirk-Othmer Encyclopedia of Chemical Technology, Vol. 8. Anthony Standed, ed. New York, Wiley, 1968, p. 258.

3. Operating Parameters - The FMC process for epoxidation of soybean oil employs a stainless steel reaction vessel with a capacity of 2.27 m^3 (600 gal). Common (18-8) stainless steel such as types 304 and 316 are satisfactory for both peroxyacetic acid formation and epoxidation reactions, with type 316 preferred. Welds in reactors and tanks are avoided as much as possible since the welds contribute to decomposition of active oxygen and may be subject to corrosion. Storage tanks for hydrogen peroxide are constructed of high-purity (99.6%) aluminum. All equipment must be thoroughly cleaned to remove any foreign materials which would decompose active oxygen. The stainless steel surfaces are passivated with nitric acid or glacial acetic acid containing small amounts of hydrogen peroxide. Continued use tends to improve the passive condition of the equipment surfaces.

Reaction times and temperatures vary according to the particular method used for epoxidation as shown in Table 10.

TABLE 10. OPERATING PARAMETERS FOR SEVERAL EPOXIDATION PROCESSES

Process Name	Catalyst	Addition Temperature	Reaction Temp.	Reaction Time	Batch Size
Archer-Daniels-Midland	Sulfuric Acid	50°-60°	50°-60°	13 hr.	N.A.
FMC	Sulfuric Acid	50°-60°	60°-65°	-[a]	907 kg
Repeated Resin	Poly(styrenesulfonic acid)	<60°	60°	4 hr.	N.A.
Mimimal Resin	Poly(styrenesulfonic acid)	N.A.	75°-80°	7-8 hr.	N.A.

[a]Reaction is continued until hydrogen peroxide has been consumed.
N.A.-indicates data is not available.

Source: Wallace, John G. Epoxidation. In:Kirk-Othmer Encyclopedia of Chemical Technology, Vol. 8. Anthony Standen, ed., New York, Wiley, 1968.

4. Utilities - No quantitative information was found on utility requirements. Electricity is required for pumping and agitation. Most process configurations require steam for initial heating and cooling water for temperature control during the reaction.

5. Waste Streams - No information was available on the amount or composition of waste streams. Fugitive emissions of acetic acid vapors can be expected. In processes using sulfuric acid catalyst, spent process water will contain high concentrations of sulfates, be saturated with epoxidized oil product and contain materials added to destroy peroxides. In processes using ion-exchange resins the spent process water will have a lower sulfate content but will contain resin degradation products. Additional waste water comes from operations which wash the product. These waters will contain the same materials as spent process liquors but in lower concentrations in most cases. Spent resin used as catalyst is a solid waste.

6. EPA Source Classification Code - None Exists.

7. References -

Darby, J. R. and J. K. Sears. Plasticizers. In: Kirk-Othmer Encyclopedia of Chemical Technology, Vol 15. Anthony Standen, ed. N.Y., Wiley, 1968, p. 720-789.

Jones, Robert W. and K. T. Chandy. Synthetic Plastics. In: Riegel's Handbook of Industrial Chemistry, 7th Ed. James A. Kent, ed. N.Y., Van Nostrand Reinhold, 1974, p. 292.

McBroom, John W. Stabilizers (PVC). In: Chemical and Process Technology Encyclopedia. Douglas M. Considine, ed. N.Y., McGraw-Hill, 1974, p. 1058.

Reents, Curtin A. Ion Exclusion. In: Chemical and Process Technology Encyclopedia. Douglas M. Considine, ed. N.Y., McGraw-Hill, 1974, p. 622.

Sheppard, C. S. Peroxides, Organic. In: Chemical and Process Technology Encyclopedia. Douglas M. Considine, ed. N.Y., McGraw-Hill, 1974, p. 838.

Wallace, John G. Epoxidation. In: Kirk-Othmer Encyclopedia of Chemical Technology, Vol 8. Anthony Standen, ed. N.Y., Wiley, 1968, p. 238-263.

APPENDIX A

RAW MATERIALS

Table A-1. CARBOXYLIC ACIDS

abietic acid
acetic acid (anhydride)
acetoystearic acid
acetyl citric acid
acetylricinoleic acid
adipic acid
azelaic acid

benzoic acid
butyric acid

capric acid
caprylic acid
citric acid

2-ethylbutyric acid
2-ethylhexoic acid

fumaric acid

hydrogenated abietic acid
p-hydroxybenzoic acid

isobutyric acid
isobutyric acid anhydride
isophthalic acid

lauric acid

maleic acid
myristic acid

oleic acid

palmitic acid
pelargonic acid
pentachlorostearic acid
phthalic acid (anhydride)

ricinoleic acid

sebacic acid
stearic acid
succinic acid

tall oil acids
tartaric acid
triacetoxystearic acid
triacetylricinoleic acid

Table A-2. ALCOHOLS USED WITH CARBOXYLIC ACIDS

amyl alcohol

benzyl alcohol
butyl alcohol
n-butyl alcohol

butoxyethoxyethyl alcohol
butoxyethyl alcohol
2-butoxyethyl alcohol

capryl alcohol
cyclohexyl alcohol

decyl alcohol
n-decyl alcohol
diethylene glycol
diethylene glycol monoethyl ether
dipropylene glycol

ethoxyethoxyethyl alcohol
ethoxyethyl alcohol
ethyl alcohol
ethylene glycol
ethylene glycol monobutyl ether
ethylene glycol monoethyl ether
ethylene glycol monomethyl ether
2-ethylhexyl alcohol

glycerol

heptyl alcohol
n-heptyl alcohol
hexyl alcohol
n-hexyl alcohol
hydroabietyl alcohol

isobutyl alcohol
isodecyl alcohol
isoheptyl alcohol
isohexyl alcohol
isononyl alcohol
iso-octyl alcohol
isopropyl alcohol
isotridecyl alcohol

linear C_7-C_9 alcohol

methoxyethyl alcohol
methoxyl-ethyl alcohol
methyl alcohol
methyl cyclohexyl alcohol

neopentyl glycol
nonyl alcohol
n-nonyl alcohol

octyl alcohol
n-octyl alcohol

pentaerylthritol
phenol
polyethylene glycol
propyl alcohol
n-propyl alcohol
propylene glycol
1, 2-propylene glycol

tetraethylene glycol
tetrahydrofurfuryl alcohol
tridecyl alcohol
triethylene glycol
trimethylolethane
2,2,4-trimethyl-1,3-pentanediol

sucrose

undecyl alcohol

Table A-3. ALCOHOLS USED WITH $POCl_3$ TO MAKE PHOSPHATE ESTERS

butoxyethyl alcohol
butyl alcohol

chloroethyl alcohol
2-chloroethyl alcohol
cresol

dichloropropyl alcohol
dimethyl phenol

ethyl alcohol
2-ethylhexyl alcohol

isopropyl phenol

octyl alcohol

phenol

xylenol

APPENDIX B

PRODUCTS

Plasticizers chart

Name[1]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics†										Manufacturers and suppliers[1]
								CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	
Abietic acid derivatives																		
Hydroabietyl alcohol (M)	1.008	1.526[2]	185	1.5×10 5@ 25°C.	–	32-33	–	I	I	C	C	P	I	I	P	C	P	504
Methyl abietate (M)	1.03	1.53[2]	160	<0.1@ 25°C.	352-356@ 760mm.	–	Approx. 2700	I	P	C	C	C	C	I	C	C	C	504
Hydrogenated methyl abietate (M)	1.02	1.52[2]	182	<0.1@ 25°C.	360-364@ 760mm.	–	Approx. 4125	I	P	C	C	C	C	I	C	C	C	504
Adipic acid derivatives																		
Benzyloctyl adipate (M)	0.998	1.479	200-220	–	235-255@ 10mm.	–	16-17[2]	I	P	C	C	–	C	P	–	C	C	146, 719
Butyl carbitol adipate (M)	1.02	–	–	–	350@ 4mm.	–	–	–	–	–	–	–	–	–	–	–	–	493
Dimethyl adipate (M)	1.058	1.426	140	–	230@ 12mm.	–	–	C	C	C	–	–	–	–	–	–	–	474, 1107
Dibutyl adipate (M)	0.961	1.434	116	–	168-170@ 17mm.	–	5-6[2]	P	C	C	C	–	–	C	C	C	C	146, 474, 485, 719, 1107, 1192
Di-isobutyl adipate (M)	0.960[2]	1.4293	160	–	135-147@ 4mm.	−20	6.0[2]	–	C	C	–	–	–	C	–	C	C	103, 128, 371, 474, 485, 1107, 1192
Di-(2-ethylhexyl) adipate (M)	0.9268[2]	1.446-1.447	192-206	2.3-2.4@ 200°C.[6]	214@ 5mm. 224@ 10mm.	−75[5]	12-15[2] 8.2@ 37.8°C.	P	C	C	C	P	C	C	C	C	C	103, 128, 132, 146, 345, 346, 474, 485, 493, 639, 715, 719, 738, 739, 839, 917, 950, 961, 982, 998, 1070, 1074, 1107, 1115, 1116, 1159, 1192
Di-(2-ethylhexyl) adipate (P)	0.926[2]	1.446-1.447[2]	206	2.4@ 200°C.	214@ 5mm.	−75[5]	–	P	C	C	C	P	C	P	P	C	C	371
Di-(2-ethylhexyl) adipate (M)	0.924-0.930[2]	1.446-1.449[2]	182-192	–	208-218@ 4mm.	–	–	–	–	C	C	–	C	–	C	C	–	232, 739
Di-(2-ethylhexyl) adipate (M)	0.924-0.928[2]	1.447-1.448[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Di-(2-ethylhexyl) adipate	0.927[2]	1.448[2]	377°F.	–	–	–	14 cs.[2]	–	–	C	C	–	C	–	–	C	–	639
Di-octyl adipate (M)	0.921-0.924[4]	1.446-1.449[2]	200	–	–	–	12-16[2]	P	C	C	C	P	C	C	P	C	C	501
Di-isononyl adipate (M)	0.924[2]	1.450[2]	225	–	250-260@ <10mm.	−59[4]	22-25[2]	I	P	C	C	C	C	I	–	C	C	146, 719, 1107
Di-isononyl adipate (M)	0.924[2]	1.450[2]	225	–	–	−59[4]	–	I	C	C	C	–	–	I	–	C	C	370
Di-isooctyl adipate (M)	0.928[2] 0.922	1.449 1.445	210 195	<0.12@ 150°C.	205-220@ 4mm.	<−70 to −41	17.7-27[2]	P	C	C	C	C	C	C	P	C	C	103, 345, 485, 839, 917, 961, 1070, 1074, 1107, 1111, 1192
Dinonyl adipate (M)	0.915-0.916[2]	1.445	202-232	–	230@ 5mm.	−65	–	P	C	–	C	C	C	–	–	C	C	1107, 1111, 1116
C_7 - $_9$ linear adipate (M)	0.919	1.444	205	3.3@ 200°C.	224@ 10mm.	–	12.8@ 25°C.	P	C	C	C	P	C	C	P	C	C	738
Di-capryl adipate (M)	0.914	1.4390	224	–	–	–	–	P	C	C	C	P	P	P	P	C	C	1107, 1116
Octyl decyl adipate (M) (*n*-octyl, *n*-decyl adipate)	0.915-0.924	1.447-1.451	200-235	<0.04@ 150°C.	210-232@ 4mm. 235@ 5mm.	<−60 to −4	16	P	C	C	C	P	C	C	P	C	C	345, 485, 493, 839, 917, 961, 1070, 1107, 1111, 1192
Straight chain alcohol adipate (M)	0.924@ 23°C.	1.447@ 23°C.	232	–	–	–	–	P	C	C	C	P	C	C	P	C	C	128, 917, 1111
Straight chain alcohol adipate (M)	0.916@ 23°C.	1.447@ 23°C.	235	–	–	–	–	P	C	C	C	P	C	C	P	C	C	917, 1111
Di-decyl adipate (M) (Di-isodecyl adipate)	0.917-0.922[2]	1.4495-1.4510	219	0.02@ 150°C. 0.58@ 200°C.	238-246@ 4mm. 245@ 5mm. 349@ 760mm.	−84[4] to −43	25-27[2]	P	C	C	C	P	P	P	P	C	P	103, 345, 474, 485, 493, 715, 839, 917, 961, 982, 1070, 1107, 1111, 1116, 1159, 1192
Dimethoxyethyl adipate (M)	1.075	1.439	–	–	185-190@ 11mm.	−16	–	C	C	C	–	–	–	–	–	–	–	1107, 1192
Diethoxyethyl adipate (M)	1.036	1.439	–	–	165@ 4mm.	<−70	–	C	C	C	–	–	–	–	–	–	–	1107, 1192
Dibutoxyethyl adipate (M)	0.997[2]	1.442	188	<0.17@ 150°C.	208-215@ 4mm.	−34	12.4[2]	P	C	C	C	C	C	P	C	C	C	103, 485, 1107, 1192
Dibutoxyethoxy ethyl adipate (M)	1.025	1.447	166	–	240-260@ 1-3mm.	–	15	I	I	C	C	–	–	C	C	–	–	1088, 1107, 1162, 1192
High molecular weight adipate (P)	1.08-1.09[4]	1.472-1.473[2]	300	–		–	2000-3000[4]	–	C	C	–	–	–	–	–	C	–	146, 719
High molecular weight adipate (P)	1.11-1.12[4]	1.472-1.473[2]	300	–	–	–	2000-3000[4]	–	C	C	–	–	–	C	–	C	–	146, 719
High molecular weight adipate (P)	1.10-1.11[4]	1.469-1.470[4]	200	–	–	–	1000-1300[4]	–	C	C	–	–	–	C	–	C	–	146, 719
Low temperature plasticizer	0.917	–	230	–	220	–	–	–	–	–	–	–	–	P	P	C	C	1074
Polypropylene adipate (P)	1.15	1.469	–	–	–	−20	10,000-20,000	–	–	–	–	–	–	–	–	C	–	206, 536, 537, 982
Modified polypropylene adipate (P)	1.10	–	–	–	–	−25	200-800	–	–	–	–	–	–	–	–	C	–	206, 536, 537, 982
Modified polypropylene adipate (P)	1.10	1.465	–	–	–	−25	2200-3000	–	–	–	–	–	–	–	–	C	–	206, 536, 537, 982
Modified polypropylene adipate	1.05	1.452	–		–	−25	–	–	–	–	–	–	–	–	–	C	–	206, 536, 537
Di-linear alkyl adipate	0.913-0.919	1.443-1.449	–	–	–	–	–	P	C	C	C	P	C	C	P	C	C	715
Azelaic acid derivatives																		
Dicyclohexyl azelate	1.0096[2]	1.4698	230	–	–	–	–	–	–	–	–	–	–	–	–	C	–	839, 1107
Di-2-ethylhexyl azelate (M)	0.917	1.446	227	–	237@ 5mm.	<−65	10.0	P	C	C	C	–	C	C	I	C	C	345, 346, 354, 485, 493, 519, 839, 1070, 1074, 1107
Di-*n*-hexyl azelate (M)	0.93-0.977[2]	1.444	205	–	216@ 5mm.	−24	7.8	C	C	C	C	–	–	P	I	C	C	354, 839, 1107
Low temperature plasticizer (M)	0.917[2]	1.446	213	–	234@ 5mm.	−32	10.2	C	C	C	C	–	–	P	I	C	C	354
Di-isooctyl azelate (M)	0.918-0.920[2]	1.448-1.450	213-219	–	225-244@ 5mm.	−68	–	C	C	C	C	–	–	P	I	C	C	345, 485, 1107

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible

[1]Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[2](M) indicates monomeric; (P) indicates polymeric. [3]Measurement made at 20 C. [4]Freezing point. [5]Measurement made at 20 C in 80% water. [6]PM closed cup. [7]Decomposes. [8]Pour point.

Plasticizers chart (Cont'd)

Name[1]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PMA	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Azelaic acid derivatives (Cont'd)																		
Diisobutyl azelate	0.932	1.4351	179	–	164-177@ 4mm.	24	–	I	C	C	C	C	I	P	P	C	C	1107
Benzoic acid derivatives																		
2-ethylhexyl-p-hydroxy-benzoate	1.04	1.519		–	238-247@ 20mm.	–	–											129
Diethylene glycol dibenzoate	1.178 1.1765[3]	1.5424 1.5449[3]	232	–	240@ 5mm.	16 28[3]	160@ 77°F.	I	C	C	C	C	I	C	C	C	C	1148
Dipropylene glycol dibenzoate (M)	1.129	1.5282	212	–	232@ 5mm.	-40	120@ 77°F.	I	C	C	C	C	C	C	C	C	C	345, 1146
	1.1260[3]	1 5300[3]																
Diethylene glycol benzoate and dipropylene glycol benzoate blend (M)	1.14	1.535	213	–	235@ 5mm.	6	–	P	C	C	C	C	C	C	C	C	C	493,1146
Triethylene glycol dibenzoate (M)	1.2718@ 30°C.	–	237	–	223-237@ 1mm.	47	–	P	P	P	P	P	P	P	P	P	P	493, 1146
Polyethylene glycol (200) dibenzoate (M)	1.158	1.5252	248	–	217-290@ 1mm.	-40		P	C	P	C	C	C	C	C	P	P	493, 1146
Polyethylene glycol (600) dibenzoate (M)	1.141	1.4984	264	–	non-distill.	3.8	–	I	P	P	P	P	P	P	P	I	I	493, 1146
Benzophenone	1.0976@ 50°	1.5975@ 45°	–	–	305	48	–	C	C	–	–	–	–	–	–	–	–	330
2,2,4-trimethyl-1,3-pentanediol isobutyrate benzoate (M)	1.020[3]	1.4848	193	–	330	-41	–	P	C	C	P	–	C	C	–	C	C	346
Neopentyl glycol dibenzoate (M)	1.2154@ 30°C.	–	424	–	–	49	–	P	C	P	C	C	P	P	C	C	P	1146
Glyceryl tribenzoate (M)	1.2619@ 30°C.	–	490	–	–	71	–	P	C	P	C	C	P	P	P	C	P	1146
Trimethylolethane tribenzoate (M)	1.2419@ 30°C.	–	530	–	–	81	–	P	P	P	P	P	P	P	P	C	P	1146
Pentaerythritol tetrabenzoate (M)	1.2801@ 30°C.	–	600	–	–	99	–	P	C	P	C	C	P	P	P	C	P	1146
Polyphenyl derivatives																		
Hydrogenated terphenyl (M)	1.001-1.007	1.560-1.575	174	2@ 150°C.	340-396	–	29@ 25°C.	I	C	C	C	–	C	C	C	C	C	738
Citric acid derivatives																		
Triethyl citrate	1.136	1.4405@ 24.5°	155	–	127@ 1mm.	-55	–	C	C	C	C	–	P	C	C	C	C	839
Tricyclohexyl citrate	1.7[3]	–	–	–	–	57	–	I	–	C	–	C	C	C	C	C	C	839
Tri-n-butyl citrate (M)	1.049[3]	1.4453[3]	185	–	170@ 1mm.	-85	–	C	C	C	C	–	C	C	C	C	C	132, 639, 839
Acetyl triethyl citrate	1.1356@ 23°	1.4386@ 23°	188	–	132@ 1mm.	-50	–	C	C	C	C	–	C	C	C	C	C	839
Acetyl tri-n-butyl citrate	1.046	1.4408@ 25.5°	204	–	173@ 1mm.	-80	–	P	P	C	C	–	C	C	C	C	C	839
Acetal tri-n-butyl citrate	1.053[3]	1.444[3]	204	–	173@ 1mm.	39 ca.[3]	–	C	C	C	C	–	–	C	–	C	C	639
Epoxy derivatives																		
Alkyl epoxy stearate (M)	0.900[3]	1.455[3]	220	–	–	-1	25[3]	I	C	C	C	I	P	I	P	C	C	501
Alkyl epoxy stearate (M)	0.920[3]	1.460[3]	210	–	–	-20	~35[3]	I	C	C	C	I	P	I	P	C	C	501
Butyl epoxy stearate (M)	0.935	1.450	–	–	–	–	–	I	I	C	C	–	–	P	I	C	C	1148
Butyl epoxy stearate (M)	0.906	1.452	–	–	–	–	–	I	I	C	C	–	–	P	I	C	C	31
Epoxy-type plasticizer (M)	0.910[3]	1.451	210	0.06@ 150°C	200-250	–	–	P	C	C	C	P	C	C	P	C	C	31
Epoxy-type plasticizer (M)	1.013	1.468	290	–	–	-23	–	–	C	C	C	–	P	C	C	C	C	748
Epoxy-type plasticizer	0.923	1.457	232	–	–	–	18.0[3]	I	C	–	C	–	–	I	–	C	–	103
Epoxy-type plasticizer	–	–	–	–	–	0°F.	–	I	C	–	C	–	–	I	–	C	–	103
Epoxy-type plasticizer	0.994	1.472	310	–	–	–	–	–	P	C	C	I	I	–	–	C	C	103
Epoxy-type plasticizer	0.991	1.471	310	–	–	–	–	–	P	C	C	I	I	I	I	C	C	103
Epoxy-type plasticizer (P)	0.920	1.4580	265	–	260@ 2mm.	-22	–	–	C	C	C	–	–	–	–	C	C	345, 639
Epoxy type plasticizer tallate (M)	0.920	1.4580	265	–	260@ 2mm.	-22	20@ 25°C.	–	C	C	C	–	–	–	–	C	C	91
Epoxy-type plasticizer (M)	0.909	1.452	196	–	–	-1	20	I	I	C	C	–	–	I	I	C	C	950
Epoxy-type plasticizer (M)	0.9160	1 4583	220	–	–	-8	50	I	I	C	C	–	–	I	I	C	C	950
Epoxy-type plasticizer (P)	0.990-0.996	1 471	310	–	–	0-5	340	I	I	C	C	–	–	P	I	C	C	950
Epoxy-type plasticizer (M)	0 991-0.995	1.472	310	<1@ 330°C		0-5	–	I	I	C	C	–	–	P	I	C	C	345
Epoxy-type plasticizer (P)	0.991-0.995	1.472	310	<1@ 330°C.	–	0-5	350	I	I	C	C	–	–	P	I	C	C	950
Epoxy-type plasticizer (M)	0.993-0.998	1.471	316	–	–	0-5	–	I	I	C	C	–	–	P	I	C	C	345
Epoxy-type plasticizer (P)	0.993-0.998	1.471	310	–	–	0-5	440	I	I	C	C	–	–	P	I	C	C	950
Epoxy-type plasticizer (M)	0.927	1.458	224	–	–	-7	40	I	I	C	C	–	–	I	I	C	C	950
Epoxy-type plasticizer (M)	0.945	1.460	296	–	–	0	90	I	I	C	C	–	–	I	P	C	C	950
Epoxidized octyl tallate (M)	0 920 ± 003	1 457	235	–	–	–	~ 35	I	C	C	C	I	I	C	P	C	C	474
Epoxy-type plasticizer (M)	0.922	1.457	216	–	260@ 2mm.	-18	–	–	C	C	C	–	–	–	–	C	C	748
Epoxy-type plasticizer	0.993	1.471	–	–		–		I	I	C	C	–	–	I	I	C	C	1070
Epoxy-type plasticizer	0.932	1.454	–	–		–	–	–	–	C	C	–	–	P	I	C	C	1070
Epoxy-type plasticizer	0 919	1.458	–	–	–	–	–	I	I	C	C	–	–	I	I	C	C	1070
Epoxy-type plasticizer	0.898	1.450	–	–	–	–		–	C	C	C	–	–	–	–	C	C	1070
Epoxy-type plasticizer	0 903	1.448	–	–	–	–	–	I	C	C	C	P	P	P	P	C	C	1070
Epoxy-type plasticizer	0.9867[3]	1 4690[3]	460°F.	0.3@ 200°C.	>200@ 5mm.	-38[4]	–	P	P	C	C	C	C	C	C	C	C	1117
Alkyl epoxy stearate (M)	0.899	1.4537	265	–	240-2mm.	-13.5	20@ 25°C.	–	C	C	C	–	–	–	–	C	C	91, 639
Epoxidized butyl ester	0.963	1.459	210	–	–	–	–	P	C	C	C	I	I	P	C	C	C	1064
Epoxidized octyl tallate (M)	0.919	1.457	230	–	–	-13	–	I	C	C	C	I	I	I	C	C	C	1064, 1116
Epoxidized octyl tallate (M)	0 923	1.457	232	–	>215@ 5mm.	-15[4]	–	–	C	C	C	–	–	–	–	C	C	1111
Epoxidized soy bean oil (M)	0.995	1.471	320	–	–	–	445[3]	I	P	C	C	I	I	I	I	C	C	103, 371, 486, 1116
Epoxidized soy bean oil (M)	0.993	1 472	310	–		–	500[3]	I	P	C	C	I	I	I	I	C	C	601
Epoxidized triglyceride	1.020	1 4710	320	–	–	–	–	P	P	C	P	I	I	I	I	C	C	677, 1064
Epoxy soy bean oil (M)	0 992	1.472	–	–	–	–	–	I	P	C	C	I	I	P	I	C	C	31
Epoxidized soy bean oil (M)	0.9956[3]	1.4727	315	–	>150@ 5mm.[5]	-4[4]	–	–	P	C	C	I	I	I	I	C	C	493, 693, 1117

*Code for column headings: Sp. Gr = specific gravity; R I = refractive index; F P. = flash point (Cleveland open cup); V P = vapor pressure; B R = boiling range; M.P = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate, EC = ethyl cellulose, PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[1]Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[2](M) indicates monomeric; (P) indicates polymeric. [3]Measurement made at 20°C. [4]Freezing point. [5]Measurement made at 20 C in 60% water. [6]PM closed cup. [7]Decomposes. [8]Pour point.

Plasticizers chart (Cont'd)

Name[2]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Epoxy derivatives (Cont'd)																		
Epoxidized soy bean oil (M)	0.992	1.4720	310	–	–	0-5	365	I	P	C	C	I	I	I	I	C	C	371, 639 1074
Epoxidized soy bean oil (P)	0.992	1.4720	310	–	–	0-5	320@25°C. ~440	I	P	C	C	I	I	I	I	C	C	91, 474
Epoxidized soy bean oil (M)	0.994	1.4720	307	–	–	–	445[3]	I	C	C	C	–	–	P	–	C	C	103
Epoxidized soy bean oil (M)	0.991	1.4710	310	–	–	–	449[3]	I	C	C	C	–	–	P	–	C	C	103
Epoxidized soy bean oil (P)	0.992	1.4720	–	–	–	–	350	I	C	C	C	–	–	P	–	C	C	1148
Epoxidized sunflower oil (P)	0.985	1.4710	–	–	–	–	320	I	C	C	C	–	–	P	–	C	C	1148
Epoxy-type plasticizer (M)	0.993	1.471	312	–	–	–4	–	I	P	C	C	I	I	I	I	C	C	748
Epoxidized soy bean oil (M)	0.996	1.4710	315	–	150@5mm.	6.5	–	I	I	C	C	–	–	I	–	C	C	1111
Epoxidized linseed oil (P)	1.020	1.4710	320	–	–	–	815-1200[3]	P	P	C	P	–	–	P	–	C	C	91, 103, 639, 1054
Epoxidized tallate ester (M)	0.923	1.4570	307	–	–	–	45[3]	I	C	C	C	–	–	P	–	C	C	103
Epoxidized tallate ester	0.922	–	230	–	–	–	–	I	C	C	C	I	I	I	C	C	C	91, 639, 1074
Epoxidized tallate ester (M)	0.920	–	–	–	–	–	45.7[3]	I	C	C	C	–	–	P	–	C	C	103
2-ethylhexyl-epoxy tallate (M)	0.923[3]	1.4581[3]	235[4]	0.3*@200°C.	215@5mm.[4]	–8.5[5]	–	I	C	C	C	I	I	I	C	C	C	693, 1117
Epoxy ester	0.9310[3]	1.456	246	0.01[3]	240@5mm.	–10[4]	–	P	P	C	C	C	C	C	C	C	C	693
Octyl epoxy stearate (M)	0.897	1.454	–	–		–	–	–	–	C	C	–	–	C	I	C	C	31
Octyl epoxy stearate (M)	0.935	1.458	–	–	–	–13[7]	20	–	–	C	C	–	–	C	C	C	C	1148
Proprietary esters																		
Monomeric esters (M)	0.940	1.489	275	–		–6	700	I	C	C	C	–	–	I	C	C	–	950
Proprietary ester	0.9446	1.4614	286	–	–	+10°F.	130[3]	I	C	C	C	–	–	C	–	C	C	103
Proprietary ester (P)	1.0077	1.4427	306	–	–	–15°F.	1410[3]	–	–	–	–	–	–	–	–	C	C	103
Proprietary ester (M)	0.929	1.452	218	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1111
Proprietary ester (P)	0.929	1.452	218	–	–	–	720	–	–	–	–	–	–	–	–	C	C	577
Proprietary ester (M)	0.932	1.425	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	493, 812A
Mixed ester	1.03[3]	1.485	205	–	–	–	–	I	C	C	C	I	C	C	C	C	I	1074
Ether derivatives																		
Bis p-(1,1,3,3-tetramethyl butyl-phenyl) ether	0.92-0.95 @25 4°C.	–	168	–	–	–	–	–	–	–	C	–	–	–	–	–	–	330
Polyvinyl ethylether	1.0±0 05	1.450	–	–	–	–	–	I	I	C	I	I	I	I	–	I	I	129
Polyvinyl methylether	1.03	1.460	–	–	–	–	–	I	I	C	I	I	C	I	–	I	P	129, 427
Formal																		
Butyl carbitol formal (M)	0.97	–	–	–	–	–25	–	I	I	C	I	I	I	I	C	C	I	493, 639, 1088
Fumaric acid derivatives																		
Dibutyl fumarate (M)	0.986	1.444	138	–	285	–20	–	–	–	–	–	–	–	C	–	C	C	519, 639, 738, 839, 917, 1107 1111
Diisooctyl fumarate	–	–	182	–	219@5mm.	–	–	–	–	–	–	–	–	–	–	C	–	839, 961, 1107
Dioctyl fumarate (M)	0.934	1.544	193	0.3@100°C.	216@5mm.	–62	–	–	–	–	–	–	–	C	–	C	C	839, 961, 1107, 1111
Di-n-butyl fumarate	0.989[3]	1.449[3]	298°F.	–	132@4mm.	–	5.6cs.[3]	–	–	–	–	–	C	–	–	C	C	639, 1107
Glycerol derivatives																		
Glycerol monoacetate (M)	1.190	1.4535	148	–	160-178 @30mm.	<–30	–	C	–	C	–	–	–	–	–	–	I	94, 485, 812A
Glycerol diacetate	1.186[3]	–	146	–	142-153@11mm.	<–30	–	C	–	C	–	–	–	–	–	–	I	94, 485
Glycerol triacetate (M)	1.160	1.429	152	<0.01[3]	259-262	–3.2[6]	23[3]	C	C	C	C	C	C	C	–	–	I	94, 129, 146 228, 346, 485 719, 733, 1117, 1192
Glycerol tributyrate (M)	1.035[3]	1.4359[3]	180	–	315	<–75	–	C	C	C	C	–	C	C	–	–	–	346
Glycerol ether acetate	1.140	1.450	–	–	–	–41	–	C	C	C	C	I	I	C	–	I	–	129
Glycol derivatives																		
Ethylene glycol di-acetate (M)	1.10	1.416	92[7]	–	–	–	–	C	C	C	C	I	I	C	–	–	–	31, 346, 1107, 1117
Diethylene glycol dipelargonate (M)	0.966[3]	1.444	210	–	229@5mm.	–15	9.5	I	C	C	C	–	–	P	C	C	C	354, 485, 961
Triethylene glycol dipelargonate (M)	0.965[3]	1.448[3]	210	–	–	<–18	–	I	P	C	C	P	–	–	C	C	C	354, 485, 961
Triethylene glycol diacetate (M)	1.115	1.437	–	–	170-197@20mm.	<–60	11-12[3]	C	C	C	C	C	–	–	–	–	–	146, 228, 719, 1107, 1117
Triethylene glycol di-(2-ethylbutyrate) (M)	0.9946[3]	1.4404[3]	196	6@200°C.	196@5mm.	–65[6]	–	I	C	C	C	C	–	C	C	C	C	1117
Triethylene glycol di-caprylate-caprate (M)	0.965	1.4455	185	–	180-247@ 2.5mm.	–	0.26 stokes	–	–	C	C	–	–	–	C	C	C	94, 103, 132, 485, 493, 812A, 961
Triethylene glycol di-(2-ethylhexoate)	0.9679[3]	1.444[3]	207	1.9@ 200°C.	219@ 5mm.	–65[6]	–	I	C	C	C	C	–	I	P	C	C	1117
Triethylene glycol dicaprylate (M)	0.966	1.453	205	–	227-278@6mm.	–5 to –15	–	I	P	C	C	P	–	–	C	C	C	94, 493, 812A, 961
Tetraethylene glycol dicaprylate	0.985	–	210	–	–	–43	–	–	–	–	–	–	–	–	–	C	C	485
Polyethylene glycol di-(2-ethylhexoate) (P)	0.9892[3]	1.4470[3]	201	–	218@ 5mm.	–55[6]	25[3]	I	C	C	C	C	C	C	I	C	C	1117
Polyethylene glycol 200 (P)	1.124[3]-1.127	1.459-1.4591[3]	171	–	–	Super cools –65	4.0-5 2cs. @ 210°F.	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 427, 585, 693, 794, 1117
Polyethylene glycol 200	1.124[3]-1.127	–	ca 180	–	–	<–40[4]	–	–	–	C	–	–	–	–	–	–	–	232

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[1] Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[2] (M) indicates monomeric; (P) indicates polymeric. [3] Measurement made at 20°C. [4] Pour point.

Plasticizers chart (Cont'd)

Name*	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PMM	PS	VA	VB	VC	VCA	Manufacturers and suppliers‡
Glycol derivatives (Cont'd)																		
Polyethylene glycol 300 (P)	1.124[3]-1.127	1.463-1.464[1]	196	–		−15 to −8[4]	5.5-6.0cs @210°F	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 427, 585, 693, 794, 1117
Polyethylene glycol 300	1.125[3]	–	ca 220	–	–	−10 to −20[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 400 (P)	1.125[3]-1.128	1.465-1.466[1]	224	–		4-8[4]	7.0-8.1cs @210°F.	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 427, 585, 693, 770, 794, 1117
Polyethylene glycol 400	1.126[3]	1.465-1.466[1]	ca 250	–	–	5-7[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 600 (P)	1.125[3]-1.128	1.466-1.468	246	–	–	20-25[4]	10.5-11.0cs @210°F.	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 427, 585, 693, 770, 794, 1117
Polyethylene glycol 600	1.126-1.127[3]	–	ca 260	–	–	16-20[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 1000	1.085	–	265	–	–	37-40[4]	–	–	–	C	–	–	–	–	–	–	–	232, 330, 693, 794, 1117
Polyethylene glycol 1000	1.088[3]	–	ca 260	–		37-39[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 1500 and 500B (P)	1.151	–	221	–	–	38-41[4]	15.0cs.@210°F.	–	–	C	–	–	–	–	–	–	–	129, 232, 693, 1117
Polyethylene glycol 1500 and 550B	1.086[3]	–	ca 215	–		37-40[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 1530		–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	794
Polyethylene glycol 1540 and 1450	1.15[3]	–	265	–	–	43-46[4]	–	–	–	C	–	–	–	–	–	–	–	232, 330, 693, 1117
Polyethylene glycol 1540 and 1450	1.088-1.089[3]	–	ca 260	–	–	46-47[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 2000	1.21	–	–	–	–	Liquid	–	–	–	–	–	–	–	–	–	–	–	232, 330
Polyethylene glycol 2000	1.20 to 1.22-1.089[3]	–	ca 260	–	–	50-51[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 4000 (P)	1.204	–	269	–	–	53-56[4]	80.0cs.@210°F	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 585, 693, 1117
Polyethylene glycol 4000	1.090[3]	–	ca 260	–	–	54.5-55.5[4]	–	–	–	C	–	–	–	–	–	–	–	232
Polyethylene glycol 6000 (P)	–	–	271	–	–	60-63[4]	800cs.@210°F.	–	–	C	–	–	–	–	–	–	–	129, 232, 330, 585, 693, 1117
Polyethylene glycol 6000	1.090[3]	–	ca 260	–	–	56-58[4]	–	–	–	C	–	–	–	–	–	–	–	232
Butyl phthalyl butyl glycolate (M)	1.097	1.490	199	0.10@150°C. 3.9@200°C.	220@10mm.	–	46.0@25°C.	C	C	C	C	C	C	C	C	C	C	738
Triglyceolester of vegetable oil fatty acid (M)	0.97	–	205	–	227-278@6mm.	–	87sus	–	–	–	–	–	–	C	–	C	C	493, 812A, 1192
Triethylene glycol ester of fatty acid (M)	0.992	1.440	200	–	227-278@6mm.	–	–	C	C	–	–	–	–	C	C	C	C	812A
Linear dibasic acid derivatives																		
Isodecyl ester (M)	0.919	1.452	185[6]	–	–	<−5°C.	–	P	C	C	C	–	C	P	–	C	C	31
Isooctyl ester (M)	0.930	1.448	185[6]	–	–	<−5°C.	–	P	C	C	C	–	C	P	–	C	C	31
n-octyl n decyl ester (M)	0.921	1.447	190[6]	–	–	<−5°C.	–	P	–	C	C	–	–	P	–	C	C	31
Nonyl ester (M)	0.922	1.448	185[6]	–	–	<−5°C.	–	P	–	C	C	–	–	P	–	C	C	31
Petroleum derivatives																		
Hydrocarbon, synthesized (P)	0.875	1.4896	–	–	313-368	–	–	–	–	–	–	–	–	C	–	P	P	831
Hydrocarbon type (P)	1.004-1.005	1.567-1.568	174	–	340-396	–	–	I	I	I	P	C	C	–	–	P	P	831
Hydrocarbon type	1.09-1.11	1.6	165	–	300-370	–	–	–	C	P	C	C	C	–	P	C	C	758
Hydrocarbon type (P)	0.960-0.975	1.590	210	–	–	25	–	I	I	I	I	I	P	P	I	I	I	831
Hydrocarbon type (P)	1.09	1.591	–	–	<220@2mm.	85	Solid	C	C	C	C	C	C	C	C	C	C	605
Highly refined white mineral oils	0.839-0.883	1.476	185-224	–	200-500	L	–	–	–	–	C	–	C	–	–	P	–	835
Polyaromatic hydrocarbon oil	0.944@15.6°C.	1.5535	160	–	304-379	–	–	–	P	P	C	P	C	–	–	C	C	72
Aromatic hydrocarbon oil	1.03-1.07@15.6°C.	1.6332[3]	160	–	282-372	–	–	–	–	–	–	–	–	–	–	C	C	72
Aromatic hydrocarbon condensate	1.06-1.09	160.162	>140	0.051@26°C.	300-370	5	–	C	C	C	C	C	C	C	C	C	C	758
Aromatic hydrocarbon	0.9840@15°C.	1.5564[3]	199	–	321-472	−18	–	I	P	P	P	P	P	I	P	P	P	723
Aromatic hydrocarbon (P)	1.07	1.606	191	–	–	25	–	I	I	I	I	P	C	C	I	I	I	758, 831
Aromatic hydrocarbon	0.9923@15°C.	1.5646[3]	224	–	349-510	2	–	I	P	P	P	P	P	P	P	C	C	723
Aromatic hydrocarbon	1.045@15.5°C.	1.6010@60°C.	188	–	343-376	−10[6]	–	–	–	–	–	–	C	–	–	C	C	172
Hydrocarbon type	0.8905@15°C.	1.4872[3]	143	–	271-410	−51	–	I	I	I	P	I	I	I	P	P	P	723
Aromatic hydrocarbon	1.0458@15°C.	1.6520[3]	154	–	280-368	−9	–	P	P	P	C	C	C	C	P	C	C	723
Aromatic hydrocarbon (M)	1.02	1.629	150	–	275-370	−40	–	C	C	C	C	C	C	C	C	C	C	605
Hydrocarbon type (M)	–	–	140	–	290-383	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.900@15.5°C.	–	145	–	302-360	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.899@15.5°C.	–	135	–	272-372	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.899@15.5°C.	–	210	–	373-468	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.901@15.5°C.	–	173	–	310-390	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.896@15.5°C.	–	145	–	287-384	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.910@15.5°C.	–	147	–	155-384	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.870@15.5°C.	–	155	–	302-365	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.959@15.5°C.	–	160	–	300-407	<0.01	–	–	–	–	–	–	–	–	–	P	–	345

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = poly-styrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

‡Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

§(M) indicates monomeric; (P) indicates polymeric. [3]Measurement made at 20°C. [4]Pour point [5]Decomposes. [6]Supercools to about −70 C.

Plasticizers chart (Cont'd)

Name*	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers‡
Petroleum derivatives (Cont'd)																		
Hydrocarbon type (M)	1.012@15.5°C.	–	174	–	320-462	<0.01	–	–	–	–	–	–	–	–	–	P	S	345
Hydrocarbon type (M)	0.991@15.5°C.	–	165	–	296-390	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	–	–	142	–	287-344	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.969@15.5°C.	–	165	–	312-420	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	–	–	181	–	324-384	<0.01	–	–	–	–	–	–	–	–	–	P	–	345
Hydrocarbon type (M)	0.986@15.5°C.	–	107	–	236-274	<0.01	–	–	–	–	–	–	–	–	–	C	–	345
Hydrocarbon type (M)	0.860-0.880[2]	1.4764[2]	149	–	–	–	–	I	P	P	C	–	–	I	–	P	P	370
Isobutyric acid derivative																		
2,2,4-Trimethyl-1, 3-pentanediol diisobutyrate (M)	0.945[2]	1.4300	143	–	280	−70	–	I	C	C	P	–	C	P	–	C	–	346
Sucrose acetate isobutyrate (M)	1.146	1.4540[4]	260	–	288	–	–	P	C	C	C	–	C	C	P	P	C	346
Isophthalic acid derivatives																		
Dimethyl isophthalate	–	–	143	<0.01[2]	150@15mm.	66-67	–	–	–	–	–	–	–	–	–	–	–	733, 839
Di (2-ethylhexyl) isophthalate (M)	0.9840[2]	1.4875[2]	232	0.69@200°C.	241@5mm.	−46[4]	–	I	C	C	C	P	C	I	C	C	C	639, 1070
Diisooctyl isophthalate (M)	0.983@23°C.	1.487@23°C.	232	–	–	–	–	I	P	C	C	P	C	P	C	C	C	345, 917
Dioctyl isophthalate (M)	0.9942	1.4838	–	–	224@1mm.	–	–	–	C	C	C	P	C	P	I	C	C	345, 917
Lactam																		
2-pyrrolidone	1.107	1.486	129.4	–	245	25	–	–	–	–	–	–	–	–	–	–	–	129, 427, 464
Lauric acid derivatives																		
Butyl laurate (M)	0.867[2]	–	–	–	175-260 @20mm.	0	–	–	C	C	C	–	C	–	C	C	–	94, 1192
1,2-Propylene glycol monolaurate (M)	0.911	–	–	–	–	0-12	–	–	–	C	C	–	C	–	C	C	–	94, 103, 485, 493, 770, 812A 1192
Ethylene glycol monoethyl ether laurate	0.89	–	–	–	–	−7 to −11	–	–	C	C	C	–	C	–	C	C	–	485
Ethylene glycol monobutyl ether laurate	0.883	–	–	–	156-198 @5mm.	−3 to −12	–	–	C	C	C	–	C	–	C	C	C	485
Glycerol monolaurate (M)	0.970	–	–	–	–	26-28	–	–	–	C	C	–	C	–	c	c	c	94, 464, 485, 1192
Diethylene glycol monolaurate (M)	0.960	–	–	–	–	9-11	–	–	–	C	C	–	–	C	–	C		94, 464, 485, 770, 1192, 1195
Polyethylene glycol 400 dilaurate (M)	0.97	–	–	–	–	4-14	–	–	–	C	–	–	–	–	–	C	C	94, 103, 464, 485, 812A, 1192, 1195
Polyethylene glycol 400 dilaurate (P)	0.97	–	–	–	–	4-14	–	–	–	C	–	–	–	–	–	C	C	354, 464
Maleic acid derivatives																		
Di-*n*-butyl maleate (M)	0.9944	1.444	141	–	281	<−80 to <−65	–	–	–	–	–	–	–	C	–	–	–	639, 738, 917, 961, 1074, 1107, 1111
Dibutyl maleate	0.9964[2]	1.445-1.446[2]	140.5	–	280.6	−85	–	–	–	–	–	–	–	C	–	–	–	739, 1107
Dibutyl maleate	0.995-0.997[2]	1.445-1.446[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739, 1107
Dioctyl maleate (M)	0.944	1.4535	180	–	195-207 @5mm.Hg.	−50	–	–	–	–	–	–	–	–	–	–	–	519, 639, 917, 1107, 1111
Di-isooctyl maleate	0.945[2]	1.457[2]	–	–	197@4mm.	–	25cs[2]	–	–	–	–	–	C	–	–	C	C	639, 1107
Mellitates																		
n-Octyl, *n*-decyl trimellitate (M)	0.972	1.482	278	–	275@1mm.	−17	–	–	–	–	–	–	–	–	–	C	C	839, 961, 1070, 1111
Tri *n*-octyl *n*-decyl trimellitate (M)	0.978@23°C.	1.482@23°C.	280	–	–	−35[4]	115	–	C	C	C	–	P	–	P	C	C	345, 474, 839, 917, 1111
Trioctyl trimellitate (M)	0.987	1.485	399	–	260@1mm.	−46[4]	300	–	C	C	C	C	P	–	P	C	C	128, 345, 474, 839, 917, 961, 1070, 1074, 1107, 1111
Isooctyl iso-decyl trimellitate (M)	0.983[2]	–	263	–	296	–	–	–	–	–	–	–	–	–	–	–	–	345, 839, 961
Triisononyl trimellitate (M)	0.979[2]	1.484[2]	266	–	–	−40[4]	–	I	C	C	C	–	–	I	–	C	C	370
Triisooctyl trimellitate (M)	0.986@23°C.	1.4830@23°C.	258	–	–	–	100	I	C	C	C	C	P	–	P	C	C	485, 639, 839, 917, 961, 982, 1107, 1111
Tri-capryl trimellitate (M)	0.977	1.4780	268	–	–	–	–	–	C	C	C	C	P	–	P	C	C	1116
Diisooctyl mono isodecyl trimellitate	0.978@23°C.	1.4838@23°C.	249	–	–	–	–	–	C	C	C	C	P	–	P	C	C	917
Triisodecyl trimellitate	0.969[2]	1.4830	270	–	–	−35[4]	–	–	–	–	–	–	–	–	–	C	–	839, 961
Tri (C 7-9 alkyl) trimellitate (M)	0.983	1.482	310	4.4@250°C.	263@10mm.	–	54.6@25°C.	–	C	C	C	C	P	–	P	C	C	738, 1107
Tri 2-ethylhexyl-trimellitate (M)	0.984[4]	1.4832	263	–	260@1mm.	−38	300	I	C	C	C	C	P	–	P	C	C	346, 474, 1107
Myristic acid derivatives																		
Isopropyl myristate (M)	0.849	1.432	146	–	–	–	–	–	C	C	C	–	–	–	–	–	–	94, 103, 132, 345, 812A, 1192
Isopropyl myristate (M)	0.853	1.433	166	–	–	–	–	–	C	C	C	–	–	–	–	–	–	1116
Isopropyl myristate-palmitate (M)	0.852	1.4340	182	–	–	–	–	–	C	C	C	–	–	–	–	–	–	1116
n-Butyl myristate (M)	0.861	1.4394	174	–	180	3	–	I	C	C	C	–	C	–	–	–	I	1192
Nitrile derivative																		
Fatty acid nitrile (M)	0.847	1.462@30°	180	1.0@140°C.	330-360	−4	–	–	C	–	–	–	–	C	C	C	C	493
Oleic acid derivatives																		
Methyl oleate (M)	0.875	1.4505	177	–	167-170@2mm.	−16	–	I	P	C	C	P	C	P	P	P	P	354, 770, 1064
n-Propyl oleate (M)	0.869	1.4494	166	–	181-189@2mm.	−20		I	P	C	C	P	C	P	P	P	P	354, 1192
Isopropyl oleate (M)	0.866	–	–	–	173-181@2mm.	–		I	P	C	C	–	C	–	–	P	P	132, 812A, 1192

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride-acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

‡Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[2]Decomposes. [4]Supercools to about −70°C.

Plasticizers chart (Cont'd)

Name[1]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Oleic acid derivatives (Cont'd)																		
Butyl oleate (M)	0.865	1.451[3]	180	–	190-230 @ 6.5mm.	<–10	8.2[4]	I	C	C	C	–	C	C	C	C	I	98, 103, 488 493, 770, 812A, 961, 1084, 1116, 1192
Amyl oleate	0.876	1.4546	186	<0.01	200-240 @ 20mm.	<–40	–	–	–	C	C	–	–	–	C	C	–	1074
Octyl fatty acid esters (M)	0.864	1.4520	210	<0.06 @ 150°C.	210-239 @ 4mm.	–	–	I	I	C	C	P	C	P	C	P	–	485, 1192
Ethylene glycol monomethyl ether oleate	0.895-0.902[3]	1.453-1.455	197	0.23 @ 150°C.	198-255 @ 4mm.	–40	–	I	C	C	C	–	P	P	C	C	C	103, 485
1,2-Propylene glycol mono oleate (M)	0.91-0.92	–	–	–	–	–19 to –22	–	–	–	C	C	–	–	–	–	C	–	94, 485, 1192
Ethylene glycol monobutyl ether oleate (M)	0.887	–	–	–	192-221 @ 2mm.	<–45	–	–	–	C	C	–	–	–	–	C	–	94, 485, 1192
Tetrahydrofurfuryl oleate (M)	0.928[3]	1.462	213	–	240 @ 5mm.	–28	9.6	P	C	C	C	C	C	C	–	C	C	354
Glycerol mono oleate (M)	0.950	–	–	–	–	6	91	P	P	P	P	P	P	P	P	P	P	94, 354, 464, 485, 812A, 1054, 1116, 1192, 1195
Glycerol mono oleate (M)	0.950	–	–	–	–	–	–	P	P	P	P	P	P	P	P	P	P	31, 464
Glycerol mono oleate (M)	0.946-0.952 @ 30°C.	1.466-1.468 @ 30°C.	200	–	–	–	190-230 @ 30°C.	–	–	–	–	–	–	–	–	P	P	501
Diethylene glycol mono oleate (M)	0.938	–	–	–	–	<–10	–	–	–	C	C	–	–	–	–	–	–	94, 464, 485, 1116, 1192, 1195
Palmitic acid derivatives																		
Isopropyl palmitate (M)	0.830-0.850	1.425-1.445	–	–	–	–	–	–	–	C	C	–	–	–	–	–	–	94, 103, 132, 345, 812A, 1192
Isopropyl palmitate (M)	0.852	1.4360	188	–	–	–	–	–	–	C	C	–	–	–	–	–	–	1116
n-Butyl palmitate (M)	0.865	1.4429	185	–	215-265 @ 20mm.	0 to 9	–	I	C	C	C	–	C	–	–	–	I	1192
Isooctyl palmitate (M)	0.863[3]	–	213	–	215-235 @ 5mm.	6-9	–	I	I	C	C	–	C	–	–	I	I	425, 961, 1192
Paraffin derivatives																		
Chlorinated paraffin (M)	1.10-1.14	1.500	None	–	–	liq. @ rm.temp.	250-3500 @ 25°C.	P	C	P	C	C	C	C	P	C	C	320, 329, 758 827
Chlorinated paraffin (M)	1.162-1.175	–	None	–	–	liq. @ rm.temp.	160-250SSU @ 210°F. 322-330 @ 210°F.	P	P	P	C	C	C	C	P	C	C	329, 504, 519 603, 758, 827
Chlorinated paraffin (M)	1.162-1.175	–	None	–	–	liq. @ rm.temp.	22-33 @ 210°F.	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.26	–	–	–	–	–	100-120 @ 25°C.	P	–	P	C	C	C	C	P	C	C	329, 504, 603, 758, 827
Chlorinated paraffin (M)	1.26	–	–	–	–	–	100-120 @ 25°C.	C	–	C	C	C	C	C	P	C	C	329, 536, 827
Chlorinated paraffin (M)	1.13-1.17	1.504	None	–	–	liq. @ rm.temp.	4000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	232, 329, 345, 758, 827
Chlorinated paraffin (M)	1.13-1.17	1.504	None	–	–	liq. @ rm.temp.	4000 @ 25°C.	C	C	C	C	C	C	C	C	C	C	320, 329, 345, 536, 827
Chlorinated paraffin (M)	1.16-1.18	1.518	None	–	–	liq @ rm.temp.	6000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	329, 345, 603, 758, 827
Chlorinated paraffin (M)	1.16-1.18	1.518	None	–	–	liq. @ rm.temp.	6000 @ 25°C.	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.65	1.535	None	–	–	100*	Solid	C	C	P	C	C	C	C	P	C	C	320, 329, 758
Chlorinated paraffin (M)	1.65	1.535	None	–	–	100*	10,000+	C	C	C	C	C	C	C	C	C	C	329
Chlorinated paraffin (M)	1.36	–	–	–	–	liq @ rm.temp.	1500-2000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	320, 329, 345, 603, 827
Chlorinated paraffin (M)	1.36	–	–	–	–	liq. @ rm.temp.	1500-2000 @ 25°C	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.33-1.36	1.516	–	–	–	liq. @ rm.temp.	4000-6000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	232, 320, 329, 345, 827
Chlorinated paraffin (M)	1.33-1.36	1.516	–	–	–	liq. @ rm.temp.	4000-6000 @ 25°C.	C	C	C	C	C	C	C	P	C	C	329, 536, 827
Chlorinated paraffin (M)	1.56	–	–	–	–	liq. @ rm.temp.	22,000-25,000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	232, 320, 329, 345, 827
Chlorinated paraffin (M)	1.56	–	–	–	–	liq @ rm.temp.	10,000+	C	C	C	C	C	C	C	P	C	C	329, 345, 536
Chlorinated paraffin (M)	1.16	1.505	None	2.3×10^{-8} @ 100°C.	–	liq. @ rm.temp.	3500-4000 @ 25°C.	P	C	P	C	C	C	C	P	C	C	206, 232, 320 329, 345, 536 537, 603, 827
Chlorinated paraffin (M)	1.24	1.518	None	2×10^{-8} @ 65°C.	–	liq. @ rm.temp.	20,000-30,000 @ 25°C.	–	–	–	–	C	C	C	–	C	C	232, 329, 345 537, 603, 827
Chlorinated paraffin (M)	1.24	1.518	None	2×10^{-8} @ 65°C.	–	liq. @ rm.temp.	20,000-30,000 @ 25°C.	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.36	1.517	None	2×10^{-8} @ 65°C.	–	liq. @ rm. temp.	1600-1700 @ 25°C	–	–	–	–	C	C	C	–	C	C	232, 320, 329, 345, 537, 603 827
Chlorinated paraffin (M)	1.35	1.517	None	2×10^{-8} @ 65°C.	–	liq. @ rm. temp.	1600-1700 @ 25°C.	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.63	–	None	–	–	80-90	Solid	C	C	P	C	C	C	C	–	C	C	320, 329, 758, 1116
Chlorinated paraffin (M)	1.63	–	None	–	–	110-120		C	C	P	C	C	C	C	C	C	C	329
Chlorinated paraffin (M)	1.23-1.26	1.510	None	1.0×10^{-7} @ 100°C.	–	liq @ rm. temp.	100-120 @ 25°C 10,000-12,500	–	–	–	–	C	C	C	–	C	C	206, 320, 329 345, 536, 537, 603, 827

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate, CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate, PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride, and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[1] Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[3] (M) indicates monomeric, (P) indicates polymeric. [4] Measurement made at 20°C. *Decomposes. *Freezing point. *Superseded to about –70°C. *PM closed cup. *Pour point.

Plasticizers chart (Cont'd)

Name[a]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Paraffin derivatives (Cont'd)																		
Chlorinated paraffin (M)	1.44	–	None	–	–	liq.@ rm. temp	3900-5100 @ 25°C	–	–	–	–	–	C	C	–	C	C	232, 329, 345, 537, 603, 827
Chlorinated paraffin (M)	1.44	–	None	–	–	liq.@ rm. temp.	3900-5100 @ 25 C.	C	C	C	C	C	C	C	C	C	C	329, 345, 827
Chlorinated paraffin (M)	1.57	–	None	–	–	liq.@ rm. temp.	25,000-27,000 @ 25°C.	–	–	–	–	–	C	C	–	C	C	232, 329, 345, 537, 603, 827
Chlorinated paraffin (M)	1.57	–	None	–	–	liq.@ rm. temp.	25,000-27,000 @ 25°C.	C	C	C	C	C	C	C	C	C	C	320, 329, 345
Chlorinated paraffin (M)	1.16	1.51	None	–	–	liq.@ rm. temp.	6000@ 25°C.	–	–	–	–	C	C	C	–	C	C	320, 329, 345, 536, 537, 603, 827
Chlorinated paraffin (M)	1.22-1.24	1.516	–	–	–	liq.@ rm.temp.	100-120@ 25°C.	–	–	–	–	C	C	C	–	C	C	329, 345, 603, 827
Chlorinated paraffin (M)	1.22-1.24	1.516	–	–	–	liq.@ rm.temp.	100-120@ 25°C.	C	C	C	C	C	C	C	C	C	C	329, 345, 536, 827
Chlorinated paraffin (M)	1.65-1.75	–	–	–	–	liq.@ rm.temp.	20,000-25,000 @ 25°C.	C	C	P	C	C	C	C	P	C	C	329, 345, 536
Pelargonic acid derivatives																		
Diethylene glycol dipelargonate	0.966[2]	1.444	210	–	229@5mm.	−15	9.5	I	C	C	C	–	I	P	C	C	C	354, 485, 961
Triethylene glycol dipelargonate (M)	0.965[2]	1.448	210	–	225-255@5mm.	<−18	–	I	P	C	C	P	–	–	C	C	C	354, 485, 961
2-Butoxyethyl pelargonate	1.4296	0.896	127	–	129-162@4mm.	50		–	C	C	C	–	C	–	C	C	C	485
Pentaerythritol derivative																		
Pentaerythritol fatty acid ester (M)	0.997	1.453	247	0.27@200°C.	261@4mm.	–	–	I	–	C	C	I	P	I	P	C	C	132, 504, 812A, 1070
Phenoxy plasticizers																		
Phenoxy	1.038	1.5134	–	600	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Phenoxy	1.060	1.5096	–	120	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Phenoxy	1.165	1.555	–	ca. 25,000	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Phosphoric acid derivatives																		
Triethyl phosphate (M)	1.065-1.072[2]	1.4055[2]	116	10@73°*	216	−56	1-2[2]	C	C	C	C	C	C	–	C	–	e	31, 146, 346, 719
Tributyl phosphate (M)	0.973-0.983[2]	1.4226[2]	193	–	177-178@27mm. 150@10mm.	<−80	3.5-12.2[2] 2.08cs.@77°F.	C	C	C	C	C	C	C	C	P	C	31, 103, 146, 252, 345, 693, 719, 722, 733, 738, 1031
Tri-(2-ethylhexyl) phosphate (M)	0.9260[2]	1.4434[2]	207	1.9@200°C.	220@5mm.	−74*	13-150[2]	C	C	C	C	I	C	C	C	C	C	31, 103, 146, 345, 371, 719, 1117
Tributoxyethyl phosphate (M)	1.020	1.434	222	<0.10@150°C.	215-228@4mm.	<−70	3.7-12.2[2]	C	P	C	C	C	P	C	C	C	C	103, 345, 371, 493, 693, 738, 1031
Triphenyl phosphate (M)	1.185-1.202	1.563-1.5518	225	0.15@150°C. 1.90@200°C.	220@5mm.	49.2	11@50°C. 9.9@55°C.	C	C	C	C	C	C	C	I	C	C	103, 345, 719 738, 1031
Cresyl diphenyl phosphate (M)	1.204-1.208	1.560	233-237	0.08@200°C.	235-255@4mm. 253@10mm.	−38[2]	48-70* 33.0@25°C.	P	C	C	C	C	C	C	C	C	C	31, 103, 146, 345, 371, 493, 719, 733, 738, 1031
Tricresyl phosphate (M)	1.160-1.175[2]	1.553-1.556	255	0.50@200°C. 29.00@300°C.	241-255@4mm.	−33[2]	78-185[2]	C	C	C	C	P	C	C	C	C	C	31, 103, 146, 345, 371, 493, 693, 719, 733, 1031
Tri-dimethylphenyl phosphate	1.145	1.5535	233	<0.01[2]	225-295@10mm.	−35*	–	P	C	C	C	P	P	C	C	–	C	103, 733
Tri-isopropyl phenol phosphate (M)	1.150-1.165	1.552	230	–	220-270	liq.@ rm.temp.	–	C	C	C	C	P	C	C	C	C	C	371
Alkyl aryl phosphate (M)	1.088-1.093	1.507-1.510	224	0.2@150°C. 1.60@200°C.	230@5mm. 239@10mm.	–	16.4@25°C.	P	C	–	C	–	C	C	C	C	C	345, 733, 738
Alkyl aryl phosphate (M)	1.07	1.506	241	0.5@200°C.	245@10mm.	–	22.5@25°C.	C	C	C	C	P	C	C	C	C	C	738
Complex alkyl phosphate[a] (M)	1.130[2]	1.448[2]	96	–	–	liq.@ rm.temp.	27.2cs.@100°F.	–	–	–	–	–	–	–	–	–	–	722
Triaryl phosphate synthetic (M)	1.155	1.55	470	–	–	–	90	C	C	C	C	P	C	C	C	C	C	371
0,0,0,-triethyl phosphorothioate (M)	1.074	1.4458	107	–	93.5-94@ 10mm.	–	1.36cs.@ 77°F	–	–	C	C	–	–	–	–	–	–	722
0,0,0,-tributyl phosphorothioate (M)	0.987	1.4491	146	–	142-145@ 4.5mm.	–	3.23cs.@ 77°F.	–	–	C	C	–	–	–	–	–	–	722
0,0,0-triisooctyl phosphorothioate (M)	0.933	1.4580	210	–	160-170@ 0.2mm.	–	13.00cs.@ 77°F.	–	–	C	C	–	–	–	–	–	–	722
Tris(2-chloroethyl) phosphate (M)	1.353[2]	1.4858	191	–	119@0.15mm.	–	522cs.@ 77°F.	–	–	–	–	–	–	–	–	C	C	577, 722, 1031
Tris(chloroethyl) phosphate (M)	1.425[2]	1.476[2]	225	–	203@ 10mm.	−60	43[2]	C	C	C	C	–	C	C	C	C	C	146, 178, 493, 719, 722, 1031
Tris(dichloropropyl) phosphate (M)	1.513	1.5019	252	–	–	–	–	C	C	–	C	C	C	C	C	C	C	31, 493
Tri xylenyl phosphate (M)	1.130-1.145	1.551-1.555	235*	–	270@ 3mm.	−35*	190[2]	P	C	C	C	–	–	C	C	C	C	31, 371
Diphenyl octyl phosphate (M)	1.08-1.09	1.506-1.512	200	–	–	−8	21-23[2]	P	C	C	C	C	C	C	C	C	C	146, 719
Diphenyl-xylenyl phosphate	1.187	1.559	240	–	238-251@ 5mm.	–	–	I	C	C	–	–	C	P	–	C	C	733
Halogenated organic polyphosphonate (M)	1.425-1.445	1.492-1.496	None	–	Not distillable	–	40-60@ 99°C.	C	–	C	C	C	–	C	–	C	C	738
Halogenated organic phosphate ester (M)	1.482	1.490-1.500	232	–	–	–	35@ 99°C.	C	–	C	C	C	–	C	–	C	C	738
Phenyl isopropyl phenyl phosphate (M)	1.135-1.171	1.546-1.553[2]	>235	–	220-230@ 1mm.	–	–	P	C	C	C	–	–	I	C	C	C	31, 146, 719
Phthalic acid derivatives																		
Alkyl benzyl phthalate (M)	1.065-1.074	1.523-1 529	229	0.5@ 200°C.	252@ 10mm	–	53@ 25°C.	P	C	–	C	-	C	C	C	C	C	738
Dimethyl phthalate (M)	1.188-1.192 1.192-1.194[2]	1.5133-1.5168[2]	149-157	<0.01[2] 91@ 200°C.	282 147@ 10mm.	0 .5*	11.4@ 25°C.	C	C	C	C	C	C	C	C	P	C	31, 132, 146, 345, 346, 601, 693, 719, 738, 1107A, 1159

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[1]Numbers refer to manufacturers and suppliers listed on page 816 See end of chart, page 785, for list of trade names and designations of suppliers.

[a](M) indicates monomeric; (P) indicates polymeric. [2]Measurement made at 20°C. *Pour point.

Table B-1. PRODUCT LIST (Cont.)

Plasticizers chart (Cont'd)

Name[a]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[f]
Phthalic acid derivatives (Cont'd)																		
Dimethyl phthalate (M)	1.194[g]	–	148	<0.01	283@6mm.	5.5[d]	–	C	C	C	C	C	C	P	C	C	C	146, 228, 719, 1159
Diethyl phthalate (M)	1.118-1.123[g]	1.4990-1.5019[g]	152	56@200°C.	296 158@10mm.	−4	9.8@25°C.	C	C	C	C	C	C	C	C	P	C	31, 132, 146, 228, 346, 348, 601, 693, 719, 738, 839, 1107A, 1159
Dipropyl phthalate	1.071	1.494	–	<0.01[g]	129-132@1mm.	–	–	C	C	–	–	–	–	–	–	–	–	330
Dibutyl phthalate (M)	1.042-1.049	1.4895-1.4926	171-185	<0.01[g] 1.1@150°C. 14@200°C.	335@760mm. 190-195@10mm.	−40	17-22.6[g] 16.6@25°C.	C	C	C	C	C	C	C	C	C	C	103, 128, 132, 146, 232, 232, 345, 346, 474, 493, 539, 693, 719, 723, 738, 770, 839, 917, 961, 982, 988, 997, 1074, 1107A, 1111, 1159
Dibutyl phthalate (M)	1.0467[g]	1.4924[g]	172	–	336@760mm.	−35	–	–	C	C	C	–	–	–	–	C	C	739
Dibutyl phthalate (M)	1.047-1.048[g]	1.4920-1.4940[g]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Diisobutyl phthalate (M)	1.040[g]	1.490	185	–	327	−50[g]	30	C	C	C	C	–	C	C	C	C	–	31, 132, 474, 639, 982, 1159
Diisobutyl phthalate (M)	1.041[5][g]	1.490[g]	168	–	305-320@760mm.	−64	–	–	C	C	C	–	–	C	–	C	–	739
Diisobutyl phthalate (M)	1.040-1.044[g]	1.4893-1.4903[g]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Diamyl phthalate	1.022	1.488[g]	171	–	342	<−55	–	I	C	C	C	C	–	C	C	P	C	330
Dihexyl phthalate (M)	1.008	1.491[g]	193	–	–	–	–	P	C	C	C	–	–	–	C	C	C	370, 1107A
Dihexyl phthalate (n) (M)	0.900-1.007[g]	1.487	188-199	–	210@5mm.	<50	–	P	C	C	C	C	C	C	C	C	C	961, 1107, 1111
Diisoheptyl phthalate	0.995[g]	1.486	200	–	–	–	31@25°C.	P	C	C	C	C	C	P	P	C	C	988
Butyl octyl phthalate (M)	0.993	1.485	199	–	225@5mm.	<−50	–	I	P	C	C	C	C	C	C	C	C	345, 346, 474, 485, 1070, 1111
Butyl isodecyl phthalate (Decyl butyl phthalate) (M)	0.991-0.998	1.486	193	–	220@5mm.	−50	–	–	–	–	–	–	C	–	–	C	C	128, 345, 917, 961, 1070, 1111
Butyl iso-hexyl phthalate	1.026	1.488	174	–	190-205@5mm.	−50	–	P	C	C	C	C	C	C	C	C	C	961
Diisononyl phthalate (M)	0.972[g]	1.486[g]	230	–	–	−48[d]	–	I	C	C	C	–	–	I	–	C	C	370, 1107A
Diisononyl phthalate (M)	0.972[g]	1.486[g]	221	–	–	−48[d]	110-120[g]	I	C	C	C	–	–	I	–	C	C	146, 639, 719
Dioctyl phthalate (M)	0.982	1.485	216	<0.01	222-230@5mm.	<−50.0	–	–	–	–	–	–	C	–	–	C	C	31, 345, 474, 485, 493, 1070, 1107A, 1111, 1159
Dioctyl phthalate (M)	0.983-0.987[g]	1.4860-1.4875[g]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Dioctyl phthalate (M)	0.9856[g]	1.4868[g]	218	–	386@760mm.	−50	–	–	–	–	–	–	–	–	–	C	C	739
Di-n-octyl phthalate	0.978[g]	1.482	219	<0.20@150°C.	220-248@4mm.	−25	–	I	C	C	C	C	C	I	C	C	C	485, 723, 770, 836
Di-iso octyl phthalate (M)	0.986[g]	1.484	219	1.0@200°C.	228-239@5mm.	−46[d]	56-83[g]	I	C	C	C	C	C	P	P	C	C	31, 103, 129, 132, 345, 370, 536A, 539, 693, 917, 961, 982, 1070, 1074, 1107A, 1111, 1159
Dinpryl phthalate (M)	0.965-0.978	1.480[g]	201-206	–	215-240@4mm.	<−60	–	P	C	C	C	P	C	P	C	C	C	1116
Mixed alcohol phthalate (M)	0.9861[g]	1.4844	–	–	220-230@4mm.	−50 to −55	–	I	C	–	C	C	C	–	–	C	C	474, 485, 1070, 1107A
Mixed alcohol phthalate	0.984@23°C.	1.4848@23°C.	204	–	–	–	–	I	C	C	C	C	C	C	P	C	C	917
Mixed normal alcohol phthalate (M)	0.976[g]	–	227	–	–	−30[d]	–	I	C	C	C	C	C	I	C	C	C	370, 917, 1070, 1111
Di-(2-ethylhexyl) phthalate (M)	0.980-0.9861[g]	1.4830-1.4859[g]	216-218	1.20-1.32 @200°C.	231@5mm. 256@10mm.	−46[d]	58.0@25°C. 80[g]	P	C	C	C	C	C	P	P	C	C	31, 103, 128, 129, 132, 232, 345, 346, 370, 474, 485, 493, 536A, 693, 716, 738, 917, 961, 982, 988, 1070, 1074, 1107A, 1111, 1159
Dinonyl phthalate (M)	0.965-0.972	1.4812	–	–	413	–	76	I	P	P	I	I	C	P	P	C	C	31, 132, 146, 232, 536A, 719, 917, 982, 1107A, 1159
n-Octyl-n-decyl phthalate (M)	0.970	1.480	227	–	250@5mm.	−28	–	I	C	C	C	C	C	I	C	C	C	31, 128, 346, 485, 519, 901, 917, 1070, 1111
n-heptyl n-nonyl n-undecyl phthalate (M)	0.968	1.482	227	0.4@200°C.	252@10mm.	−55[d]	41@25°C.	I	C	C	C	C	C	I	C	C	C	738
Di-n-heptyl phthalate	0.985-0.991	1.480-1.486	–	–	–	–	–	P	C	C	C	C	C	P	C	C	C	716
n-heptyl/n-nonyl phthalate	0.976-0.982	1.479-1.485	–	–	–	–	–	I	C	C	C	C	C	P	C	C	C	716
n-heptyl/n-nonyl/n-undecyl phthalate	0.969-0.975	1.479-1.485	–	–	–	–	–	I	C	C	C	C	C	P	C	C	C	716
n-nonyl/n-undecyl phthalate	0.967-0.963	1.478-1.484	–	–	–	–	–	I	C	C	C	C	C	I	C	C	C	716

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[f] Numbers refer to manufacturers and suppliers listed on page 816. See end of chart, page 786, for list of trade names and designations of suppliers.

[g](M) indicates monomeric; (P) indicates polymeric. [d]Measurement made at 20°C. [i]Pour point. [k]Freezing point.

Plasticizers chart

(Cont'd)

Name*	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers‡
Phthalic acid derivatives (Cont'd)																		
Heptyl benzyl phthalate	0.064-1.072	1.519-1.526	–	–	–	–	–	–	–	C	C	C	–	–	–	C	–	716
n-decyl* n-octyl phthalate (M) (Phthalate of mixed n-alcohols)	0.968	–	232	–	–	-30[4]	–	I	C	C	C	C	C	I	C	C	C	1070, 1111
Octyl decyl phthalate (M) (Isooctyl isodecyl phthalate) (Isooctyl decyl phthalate)	0.967	1.482-1.486	221	0.01@150°C.	236-248@4mm.	-48	–	P	C	C	C	P	C	P	C	C	C	103, 474, 485, 917, 961, 1070, 1111
Didecyl phthalate (diisodecyl phthalate) (M)	0.961-0.967	1.4835[3]	232	0.3@200°C.	356@760mm.	-37[4]	81-108[3]	I	C	C	C	C	C	I	C	C	C	103, 128, 129, 132, 232, 345, 346, 370, 474, 485, 493, 536A, 693, 722, 738, 917, 961, 988, 1070, 1074, 1111, 1107A, 1159
Diisodecyl phthalate (M)	0.9681[3]	1.4850@20°C.	232.2	–	249-256@4mm.	-53	–	–	–	–	C	–	–	–	–	C	–	31, 739, 982
Diisodecyl phthalate (M)	0.966-0.970[3]	1.4845-1.4865[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Diisodecyl phthalate	0.961-0.967	1.4835[3]	232	0.3@200°C.	356@760mm.	-37	–	I	C	C	C	C	C	I	C	C	C	715
Diisotridecyl phthalate (M)	0.946-0.962[3]	1.483-1.486[3]	230	–	–	–	250-310[3]	–	–	–	–	–	–	–	–	C	C	501
Diundecyl phthalate (M)	0.954	1.481	255	0.6@200°C.	262@10mm.	-20	53.7@25°C.	I	P	I	P	I	P	C	C	C	C	738
Diundecyl phthalate	0.95	1.480	–	–	–	-20	–	–	–	–	–	–	–	C	C	C	C	1070
Ditridecyl phthalate (M)	0.9512	1.4845	238	–	240@2mm.Hg.	-37[4]	210-225[3]	I	–	–	–	–	–	I	C	C	C	103, 128, 132, 232, 345, 370, 485, 536A, 839, 917, 961, 982, 1070, 1074, 1111, 1159
Decyltridecyl phthalate (M)	0.956	1.4830	–	–	–	–	–	P	C	C	C	P	C	P	C	C	C	345, 917, 1070
Blend (50/50) of di-octyl and di-octyl-decyl phthalates	0.974	1.483	218	–	240@5mm.	–	–	I	C	C	C	C	C	I	C	C	C	917
Blend (50*50) of di-octyl and di-decy phthalates	0.972	1.4835	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
Octyl fatty phthalic ester (M)	0.959@20°20°	1.479	213	1.2@200°C.	215-235@4mm.	–	49[3]	I	C	C	C	C	C	I	P	C	C	103, 128
Ethylhexyl-decyl phthalate (M)	0.9729[3]	1.4851[3]	230	0.54@200°C.	245@5mm.	-48[4]	–	I	C	C	C	P	C	I	P	C	C	474, 917
Butyi-ethylhexyl phthalate (M)	0.9941	1.4868	210	1.8@200°C.	224@5mm.	-37[4]	–	I	C	C	C	P	C	I	P	C	C	103, 345, 485, 693, 917, 961, 1070, 1111
Mixed alkyl phthalate (M)	0.973	1.482	218	–	240@5mm.	–	42[3]	I	C	C	C	C	C	I	C	C	C	103, 917
Mixed normal alkyi phthalate (M)	0.964-0.970	1.483	238	–	–	-19	–	I	C	C	C	C	C	I	P	C	C	1111
Fatty acid phthalate (M)	0.952[3]	1.478	224	<0.06@150°C.	215-235@4mm.	–	46[3]	C	–	C	C	P	C	C	C	C	C	103, 770
Dialkyl phthalate (M)	1.120[3]	1.516[3]	166	2.4@150°C.	156-175@4mm.	-70	9.0[3]	C	C	C	C	–	C	C	C	C	C	103
Dialkyl phthalate	0.994	1.4875	>150	–	–	–	40cs.@25°C.	–	–	–	–	–	–	C	C	C	C	536A
Hydroabietyl phthalate (M)	1.055[3]	1.513[4]	–	–	–	63	–	I	–	C	P	I	P	I	P	C	P	504
Butyl cyclohexyl phthalate (M)	1.076	1.5071[3]	194	–	189-222@5mm.	–	–	I	C	C	C	–	C	C	C	C	C	228, 1107
Butyl benzyl phthalate (BBP) (M)	1.111-1.123	1.535-1.540	199	0.16@150°C. 1.9@200°C.	370@760mm. 235-255@10mm.	–	61-63[3] 41.5@25°C.	P	C	C	C	–	C	C	C	C	C	128, 146, 345, 474, 639, 715, 719, 738
Butyl benzyl phthalate (M)	1.1206[3]	1.5395[3]	198.9	–	370@760mm.	-35	–	C	–	C	C	–	C	C	C	C	–	739
Butyl benzyl phthalate (M)	1.120-1.124[3]	1.5390-1.5420[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	739
Butyl benzene phthalate	1.120[3]	1.541[3]	410°F.	–	–	–	53cs.[3]	–	–	C	–	C	C	–	–	–	C	536A
Octyl benzyl phthalate (M)	1.069	1.526	–	–	–	–	53@25°C.	C	C	C	C	C	C	C	C	C	C	738
Dicyclohexyl phthalate (M)	1.148-1.29[3]	–	207	<0.01@150°C.	212-218@5mm. 231-248@10mm.	58-65	Solid 223@60°C.	P	C	C	C	C	C	C	P	C	P	103, 128, 146, 228, 345, 474, 536A, 719, 733, 738, 839
Di(methylcyclohexyl) phthalate (M)	1.075	1.516	199	0.76@200°C.	250@2mm.	–	15,000-20,000[3]	I	C	C	C	P	C	C	C	C	C	128, 146, 719
Di(methyl)cyclohexyl phthalate (M)	1.06-1.08[3]	1.514-1.516[3]	210	–	–	–	15,000-25,000[3]	I	C	C	C	C	C	C	C	C	C	501
Diphenyl phthalate (M)	1.28	1.572@74°	224	–	250-257@14mm.	69	Solid	I	C	C	C	–	C	C	I	C	C	738
Alkyl aryl modified phthalate (M)	1.042	1.522	152	19.6@150°C.	–	–	–	–	P	P	P	–	P	–	–	C	C	738
Alkyl aryl modified phthalate (M)	0.951	1.484	163	–	–	–	–	–	P	P	P	–	P	–	–	C	C	738
Alkyl aryl phthalate	1.035@23°C.	1.512@23°C.	–	–	327	–	–	–	–	–	–	–	–	–	–	C	C	917
Alkyl aryl phthalate	1.035@23°C.	1.511@23°C.	–	–	328	–	–	–	–	–	–	–	–	–	–	C	C	917
Alkyl aryl phthalate (M)	1.052	1.521	–	–	–	–	–	–	–	C	C	C	–	–	–	C	–	738
Alkyl aryl phthalate	1.104@23°C.	1.523@23°C.	–	–	–	-36	–	–	–	C	–	–	–	C	–	C	C	917
Alkyi aryl phthalate	1.073@23°C.	1.519@23°C.	–	–	–	-20	–	–	–	C	–	–	–	C	–	C	C	917
Modified phthalate (M)	0.977	1.507	–	–	–	–	–	–	P	P	P	–	P	–	–	C	C	738
Modified phthalate (M)	0.990	1.513	190	–	–	–	–	–	–	–	C	–	C	–	–	C	C	738
Modified phthalate (M)	0.985	1.500	–	–	–	–	–	–	–	–	C	–	C	–	–	C	C	738
Modified phthalate (M)	0.978[3]	1.450	147	11@150°C.	287	-58	–	I	C	C	C	–	C	C	C	I	–	346
Modified phthalate (M)	0.984[3]	1.448	148	–	296	-104	–	I	C	C	P	C	C	I	P	C	C	346
Modified phthalate (M)	0.980[3]	1.476	186	–	329	-47	–	I	C	C	C	C	C	I	P	C	C	346
2-ethyl hexyl isodecyl phthalate (M)	0.973	1.485	445	0.54@200°C.	245@5mm.	-48[4]	–	–	–	–	C	–	C	–	–	C	C	345, 693, 1070, 1111
Dimethoxyethyl phthalate (M)	1.171[3]	1.500	210	<0.01@20°C. 0.25@150°C.	190-210@340mm.	-40	53[3]	C	C	C	C	–	C	C	C	C	C	103, 228, 346, 1031, 1192

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

‡Numbers refer to manufacturers and suppliers listed on page 815 See end of chart, page 785, for list of trade names and designations of suppliers

§(M) indicates monomeric; (P) indicates polymeric. [3]Measurement made at 20°C. [4]Freezing point.

Plasticizers chart (Cont'd)

Name[2]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Phthalic acid derivatives (Cont'd)																		
Diethoxyethoxyethyl) phthalate (M)	1.121	1.492	201	1.40@200°C.	220-260@4mm.	–	82[5]	–	–	–	–	–	–	–	–	–	–	103
Dibutoxyethyl phthalate (M)	1.063	1.483	208	<0.01@20°C. 0.06@150°C.	210-233@4mm.	–	42[5]	I	C	C	C	C	C	C	C	C	C	103, 146, 228, 1192
Bis-(diethylene glycol monoethyl ether) phthalate	1.12-1.14	1.492	232	<0.10@150°C.	200-260@4mm.	–35	–	C	C	C	C	–	P	C	–	C	C	103
High molecular weight phthalate	1.06	1.448	–	–	–	–	–	–	C	C	–	–	–	P	C	C	C	917
High molecular weight phthalate	1.033@23°C.	1.4994@23°C.	243	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
High molecular weight phthalate	1.170@23°C.	1.5240@23°C.	230	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
High molecular weight phthalate	1.045@23°C.	1.497@23°C.	350	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
High molecular weight phthalate (P)	1.09-1.10[6]	1.503-1.505[3]	220	–	–	–	2000-3000[3]	–	–	–	–	–	–	–	–	C	–	146, 719
Straight chain alcohol phthalate (M)	0.976	1.4828@23°C.	238	–	–	–	33	–	C	C	C	–	C	–	C	C	C	917, 982, 1111, 1159
Straight chain alcohol phthalate (M)	0.968	1.4822@23°C.	243	–	–	–	48	–	C	C	C	–	C	–	C	C	C	917, 982, 1111, 1159
Straight chain alcohol phthalate (M)	0.964	1.4847	>150	–	–	–	34cm.@25°C.	–	–	–	–	–	–	–	–	C	–	536A
Straight chain alcohol phthalate (M)	0.960	1.4842	>150	–	–	–	–	–	–	–	–	–	–	–	–	C	–	536A
Polyesters																		
Polyester (P)	1.05	1.463	246	–	–	40°F.	575[3]	I	C	–	C	–	–	C	–	C	C	103
Polyester (P)	1.11	1.467	268	–	–	30°F.	5570[3]	I	C	C	I	–	–	P	–	C	C	103
Polyester (P)	1.15	1.4719	300	–	–	45°F.	117,600[3]	I	C	C	I	I	C	P	I	C	C	103
Polyester (P)	1.107	1.4803	243	–	–	35°F.	5330[3]	I	C	C	I	–	–	P	–	C	C	103
Polyester (P)	1.1146	1.5192	270	–	–	46.4°F.	3120[3]	–	–	–	–	–	–	–	–	C	C	103
Polyester (P)	1.09	1.504	235	–	–	–8°F.	1140[3]	I	C	C	P	–	–	P	–	C	C	103
Polyester	–	–	–	–	–	42°F.	–	I	C	C	I	I	C	P	I	C	C	103
Polyester (P)	1.092	1.477	260	–	–	50°F.	1965[3]	I	C	C	I	I	C	P	I	C	C	103
Polyester (P)	1.02	1.484	238	–	–	–36°F.	200[3]	I	P	C	P	–	–	P	–	C	C	103
Polyester (P)	1.06	1.504	240	–	–	–5°F.	795[3]	I	C	C	P	–	–	P	–	C	C	103
Polyester (P)	1.10	1.514	232	–	–	20°F.	3960[3]	I	C	C	P	–	–	P	–	C	C	103
Polyester, acetylated	1.15	1.462	250	–	–	–25	–	P	C	C	I	I	P	P	I	C	C	129
Polyester, acetylated	1.13	1.468	285	–	–	–23	–	P	C	C	I	I	P	P	I	C	C	129
Polyester, acetylated	1.13	1.468	285	–	–	–20	–	P	C	C	I	I	P	P	I	C	C	129
Polyester, acetylated	1.124@20/20°C.	1.4695	285	–	–	–	–	–	–	–	–	–	–	–	–	C	–	839
Polyester, acetylated	1.116[4]	1.4660	277	–	–	–	–	–	–	–	–	–	–	–	–	C	–	839
Polyester	1.125	1.4685	–	–	–	–	–	–	C	C	–	–	–	C	–	C	C	748
Polyester	1.027	1.4945	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	748
Polyester (P)	1.055[3]	1.4685[3]	288	–	–	–10[6]	16,520[3]	I	I	C	I	–	I	I	I	C	C	1117
Polyester (P)	1.03	1.460	260	–	–	–8	–	P	P	P	I	I	I	P	P	C	C	354
Polyester (P)	1.01	1.477	560°F	–	–	31°F	115	–	–	–	–	–	–	–	–	–	–	354
Polyester (P)	1.04	1.488	580	–	–	16	270	–	–	–	–	–	–	–	–	–	–	354
Polyester (P)	1.08	1.466	625	–	–	–4	2250	–	–	–	–	–	–	–	–	–	–	354
Polyester (P)	1.06	1.477	280	–	–	0	850	P	P	P	I	I	I	P	P	C	C	354
Polyester (P)	1.08	1.479	277	–	–	2	2800	P	P	P	I	I	I	P	P	C	C	354
Polyester (P)	1.01	1.469	232	–	–	–8	220	P	C	C	I	I	I	P	P	C	C	354
Polyester (P)	1.08	1.460	305	–	–	<–30	16,000	P	P	P	I	I	I	P	P	C	C	354
Polyester (P)	1.06	1.470	316	–	–	13-15	–	I	I	C	I	–	–	I	I	C	C	950
Polyester (P)	1.15	1.471	288	–	–	<–25	2000[3]	I	C	C	I	–	–	C	I	C	C	960
Polyester (P)	1.13	1.470	288	–	–	–25	1100[3]	I	C	C	I	–	–	C	I	C	C	960
Polyester (P)	1.08	1.466	280	–	–	7	23[3]	I	C	C	P	–	–	P	P	C	C	950
Polyester (P)	1.11	1.467	279	–	–	7	75[3]	I	C	C	I	–	–	P	I	C	C	960
Polyester (P)	1.08	1.466	299	–	–	4	53[3]	I	C	C	P	–	–	P	P	C	C	960
Polyester (P)	1.10	1.467	279	–	–	7	8800	I	C	C	I	–	–	P	I	C	C	1192
Polyester (P)	1.08	1.466	299	–	–	4	11,500	I	C	C	P	–	–	P	P	C	C	1192
Polyester (P)	1.099	1.466	277	–	–	–1	62[3]	I	C	C	P	–	–	P	P	C	–	950
Polyester (P)	1.128	1.470	232	–	–	7	254	I	P	C	I	–	–	P	I	C	–	960
Polyester (P)	1.11	1.466	310	–	–	–10	107[3]	I	C	C	I	–	–	P	I	C	C	960
Polyester (P)	1.10	1.501	257	–	–	–27	13[3]	I	C	C	I	–	–	P	P	C	C	950
Polyester (P)	1.11	1.503	274	–	–	–20	48[3]	I	C	C	I	–	–	P	I	C	C	960
Polyester (P)	1.08-1.09[6]	1.472-1.473[6]	300	–	–	–	2000-2300@50°C.	–	C	C	–	–	–	–	–	C	–	146, 719
Polyester (P)	1.11-1.12[6]	1.472-1.473[6]	300	–	–	–	2000-2300@50°C.	–	C	C	–	–	–	C	–	C	–	146, 719
Polyester (P)	1.10-1.11[6]	1.469-1.470[6]	290	–	–	–	1000-1300@50°C.	–	C	C	–	–	–	C	–	C	–	146, 719
Polyester	1.03	1.460	245	–	–	–10	–	–	C	C	C	C	–	–	P	C	C	330
Polyester	1.22	–	238	–	197@4mm.	–	–	C	C	C	I	–	–	C	I	P	P	504
Polyester	1.125	1.471	288	–	–	–35[6]	–	–	–	–	–	–	–	–	–	C	–	839
Polyester	1.10[6]	1.4684	290	–	–	–10	–	I	C	C	I	I	C	P	I	C	C	519
Polyester	1.050	1.504	–	–	–	–	–	P	C	C	C	–	–	P	C	C	C	90
Polyester (P)	1.12	1.489	257	–	–	–	9500@77°F.	I	C	C	C	C	–	C	C	C	C	1116
Polyester (P)	1.086	1.468	290	–	–	–	6100@77°F.	I	C	C	C	C	I	P	–	C	C	1116

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.
[1] Numbers refer to manufacturers and suppliers listed on page 818. See end of chart, page 786, for list of trade names and designations of suppliers.
[2] (M) indicates monomeric; (P) indicates polymeric. [3] Measurement made at 20°C. [4] Pour point. [5] Calculated from 20/20°C. [6] Developed for polyvinyl alcohol.

Plasticizers chart (Cont'd)

Name[2]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Vis-cosity, cp.	Compatibility with plastics†										Manu-facturers and suppliers[1]
								CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	
Polyesters (Cont'd)																		
Polyester (P)	1.099	1.456	290		–	–	3600@77°F.	I	C	C	C	C	I	P	–	C	C	1116
Polyester (P)	1.065	1.466	280	–	–	–	2700@77°F.	I	C	C	P	–	–	P	P	C	C	1116
Polyester (P)	1.10	1.4658	293	–	–	–	5800@77°F.	I	C	C	C	C	I	P	–	C	C	1116
Polyester (P)	1.025	1.4738	280	–	–	–	565@77°F.	I	P	C	P	P	P	I	C	C	C	1116
Polyester (P)	1.136	1.4960	243	–	–	–	1300@77°F.	I	C	C	P	C	I	C	C	C	C	1116
Polyester (P)	1.051	1.4713	254	–	–	–	1400@77°F.	I	C	C	C	–	–	P	P	C	C	1116
Polyester (P)	1.100	1.4650	280	–	–	–	7700@77°F.	I	C	C	C	C	–	P	–	C	C	1116
Polyester (P)	1.19	1.479	316	–	–	–	5900@25°C.	C	I	C	I	I	I	C	I	I	I	1116
Polyester	1.074	1.4660	275	–	–	–	–	I	I	C	I	–	–	I	I	C	C	485
Polyester	1.153	1.4662	270	–	–	–	–	I	I	C	I	–	–	I	I	C	C	485
Polyester	1.0626	1.4660	290	–	–	–	–	I	I	C	I	–	–	I	I	C	C	485
Polyester	1.04	1.460	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.07	1.468	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.09	1.466	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.09	1.470	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.12	1.467	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.13	1.480	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.093	1.470	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester	1.075	1.465	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	1070
Polyester (P)	1.129	–	–	–	–	–	11,000@25°C.	I	C	C	C	I	C	C	C	C	C	738
Polyester	1.098	1.4666@23°C.	280	–	–	10	–	I	C	C	P	–	–	P	P	C	C	917
Polyester	1.062	1.4898	<500	–	–	8	–	I	C	C	P	–	–	P	P	C	C	917
Polyester (P)	1.082	1.465	530°F.	–	–	–	3500@25°C.	I	C	C	I	–	–	C	C	C	C	738
Polyester (P)	1.107	1.477	540°F.	–	–	–	9800@25°C.	I	C	C	I	–	–	C	C	C	C	738
Polyester (P)	1.035	1.458	495°F.	–	–	–	300@25°C.	I	C	C	I	–	–	C	C	C	C	738
Polyester (P)	1.085	1.465	550°F.	–	–	–	4900@25°C.	I	C	C	I	–	–	C	C	C	C	738
Polyester (P)	1.066	1.4650[3]	254	–	–	–	4100@25°C.	P	C	C	P	P	I	C	–	C	C	346
Polyester (P)	1.0443[3]	1.4642	243	–	360@760mm.	−8	3850@25°C.	P	C	C	P	–	I	C	–	C	C	346
Polyester	1.084@23°C.	1.4808@23°C.	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C8	917
Polyester	1.091@23°C.	1.4810@23°C.	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
Polyester	1.070@23°C.	1.4724@23°C.	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C8	917
Polyester	1.081@23°C.	1.4748@23°C.	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	917
Polyester (P)	1.060	1.464	–	–	–	18	5000	C	C	P	P	C	I	I	I	C	P	474
Polyester (P)	1.15	1.486	–	–	–	5	105,000	I	I	C	I	I	C	P	I	C	P	474
Polyester (P)	1.097	1.470	278	–	–	–	30,000	I	C	C	P	–	–	P	P	C	C	474
Polyester	1.034[3]	1.460	265	–	–	−25	–	–	–	–	–	–	–	–	C	C	–	1074
Polyester	1.076	–	245	–	–	2	–	–	–	–	–	–	–	–	–	C	–	1074
Polyester	1.03	1.457	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	812A
Polyester	1.062@23°C.	1.4883@23°C.	227	–	–	–	–	–	C	C	–	–	–	P	P	C	C	917
Polyester	1.20	1.47	–	–	–	–	–	I	I	C	I	I	I	C	I	I	I	205
Polyester #10678	1.042	–	270	–	–	−35	–	I	I	C	I	–	P	P	P	C	C	485
Polyester #10675	1.072	–	245	–	–	−32	–	P	P	C	I	–	P	P	P	C	C	485
Polyester #10676	1.083	–	244	–	–	−30	–	P	P	C	I	–	P	P	P	C	C	485
Polyester #10674	1.118	–	270	–	–	−25	–	I	I	C	I	–	P	P	P	C	C	485
Polyester #10680	1.094	–	–	–	–	−22	–	I	C	C	I	–	P	P	P	C	C	485
Polyester #10677	1.092	–	265	–	–	−30	–	P	P	C	I	–	P	P	P	C	C	485
Polyester #10673	1.092	–	235	–	–	−15	–	I	C	C	I	–	P	C	I	C	C	485
Polyoxypropylene derivatives of trimethylol propane (P)	1.00-1.03	–	>121	Nil	–	Liquid	300-900@77°F.	–	–	–	–	C	–	C	C	–	–	129
Polyurethane based (P)	1.14	–	–	–	–	–	Solid	–	–	–	–	–	–	–	–	C	–	146, 719
Ricinoleic acid derivatives																		
Methyl ricinoleate (M)	0.925	1.4620	190	–	170@1mm.	−30[4]	–	P	C	C	C	P	–	C	C	I	I	138, 748
Methyl acetyl ricinoleate (M)	0.938	1.4545	196	–	185@1mm.	−15	–	P	C	C	C	P	P	C	C	C	C	138, 748
Methyl acetyl ricinoleate (modified) (M)	0.958	1.4580	207	–	–	−40		I	C	C	C	–	–	C	C	C	C	748
Butyl ricinoleate (M)	0.917	1.4620	207	–	185@1mm.	−10	–	I	C	C	C	–	P	C	C	I	C	138, 748, 917
n-Butyl acetyl ricinoleate (M)	0.928	1.4556	210	–	195@1mm.	−30 to −65	–	I	C	C	C	P	P	C	C	C	C	138, 639, 748, 1116, 1159
Ethylene glycol ricinoleate (M)	0.969	1.4740	241	–	–	−21	–	–	–	C	C	–	–	–	C	I	–	138, 485, 748
Propylene glycol ricinoleate (M)	0.960	1.469	221	–	–	< −16	–	–	–	C	C	–	–	–	–	–	–	138, 485, 748
Methoxyethyl ricinoleate (M)	0.951	1.4645	207	–	185@1mm.	−37	–	I	C	C	C	–	P	C	C	C	C	748
Methoxyethyl acetyl ricinoleate (M)	0.960	1.4570	215	<0.04@150°C.	195@1mm.	−60	–	I	C	C	C	–	P	C	C	C	C	748
Methoxyethyl acetyl ricinoleate (modified) (M)	0.968	1.4630	238	–	–	−46	–	I	C	C	C	–	–	C	C	C	C	748
Glycerol monoricinoleate (M)	0.981	1.4770	265	–	–	< −50	–	–	–	C	C	–	–	–	C	–	–	138, 464, 485, 748, 770
Diethylene glycol monoricinoleate (M)	0.972-0.980	–	–	–	–	< −60		–	–	C	C	–	–	–	–	–	–	464, 485, 770
Glyceryl triacetyl ricinoleate (M)	0.965	1.4685	290	–	–	−35[4]	–	I	I	C	C	–	P	C	–	C	C	138, 748

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible

[1]Numbers refer to manufacturers and suppliers listed on page 815. See end of chart, page 785, for list of trade names and designations of suppliers.

[2](M) indicates monomeric; (P) indicates polymeric. [3]Measurement made at 20°C. [4]Pour point. [5]Calculated from 20/20°C. [6]Developed for polyvinyl alcohol.

Plasticizers chart (Cont'd)

Name*	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers‡
Sebacic acid derivatives																		
Dimethyl sebacate (M)	0.990		–	–	294	–	–	C	C	C	C	C	C	C	C	C	C	474, 1107, 1116
Dibutyl sebacate (M)	0.934-0.942[3]	1.440-1.4423[3]	202	3mm.@ 180°C.	344-345 175-180@3mm.	-12	25	I	P	C	C	C	C	P	P	C	C	128, 345, 485, 493, 831, 839, 917, 950, 961, 1074, 1107, 1111, 1116, 1159
Di-2-ethylhexyl sebacate (M)	0.910-0.915[3]	1.450-1.452[3]	220		–	<-60	–	I	P	C	C	C	C	P	P	C	C	501
Dioctyl sebacate (M) (Di-2-ethylhexyl)	0.911-0.913	1.449-1.451	215	–	248@4mm.	-40	–	I	P	C	C	C	C	P	P	C	C	345, 485, 493, 839, 917, 950, 961, 1074, 1107, 1111, 1116, 1159
Di-nonyl sebacate (M)	0.909	–	249	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1107, 1116
Di-isooctyl sebacate (M)	0.912-0.9160[3]	1.447	235-246	–	232-246@4mm.	-60 to -42	–	I	P	–	C	C	C	P	P	C	C	345, 485, 917, 961, 1107, 1111
Dibutoxyethyl sebacate	0.964-0.970	1.4447	–	–	255@10mm.	-10	–	–	–	–	–	–	–	–	–	C	C	485, 917, 1107
Dibenzyl sebacate (M)	1.05	1.521[3]	236	–	265@4mm.	28	–	P	P	C	C	C	C	C	C	P	P	1116
Di-isopropyl sebacate (M)	0.936	1.4310	190	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1107, 1116
Mixed sebacate adipate ester	0.93	1.445	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	770, 917
Stearic acid derivatives																		
n-Butyl stearate (M)	0.858-0.862	1.4418	188	–	220-225@25mm.	16	8@25°C.	I	C	C	C	–	C	–	–	–	I	94, 103, 132, 228, 252, 354, 485, 493, 606, 770, 831, 1116, 1192
n-Butyl-stearate (M)	0.85-0.86@ 30°C.	1.441-1.443@ 30°C.	196	–	–	–	8.5@30°C.	–	–	–	–	–	C	–	–	–	–	501
Butoxyethyl stearate (M)	0.882	1.446	210	<0.06	215-245	–	–	–	–	–	C	–	C	–	–	–	–	94, 103, 486, 1192
Octyl stearate	0.851-0.857	–	–	–	–	1-6	–	–	–	–	–	–	–	–	–	–	–	1074, 1192
Octyl stearate (M)	0.862-0.865[3]	1.452-1.454[3]	210	–	–	–	13-15[3]	–	–	–	–	–	–	–	–	P	P	501
Octyl stearate (M)	0.85-0.86[3]	1.448-1.450[3]	200	–	–	–	14-16[3]	–	–	–	–	–	–	–	–	P	P	501
1,2-Propylene glycol monostearate (M)	0.93	–	–	–	182-210@1mm.	37-39	–	–	–	C	–	–	–	–	–	–	–	94, 464, 485, 812A, 1116, 1192, 1195
Ethylene glycol monomethyl ether stearate	0.885	–	–	–	220-275@20mm.	20-24	–	–	C	C	C	–	–	–	–	–	–	485, 1192
Ethylene glycol monobutyl ether stearate (M)	0.877-0.882[3]	1.446	216	<0.01[3] 0.06@150°C.	215-250@4mm.	15-17	–	I	P	C	C	I	C	P	C	P	P	103, 485, 1192
Glycerol monostearate (M)	0.970	–	–	–	–	55-57	Solid	–	–	–	–	–	–	–	–	–	–	31, 94, 103, 354, 464, 485, 770, 812A, 1148, 1192, 1195
Glycerol monostearate (M)	0.920-0.925@ 60°C.	1.447-1.449@ 60°C.	190-220	–	–	53-58	50-80@60°C.	–	–	–	–	–	–	–	–	–	–	501
Glyceryl monodeate (M)	0.950	–	–	–	–	7.5 max.	Soft solid	–	–	–	–	–	–	–	–	–	–	485
Glyceryl monoleate (M)	0.96	1.475	–	–	–	–	Liquid	–	–	–	–	–	C	C	–	C	–	1148
Glyceryl tri-acetoxy stearate (M)	0.955	1.4595	300	–	–	–	–	P	C	C	C	–	P	C	C	C	C	138, 464, 748
Butyl acetoxystearate (M)	0.922	1.4480	207	–	–	-7	–	P	C	C	C	–	P	C	C	C	C	138, 748
Diethylene glycol distearate (M)	0.96	–	–	–	–	48	–	–	–	C	C	–	–	–	–	–	–	94, 485, 770
Tetraethylene glycol monostearate	0.971	–	–	–	–	35-40	–	–	–	C	C	–	–	–	–	–	–	485, 1192
Methyl pentachlorostearate (stabilized)	1.19	–	164	0.015@120°C.	–	-39	–	I	C	C	C	C	C	C	I	C	C	519
Methoxyl-ethyl acetoxystearate (M)	0.948	–	–	–	–	–	–	P	C	C	C	–	–	C	C	C	C	138, 748
Styrene derivatives																		
Poly alpha methylstyrene resin	1.01@60°	1.58@60°	166	–	150-300@5mm.	–	–	I	C	P	C	P	C	P	C	P	P	330
Poly alpha methylstyrene resin	1.04@60°	1.57@60°	182	–	150-300@5mm.	–	–	I	C	P	C	P	C	P	C	P	P	330
Poly alpha methylstyrene resin (P)	1.07@15.6°C.	1.61[3]	–	–	–	99-143	–	I	I	I	I	P	C	I[4]	I	P	P	72, 758
Styrene resin	1.02-1.07	1.57-1.60	–	–	–	5-140	–	P	P	P	P	P	C	P	I	P	P	831
Styrene resin	1.04	1.58	–	–	–	100, 120	–	I	I	I	I	P	C	I	I	P	P	831
Styrene derivative	1.08	1.599	–	–	>300	-15	–	C	C	C	C	C	C	C	C	C	C	758
Succinic acid derivatives																		
Dibutyl succinate	0.974	1.428	–	–	255	-19	–	C	C	C	–	–	–	–	–	–	–	485
Sucrose derivatives																		
Sucrose octoacetate	1.28[5]	–	307	–	260@0.01mm.	89	–	C	–	C	C	–	–	C	–	–	–	1117
Sucrose acetate isobutyrate (M)	1.146	1.4540	260	–	288	–	–	P	C	C	C	–	C	C	P	–	P	346
Sucrose benzoate (hard resin modifier)	1.25	1.577	260	–	–	98	–	C	C	C	C	C	C	C	I	C	C	1146
Sulfonic acid derivatives																		
Benzenesulfonbutylamide	1.148	1.525	–	–	205-220@10mm.	–	–	C	C	C	C	P	I	C	–	I	P	129, 1107
Benzenesulfonmethylamide (M)	1.26[5]	–	180	–	220-230@12mm.	–	–	C	C	C	C	–	–	–	–	–	–	146, 719, 1107
O and p-toluenesulfonamide (M)	1.353	–	208	–	360	105	–	P	P	P	C	–	I	C	I	I	I	738
O and p-toluene-ethylsulfonamide (M)	1.188	1.540	174	0.45@150°C. 5.50@200°C.	340	18	425@25°C.	C	C	C	C	–	C	C	C	I	I	738
n-Cyclohexyl p-toluenesulfonamide (M)	1.125	–	–	–	350	86	–	P	P	C	C	–	P	–	–	–	–	738

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

‡Numbers refer to manufacturers and suppliers listed on page 816. See end of chart, page 785, for list of trade names and designations of suppliers

§(M) indicates monomeric; (P) indicates polymeric. ¶Measurement made at 20°C. **Pour point. ††Calculated from 20/20°C. ‡‡Developed for polyvinyl alcohol.

Plasticizers chart (Cont'd)

Name[1]	Sp. Gr.* at 25°C.	R.I. at 25°C.	F.P., °C.	V.P., mm. Hg.	B.R., °C.	M.P., °C.	Viscosity, cp.	Compatibility with plastics† CA	CAB	CN	EC	PM	PS	VA	VB	VC	VCA	Manufacturers and suppliers[1]
Sulfonic acid derivatives (Cont'd)																		
Hydroxyalkyl benzene sulfonamide[2]	1.24	1.527	–	240°C[4]	–	<–20	–	C	C	C	–	C	–	C	–	I	I	166
Sulfonamide-formaldehyde (P)	1.35	1.430	–	–	–	–	–	C	C	C	C	C	P	C	C	P	C	738
Sulfonamide-formaldehyde (P)	1.256	–	–	–	–	–	–	C	C	C	C	C	P	C	C	P	P	738
Urea-formaldehyde-modified	1.07	1.477	–	–	–	–	–	P	P	C	C	I	C	C	–	P	C	129
Alkyl-sulfonic ester of phenol(M)	1.05	1.500	200-230	–	–	–	90-120[3]	I	C	C	C	–	C	I	–	C	C	146, 719
Tall oil derivative																		
Methyl ester of tall oil (M)	0.98	1.492[3]	171	–	–	–	Approx. 23@ 100°F	P	–	P	C	–	–	P	C	C	C	504
Isooctyl ester of tall oil (M)	0.86	–	–	–	–	–	–	–	–	P	C	–	–	P	C	C	C	493
Tartaric acid derivatives																		
Dibutyl tartrate	1.093	1.447	170	–	292-312	20-22	–	C	C	C	C	C	–	C	–	–	C	94

*Code for column headings: Sp. Gr. = specific gravity; R.I. = refractive index; F.P. = flash point (Cleveland open cup); V.P. = vapor pressure; B.R. = boiling range; M.P. = melting point; CA = cellulose acetate; CAB = cellulose acetate butyrate; CN = cellulose nitrate; EC = ethyl cellulose; PM = polymethyl methacrylate; PS = polystyrene; VA = polyvinyl acetate; VB = polyvinyl butyral; VC = vinyl chloride; and VCA = vinyl chloride acetate.

†Code for compatibility: C = compatible, P = partially compatible, I = incompatible.

[1] Numbers refer to manufacturers and suppliers listed on page 815. See below for list of trade names and designations of suppliers.

[2] (M) indicates monomeric; (P) indicates polymeric. [3] Measurement made at 20°C. [4] Pour point.

Trade names and designations of plasticizers

Numbers in parentheses indicate companies listed on page 815 which use these specific trade names or designations. These designations are usually used for more than one plasticizer, the specific material being indicated by a following number, letter, or group of numbers or letters.

Abalyn (504)
ABG (129)
Abitol (504)
Acetin (146, 719)
Admex (103)
Adimoll (146, 719)
Adipol (371)
Aldo (464)
AMS (72)
Aroclor (738)

Benzoflex (1146)
Bisoflex (132)
Blandol (1192)

Carbowax (1117)
CD (172)
Cereclor (206, 536, 537)
Chemial (228)
Chlorez (329)
Chlorowax (320, 917)
Citroflex (839)
Clophen (146, 719)
Clorafin (504)
CPF (827)
CP-485 (519)
Crestapol (982)
Cryoflex (1162)

D.A.P. (536A)
Deltaflex (917)
Dellatol (146, 719)
Diablo (320)
Diacetin (146)
Disflamoll (146, 719)
Dow (330)
Drapex (91)
Drewmulse (812A)

Edenol (501)
Emery (354)
Epoxol (1054)
Escoflex (345)
Estynox (748)
Ethosperse (464)

Flexchlor (827)
Flexol (1117)
Flexricin (748)

Gafanol (427)
Gantrez (427)
Glaurin (464)
Gloria Kaydol (1192)
Glycolube (464)

Halleo (485)

Hatco (474)
Hatcol (474)
HB (738)
Hercoflex (504)
Hercolyn (504)
Hexaplas (206, 536, 537)

Isochemflex (577)
Isaplast PU (165)

Jayflex (370)
Jeffox (585)

Kenflex (605)
Kenplast (605)
Kesscoflex (94)
Kodaflex (346)
KP (371)
Kronitex (371)
Kronox (371)

Lankroflex (536A)
Leflex (693)
Lindol (1031)
Lipal (812A)
Loxiol (501)
Lutanol (129)

Mesamoll (146, 719)
Metalyn (504)
Mobilsol (723)
Monoplas (982)
Monoplex (950)
Monsanto (738)
Morflex (839)
MPS (519)

Natrochem (493)
Nevillac (758)
Neville (758)
Nevinol (758)
Nopco (770)
Nopalcol (770)
Nuoplaz (1074)

Palamoll (129)
Palatinol (129)
Panaflex (72)
Paraplex (950)
Paricin (748)
Paroil (329)
Pegosperse (464)
Peroxidol (917)
Pfizer (839)
Phosflex (1031)
Phosgard (738)

Picco (831)
Piccocizer (831)
Piccolastic (831)
Plastigen (129)
Plastolein (354)
Plastomoll (129)
Pliabrac (31)
Pluracol (129)
Pluronic (129)
Polycin (748)
Polycizer (493)
PX (1111)
2-Pyrol (427)

Quadrol (129)

Resoflex (205)
Rucoflex (961)
RS (917)

SAIB (346)
Santicizer (738)
Santolite (738)
Sherflex (997)
Sicol (739)
SOA (1117)
Staflex (917)
Starfol (103)

Super-Chlor (329)

Tetronic (129)
Thanol (585)
TP (1088)
Triacetin (146, 719)
Triol (585)
Truflex (1070)

Ultramoll (146, 719)
Unichlor (758)
Uniflex (1116)
Unimoll (146, 719)
Upox (577)

Vereflex (1148)
Vestablit Epoxi (1148)
Vestinol (232)
Vircol (722)
Vinylube (464)

Wareflex (1162)
Wilmar (1192)
Witco (1195)
Witcizer (1195)

Manufacturers/suppliers of materials and equipment listed in charts.

Addresses appear in the Directory Section, p. 819.

1. AAA Plastics Equipment Co.
2. AEG Isolier-und Kunststoff GmbH
3. AFEX AG
4. AGA Corp.
5. AKU Goodrich B.V.
6. AMSCO Div., Union Oil Co. of Calif.
7. AMUT S.p.A.
8. ARCO Chemical Co.
9. ARCO/Polymers, Inc.
10. A & S Corp.
11. A.S.C. Industries Inc.
11A. ASEA
12. Aarlite, Inc.
13. Abbott Machinery Div., U.S. Packaging Corp.
14. Aceto Chemical Co., Inc.
15. Acme Plastics Machinery Corp.
16. Acme Resin Co., Unit of CPC International
17. Adams & Associates, Inc.
18. Adams Bros. Plastic
20. Adell Plastics, Inc.
21. Adem Works
22. Advanced Machine Planning, Inc.
23. Air Products & Chemicals, Inc.
24. Air-Vac, Inc.
25. Akron Extruders, Sub. Bolton-Emerson, Inc.
26. Akzo Chemie bv
26A. Akzo Chemie GmbH (Interstab)
26B. Akzo Chemie U.K. Ltd., Interstab Div.
27. Akzo Plastics nv
28. Alambres Dominicanos C por A
29. Al-Be Industries, Inc.
30. Albis Corp.
31. Albright & Wilson, Ltd., Industrial Chemicals Div.
32. Alcan Metal Powders, Div. Alcan Aluminum Corp.
33. Alchem Plastics, Inc.
34. Alcolac, Inc.
35. Alframine Corp.
36. Alliance Mold Co., Molding Equipment Div.
37. Allied Chemical Corp., Plastics Div.
37A. Allied Chemical Corp., Specialty Chemicals Div.
38. Allied Color Industries, Inc.
39. Allwood Hydraulic Press Co.
40. Alnor Instrument Co.
41. Alpha-Monarch Corp.
42. Alpine American Corp.
43. Aluminum Co. of America
44. Amaco, Inc.
45. Amacoil Machinery, Inc.
45A. Amcel, Ltd.
46. Amco Plastic Processors, Inc., Colorant Div.
47. American Acrylic Corp.
48. American Barmag Corp.
50. American Chemical Corp.
51. American Cyanamid Co., Industrial Chemicals & Plastics Div.
52. American Cyanamid Co., Elastomers & Polymer Additives Dept.
53. American Cyanamid Co., Dies & Chemicals Dept.
54. American Cyanamid Co., Plastics Div.
55. American Hoechst Corp.
56. American Hoechst Corp., Film Div.
57. American Hoechst Corp., Chemicals & Plastics Div.
58. American Hydrotherm Corp., Sub. Ecological Science Corp.
59. American Instrument Co., Div. Travenol Laboratories, Inc.
60. American Insulator Corp.
61. American Packaging Corp.
61A. American Polymers, Inc.
62. American Pyroxylin Corp.
63. American Renolit Corp.
64. American Resin Corp.
65. American Stuebbe Div., Demag Plastic Machinery
67. American Thermoplastics Corp.
68. Americhem, Inc.
69. Ames, B.C., Co.
70. Ametek/Instruments and Controls
71. Ametek/Westchester Plastics
72. Amoco Chemicals Corp.
73. Amoco Chemicals Corp., Industrial Products Div.
74. Ampacet Corp.
75. Amprobe Instrument
76. An-Cor Industrial Plastics, Inc.
77. Anderson Development Co.
78. Andouart, Societe des Etablissements
79. Andria Plastics Corp.
80. Ankerwerk, Div. Demag Machinery Group
81. Ankerwerk Nurnberg GmbH
82. Apache Foam Products, Div. Multimaster Onyx Corp.
83. Applied Fluidics, Inc.
84. Applied Plastics Co.
85. Applied Systems Corp.
86. Aquitaine-Organico
87. Aragon Div., Certain-Teed Machinery Corp.
88. Arapahoe Chemicals, Div. Syntex Corp.
89. Arburg Maschinenfabrik
90. Argus Chemical Corp., Halby Div.
91. Argus Chemical Corp.
92. Arkansas Co.
93. Arlon Products, Inc.
94. Armak Chemicals Div.
95. Armen, Inc.
96. Armstrong Cork Co.
97. Armstrong Products Co., Inc.
98. Aro Corp.
99. Arrow Industries Inc.
100. Artmor Plastics Corp.
101. Arvey Corp., Lamcote Div.
101A. Asahi Chemical Industries Co., Ltd.
101B. Asahi-Dow, Ltd.
101C. Asahi Glass Co., Ltd.
102. Asahi Yukiazi Kogyo Co., Ltd.
103. Ashland Chemical Co., Div. Ashland Oil & Refining Co.
104. Associated Lead Mfg., Ltd.
105. Astronautic Industries, Inc.
106. Athena Controls, Inc.
107. Atlantic Laminates, Div. Oak Industries, Inc.
108. Atlantic Powdered Metals, Inc.
109. Atlas Coatings Corp.
110. Atlas Hydraulic Div., Hussong-Walker Davis
111. Atlas Machine & Tool Corp.
112. Atlas Minerals & Chemicals Div., ESB, Inc.
113. Atlas Vac Machine Div., Planet Products Corp.
114. Autojector, Inc.
115. Automatic Packaging Machinery Co.
116. Automatic Timing & Controls, Inc.
117. Automation Devices, Inc.
118. Automation Products, Inc.
119. Auto-Place, Inc.
120. Autotron, Inc.
121. Auto-Vac Co.
122. Avecor, Inc.
123. Aviaplastique, S.A. (KAP)
124. Avnet Machinery, Div. Avnet, Inc.
125. Avnet Shaw Div., Avnet, Inc.
126. Axel Plastics Research Laboratories, Inc.
127. Aztec Chemicals, Div. Dart Industries, Inc.
128. BASF Canada, Ltd.
129. BASF Wyandotte Corp.
130. BASF AG
131. B.B.I., Inc.
132. BP Chemicals International, UK Plastics Dept.
134. Babcock & Wilcox Co., Refractories Div.
135. Bailey, J.W., Machinery, Ltd.
136. Bakelite, La
137. Bakelite Xylonite, Ltd.
138. Baker Castor Oil Co., Product Development
139. Baker Perkins, Inc.
140. Barber-Colman Co., Industrial Instruments Div.
141. Barnes Engineering Co.
142. Barr Polymer Systems, Inc.
143. Battenfeld Corp. of America
144. Bausano & Figli
145. Baychem Corp., Verona Div.
146. Bayer AG
147. Beckman Instruments, Inc.
148. Beetle Plastics, Inc.
149. Bekum Maschinenfabriken GmbH
150. Belding Chemical Industries
151. Beloit Corp., Plastics Machinery Div.
152. Berdon, Inc.
153. Berges, C.W., Machinenfabrik
154. Bernel Foam Products Co.
155. Berstroff, Hermann, Maschinenbau GmbH (Transmares Corp., U.S. Rep.)
156. Betol Machinery, Ltd.
157. Bielloni Construzioni Italiane
158. Billion S.A.
159. Bin-Dicator Co.
160. Bipel International, Inc., (Sales Ramco)
161. Black Clawson Co., Dilts Div.
162. Blane Chemical Div., Reichhold Chemicals, Inc.
163. Bleiborger Bergwerks Union
164. Bogert Machine Corp. (U.S. rep. for Mauser KG)
165. Bohme, Dr. Th., KG
166. Bolling, Stewart, & Co., Div. Intercole Automation, Inc.
167. Bolton-Emerson, Inc.
168. Bone Cravens, Ltd.
169. Borden Chemical Corp., Thermoplastic Div.
170. Borden Chemical, Div. Borden, Inc.
171. Borg-Warner Corp., Chemicals-Plastics
172. Boron Oil Co.
174. Brabender, C.W., Instruments, Inc.
175. Bradley & Turton, Ltd.
176. Brandenburger, Joachim, Spezialmaschinenbau
177. Brandywine Fibre Products Co.
178. British Celanese, Ltd.
179. British Industrial Plastics, Ltd., Engineering Div. (U.S. sales rep. Ramco Ind.)
180. British Oxygen Chemicals, Ltd.
181. Brookfield Engineering Laboratories, Inc.
182. Brooks Instrument Div., Emerson Electric Co.
183. Brown Machine Div., Koehring Co.
184. Brown Plastics Engineering Co., Inc.
185. Brummer & Co. (Dumat)
186. Brunswick Corp., Technical Products Div.
187. Bucher-Guyer, Ltd.
188. Buckman Laboratories International, Inc.
189. Budd Co./Polychem Div.
189A. Budd Plastic Products Div.
190. Buhler Bros. (England), Ltd.
191. Bulova Watch Co.
192. Butler Mfg. Co., Salina Div.
193. CDI Dispersions
195. CIBA-GEIGY Marienberg GmbH
196. CIBA-GEIGY Corp., Polymer Additives Dept.
197. CIBA-GEIGY Corp., Plastics & Additives Div.
198. CIBA-GEIGY (UK) Ltd.
199. CIBA-GEIGY Ltd., Plastics Dept.
200. CTL-Dixie, Inc.
201. Cabot Titanita, Inc., Cabot Corp.
202. Cadillac Plastics & Chemical Co.
203. Calfoam Div., Mobay Chemical Co.
204. Callery Chemical Co., Div. Mine Safety Appliances Co.
205. Cambridge Industries Co.
206. Canadian Industries, Ltd., Industrial Chemicals Div.
207. Canada Machinery Corp.
208. Canrad Hanovia Industries, Inc.
209. Caradco Div., Scovill Mfg. Co.
210. Carborundum Co.
211. Cardinal Chemical Co.
212. Carlon, an Indian Head Co.
213. Carolina Color Corp.
214. Carpenter, E.R., Co.
215. Carus Chemical Co., Inc.
216. Carver, Fred S., Inc.
217. Castall, Inc.
218. Celanese Piping Systems, Inc.
219. Celanese Plastics Co.
221. Cement Asbestos Products Co.
222. Certain-Teed Products Corp., Plastics Div.
223. Chase Chemical Corp.
224. Chemanox, Inc.
225. Chemetron Corp., Inorganic Chemicals Div.
226. Chemetron Corp., Organic Chemicals Div.
227. Chemetron Corp., Pigments Div.
228. Chemical Farmaceutici S.p.A.
229. Chemical Development Corp.
230. Chemical Products Corp.
231. Chemical Sales Co.
232. Chemische Werke Huls AG
233. Chemplex Co.
234. Chevron Chemical Co.
234A. Chisso Corp.
235. Chroma Corp.
236. Cincinnati Development & Mfg. Co.
237. Cincinnati Milacron Austria GmbH
238. Cincinnati Milacron Chemicals, Inc.
239. Cincinnati Milacron, Plastics Machinery Div.
240. Cities Service Co.
241. Cities Service Co., Plastics Div.
242. Claremont Polychemical Corp.
243. Clifton Hydraulic Press Co.
244. Clopay Corp.
245. Clow Corp., Plastics Div.
246. Colonial Kolonite Co.
248. Color Chip Corp.
249. Colorco, Inc.
251. Comet Industries, Inc.
252. Commercial Solvents Corp.
253. Compo Industries, Inc.
254. Conair, Waeschle Systems, Inc.
255. Conap, Inc.
257. Conoco Chemicals, Div. Continental Oil Co.
258. Conolite Div., Woodall Industries, Inc.
259. Conrac Corp., Cramer Div.
260. Consoweld Corp.
261. Construcciones Margarit S.L.
262. Continental Oil Co.
263. Continental Plastics Industries, Inc.
264. Control Process, Inc.
265. Cooke Color & Chemical Div., Reichhold Chemicals, Inc.
267. Cosden Oil & Chemical Co.
267A. Cosmo Plastics Co.
268. Cosmoplastics S.R.L.
268A. Cottrell Paper Co., Inc.
269. Covema Plastics Processing Machinery, Covema SRL
270. Coz Chemical Co., Div. Allied Products Corp.
271. Cresline Plastics Pipe Co., Inc.
272. Crest-Foam Corp.
273. Crimsco, Inc.
274. Crompton & Knowles Corp., Chemicals Group
275. Crompton & Knowles Corp., Plastics Color Div.
275A. Crown Engineered Materials, Div. Crown-Line Plastics, Inc.
276. Crown Products Corp.
277. Crown Zellerbach Corp.
278. Cupples Coiled Pipe, Inc.
279. Curry Arts Molding & Laminating Co.
280. Curtin-Herbert Co.
281. Curwen & Newbery, Ltd.
282. Custom Chemicals Co., Inc.
283. Customcolor, Inc.
284. Custom Compounding Corp.
285. Custom Machine Design Corp.
285A. Custom Resins Inc.
286. DSM

Table B-1. PRODUCT LIST (Cont.)

286A. Dai Nippon Ink & Chemical Inc.
287. Dai Nippon Tokyo Co.
288. Daicel, Ltd.
289. Daikin Kogyo Co., Ltd.
290. Dake Corp.
291. Daniels Hamilton, Ltd.
292. Danly Machine Corp.
293. Danson Corp., Ltd.
294. Dart Industries Inc., Chemical Group
297. Davies Nitrate Co.
298. Davis, Frank D., Co., Sub. Rockwood Industries, Inc.
299. Davis Meter & Supply Co.
300. Davis-Standard/Goulding/Hobbs Div., Crompton & Knowles Corp.
301. Dayco Corp., Packaging Film Div.
302. Day-Glo Color Corp.
303. DeBell & Richardson, Inc.
304. Decar Plastics Corp.
305. Decor Laminates, Inc.
306. Deelite Blacklite Corp.
307. Deerfield Plastics Co., Inc.
308. DeGussa, Inc.
309. Dekoron Div., Samuel Moore & Co.
310. Delavan Mfg. Co.
312. Delta-Chicago Inc., Clad Rex Div.
313. Demag Kunstsofftechnik GmbH
314. Denki Kagaku Kogyo K.K.
315. Design Center, Inc.
316. Devcon Corp.
317. Dew-Foam Industries
318. Di-Acro, Div. Houdaille Industries, Inc.
320. Diamond Shamrock Chemical Co., Plastics Div.
320A. Dia-Premix Co., Ltd.
321. Dillon, W. C., & Co.
322. Dimensional Pigments, Inc.
323. Ditron, S.R.L.
324. Dixon Corp.
324A. Dodge Fluorglas, Dodge Industries Inc., Oak Materials Group
325. Dohrman Envirotech
326. Dolci, Ing. L., S.p.A.
327. Donray Products Co.
328. Double A Products Co., Sub Brown & Sharpe Mfg. Co.
329. Dover Chemical Corp.
330. Dow Chemical Corp.
331. Dow Corning Corp.
332. Drabert Sohne, Maschinenfabrik
332A. Drainage Engineering Co.
333. Drouet-Diamond
334. Dunning & Boschert Press Co.
335. du Pont, E.I., de Nemours & Co., Inc.
335A. du Pont, E.I., de Nemours & Co., Inc., Film Div.
335B. du Pont, E.I., de Nemours & Co., Inc., Textile Fibers Div.
336. Durez Div., Hooker Chemical Corp.
337. Dynachem Corp.
338. Dynamit Nobel AG
339. Dynamit Nobel of America, Inc.
340. Dynisco
341. EG & G, Cambridge Systems
342. Eagle-Picher Industries, Inc.
343. Eagle-Picher Industries, Inc., Chemicals & Fibers Div.
344. Eagle Signal, a Systems Div. G & W Industries
345. East Coast Chemicals Co.
346. Eastman Chemical Products
347. Egan Machinery Co.
349. Electric Trading Co.
350. Electro-Flex Heat, Inc.
351. Electro-Mechano Co.
352. Emerson & Cuming, Inc.
353. Emser Werke AG
354. Emery Industries, Inc.
355. Engel, Ludwig, KG
356. Engineering Plastics, Inc.
356A. Engineering Plastics Ltd.
357. Engineering Plastic Machinery Co.
358. Enka Glanzstoff Plastic NV, Engineering Plastics Dept.
359. Erie Foundry Co.
360. Eronel Industries
361. Esgo Plastics Machinery, Ltd.
361A. Essex International Inc., Copolymer Products
362. Essex Wire Corp.
362A. Ethyl Corp., Industrial Chemicals Div.
363. Ethyl Corp., Polymer Div.
364. Eurotherm Corp.
365. European Plastic Machinery Mfg. Co.
366. Evans Chemetics, Inc.
366A. Ex-Cell-O
367. Extruders, Inc.
368. Extrudyne Co.
369. Exxon Chemical Co. U.S.A., Film Div.
370. Exxon Chemical Co. U.S.A., Plastics Lab.
371. FMC Corp., Industrial Chemicals Div.
372. FMC Corp., Packaging Machinery Div.
373. FMC Corp., Parts & Materials Handling Div.
374. Fabricon Products, Div. Eagle-Picher Industries, Inc.
375. Fahr Bucher GmbH
376. Fairmount Chemical Co.
377. Fameo Plastics Mfg. Co., Div. Familian Corp.
378. Farbwerke Hoechst AG
379. Farrel Co., Div. USM Corp.
380. Fast Heat Element Mfg. Co.
380A. Federal Mogul Corp., Colonial Plastics Div.
381. Fellows Corp.
382. Felten & Guilleaume Dielektra AG
383. Fenwal, Inc.
384. Ferguson, James, & Sons, Ltd.
385. Ferro Corp., Color Div.
386. Ferro Corp., Composites Div.
386A. Ferro Chemical, Div. of Ferro Corp.
387. Ferry Machine Co.
388. Fibco Plastics, Inc.
389. Fibercast Co., Div. Youngstown Sheet & Tile Co.
390. Fiberfil Div., Dart Industries, Inc.
391. Fiberite Corp.
392. Fincor Div., North American Rockwell
393. Fine Organics, Inc.
394. Firestone Plastics Co., Div. Firestone Tire & Rubber Co.
395. Firestone Synthetic Fibers Co.
396. Firestone Synthetic Rubber & Latex Co.
397. Fischer Blow Molding Equipment
398. Fischer & Porter Co.
399. Fischer Scientific Co.
399A. Fischer-Voith Plastics Machines, Inc.
400. Fjellman American, Inc.
401. Flexible Products Co.
402. Flexiplast, Inc.
403. Flex-O-Glass, Inc., Plastics Div.
404. Flintkote Co.
405. Florin, Ltd.
406. Fluidyne Instrumentation
407. Fluorocarbon Co.
408. Ford Motor Co., Paint & Vinyl Operations
409. Formica Corp.
410. Formica, Ltd.
411. Fortin Laminating, Div. Monogram Industries, Inc.
412. Fortin Plastics, Inc.
413. Foster Grant Co.
414. Fostoria-Fannon, Inc.
415. Foxboro Co.
416. Fox Valve Development Co.
417. Franklin Fibre-Lamitex Corp.
418. Freeman Chemical Corp., Sub. H. H. Robertson Co.
419. French Oil Mill Machinery Co.
420. Fried Novelties
421. Frieseke & Hoepfner GmbH
422. Frilvam S.p.A.
423. Froendenberger Maschinen & Apparatebau GmbH
423A. Fudow Chemical Co.
424. Fuller Co.
425. Furane Plastics, Inc.
426. Furukawa Electric Co.
427. GAF Corp.
428. G.B.F. Costruzioni Meccanische S.p.A.
429. GKN Winder Ltd.
431. GSE, Inc.
432. Gammaflux, Inc.
433. Garden State Chemical
434. Gardner Laboratory, Inc.
435. Gart Mfg. Co.
436. Gelman, Herman A., Co.
437. Gem-O-Lite Plastics Corp.
438. General Color Co., Div. H. Kohnstamm Co.
439. General Engineering Co.
440. General Electric Co., Industrial Control Products Div.
441. General Electric Co., Industrial Sales Div.
442. General Electric Co., Insulating Materials Dept.
443. General Electric Co., Laminated Products Dept.
444. General Electric Co., Engineering Polymers Product Dept.
444A. General Electric Co., Plastics Div.
444B. General Electric Co., Noryl Operations
445. General Electric Co., Silicone Products Dept.
445A. General Electric Plastic NV
446. General Foam Plastics Corp.
446A. General Industries Co.
446B. General Instrument Corp., Semi Conductor Div.
447. General Mills Chemicals, Inc.
448. General Plastics Corp.
449. General Plastics Mfg. Co.
450. General Tire & Rubber Co., Chemical Plastics Div.
451. Gentran, Inc.
452. Getty Machine & Mold, Inc.
453. Gifford-Hill Co., Inc.
455. Gilman Bros. Co.
456. Glamorgan Pipe & Foundry Co.
457. Glassoloid Plastics, Inc.
458. Glastic Corp.
459. Glidden Pigments, SCM Corp.
460. Glitterex Corp.
461. Global Process Equipment, Inc.
462. Gloucester Engineering Co., Inc.
463. Gluco
464. Glyco Chemicals, Inc.
465. Gold Leaf & Metallic Powders, Inc.
466. Goodrich, B. F., Chemical Co.
467. Goodyear Aerospace Corp.
469. Goodyear Tire & Rubber Co., Chemical Div.
469A. Gould Inc., Electric Motor Div.
470. Grace, W.R., & Co., Construction Products Div.
471. Grace, W.R., & Co., Cryovac Div.
472. Grace, W.R., & Co., Davison Chemical Div.
473. Grace, W.R., & Co., Ellay Rubber Div.
474. Grace, W.R., & Co., Hatco Chemical Div.
475. Grace, W.R., & Co., Marco Chemical Div.
476. Graham Engineering Corp.
477. Great Lakes Chemical Corp.
478. Great Lakes Foundry Sand Co., Mineral Products Div.
479. Guardian Chemical Corp.
479A. Guardian Electric Mfg. Co.
480. Gulf Oil Chemicals Co., Gulf Adhesives
481. Gulf Oil Chemicals, Plastics Div.
482. Gyromat Corp.
483. HITCO, Defense Products Div.
484. Haake, Inc.
485. Hall, C.P., Co.
486. Hallikainen Instruments
487. Hammond Plastics, Inc.
489. Harrel, Inc.
490. Harshaw Chemical Co., Div. Kewanee Oil Co.
491. Harte & Co., Inc., Sub. Diamond Shamrock Corp.
492. Harvey Hubbell, Inc., Plastics Div.
493. Harwick Chemical Corp.
494. Hasting Plastics, Inc.
495. Haveg Industries
495A. Hawley Products Co.
496. Haysite Div., Synthane-Taylor Corp.
497. Hayssen Mfg. Co.
498. Heath Tecna Corp., Precision Structures Div.
499. Heil Process Equipment Corp.
499A. Helman Co., E. Div. U.S. Industries Inc.
500. Henkel, Inc., Chemical Specialties Div.
501. Henkel International GmbH
502. Herbert Associates, Ltd.
503. Herbert Machine Tools, Ltd.
504. Hercules, Inc.
507. Hightemp Resins, Inc.
508. Hillard Industries, Inc.
509. Hills-McCanna Div., Pennwalt Corp.
510. Hilton-Davis Chemical Co.
511. Hitachi Chemical Co., Ltd.
512. Hobbs Mfg. Co., Davis Standard Div.
513. Hobbs-Williams Machinery, Ltd.
514. Hoke, Inc.
516. Hommel, O., Co.
517. Honeywell, Apparatus Controls
518. Honeywell, Industrial Div.
519. Hooker Chemical Corp.
521. Hoover Ball & Bearing Co., Uniloy Div.
522. Hoover Ball & Bearing Co., Reynolds Chemical Products Div.
523. Horton Hydraulics, Div. Edward Horton Co.
524. Houghton, E.F., & Co.
525. Howard Industries, Inc.
526. Howe Industries, Inc.
527. Howell Industries, Inc.
528. Hull Corp.
529. Humphrey Chemicals Corp.
530. Hunkar Laboratories, Inc.
531. Hupfield Bros.
532. Husky Injection Molding Systems, Ltd.
533. Hydrates, Inc.
534. Hydrodynamics, American Instruments Co., Div. Travenol Lab., Inc.
535. Hysol Div., Dexter Corp.
535A. IBM
536. ICI America, Inc.
536A. ICI Lankro Plasticizers Ltd.
537. ICI Ltd., Plastics Div.
538. IRIS Corp., Sub American Silk Label Mfg. Co.
539. ITT Thompson, Plastics Div.
540. ITT Vulcan Electric
541. Idemitsu Petrochemical Co.
542. Identification Service Corp.
544. Ikegai Iron Works, Ltd.
546. Illig, Adolf, Maschinenbau
547. Ingersoll-Rand/Negri Bossi Div.
550. Incoe Corp.
551. Indev, Inc.
552. Indol Chemical Co.
553. Indussa Corp.
554. Industrial Chemical & Dye Co., Inc.
554A. Industrial Dielectrics Inc.
555. Industrial Nucleonics Corp.
556. Industrial Plastic & Bearing Sales Div.
557. Industrial Plastic Fabricators, Inc.
558. Industrial Temperature Control Co.
559. Industrial Timer Corp.
560. Industrie-Werke Karlsruche A.G., Packaging Machinery Div.
561. Infra Systems, Inc., Sub. Industrial Nucleonics
562. Infrared Industries, Inc., Electronics
563. Inmont Corp.
564. Insulating Fabricators of New England, Inc.
567. International Foam Div., Holiday Inns of America, Inc.
568. International Industrial Products Corp.
569. Interox Chemicals, Ltd.
570. Interplastics Corp., Commercial Resins Div
571. Interstab, Ltd.
572. Ionac Chemical Co., Div. of Sybron Corp.
573. Ircon, Inc.
574. Ishihara Sangyo Kaisha Ltd., International Sales Dept.
575. Ishikawajima-Harima Heavy Industries Co., Ltd., Industrial Machinery Div.
576. Island Co.
577. Isochem Resins Co.
578. Isola S.p.A.
579. Isola Werke AG
580. Iten Fibre Co.
581. Jaco Mfg. Co.
582. Jamieson Laboratories
582A. Japan Interstab Ltd.
583. Japan Steel Works, Ltd.
584. Jarecki Corp.
585. Jefferson Chemical Co., Inc.
586. Jeffrey Mfg. Co.
587. Jet Stream Plastics, Ralph Jones Co.
588. Joanna Western Mills Co., Plastic Fabric Div.
589. Johns-Manville
590. Johnson Plastics Machinery Div., Leesona Corp.

Table B-1. PRODUCT LIST (Cont.)

591. Jomar Industries, Inc.
592. Jordon Controls, Inc.
593. Jordon Valve Div., Richards Industries, Inc.
594. Kalle Aktiengesellschaft
595. Kanegafuchi Chemical Industries Co., Ltd.
596. Kard Corp.
597. Kato-Riki Mfg. Co
598. Kaufman SA
599. Kautex Machines, Inc.
599A. Kawaguchi Ltd
600. Kayeness, Inc
601. Kay-Fries Chemicals, Inc.
603. Keil Chemical Co.
604. Kelley-Pickering Chemical Corp
605. Kenrich Petrochemicals, Inc.
606. Kenro Corp
607. Kent Cambridge Instrument Co., Div. Kent Cambridge Corp
608. Kent Machine Co., Div. Lamson & Sessions Co.
609. Kerona, Inc
610. Kerona Plastics Extrusion Co.
611. Kerr-McGee Chemical Corp
612. Kiefel GmbH
613. Killion Extruders, Inc
614. Kleen Chemical Mfg Co
615. Kleineweters Industrie-Companie GmbH
616. Klockner-Moeller GmbH
617. Knox, Inc., Controls Div
618. Koch, H., & Sons Inc
619. Koehring Co., HPM Div
619A. Koehring Co., Prodex, HPM Div.
620. Kohler General, Inc
621. Kohnstamm, H., & Co.
622. Kohnstamm Co., Ltd.
623. Kontrols, Inc.
624. Koppers Co., Organic Materials Div.
625. Kornylak Corp
626. Kras Corp.
627. Krauss & Lensing GmbH
628. Krauss-Maffei Corp
629. Kreier, George, Jr., Inc.
630. Kristal Kraft, Inc.
631. Kroll Equipment Co
632. Kronos Titan-GmbH
632A. Kronos SA/NV (Belgium), Sub. NL Industries
632B. Kronos Titan A/S (Norway), Sub. NL Industries
633. LFE Corp., Process Controls Div.
634. LNP Corp
635. Laminations, Inc.
636. Landers-Segal Color Co
637. Land Instruments, Inc
638. Landis & Gyr, Inc.
639. Lankro Chemicals, Ltd
639A. Lasco Industries
640. Latex Fiber Industries
641. Lati Industria Thermoplastica S.p.A.
642. Lawter Chemicals, Inc.
643. Lawton, C.A., Co.
644. Leader, Denis, Ltd
645. Leathertone, Inc
646. Leeds & Northrup Co.
648. Leopold Co
649. Leslie Co.
650. Lester, Gerd, Corp
651. Lester Engineering Co
652. Lewis, J.P., Co
653. Lewis, G.B., Co.
654. Lewis Welding & Engineering Corp.
656. Lion Precision Corp
657. Liquid Nitrogen Processing Corp
658. Lithium Corp. of America, Sub. Gulf Resources & Chemical Corp
659. Lonza, Inc.
661. Love Controls Corp.
662. Lowey, Gene, Inc
664. Luchter Instruments
665. Lumar Optical Mfg. Co., Inc.
666. Lumeca, S.A
667. Lunn Laminates, Inc
668. MAS S.p.A.
669. MEK Chemical Co., Inc.
670. M & N Modern Hydraulic Press Co.
671. M & Q Plastics Products
672. M R Plastics & Coatings, Inc.
673. M-R-S Chemicals, Inc.
674. M & T Chemicals, Inc., Sub. American Can Co.
674A. M & T Chemicals Inc., Apogee Products
675. Machine Factory & Foundry Netstal, Ltd.
676. Machine Tool Works, Oerlikon Buhrle Ltd.
677. Mallinckrodt Chemical Works
677A. Manning Paper Div., Hammerhill Paper Co.
678. Marblette Corp
679. Margolis, A., & Sons
680. Marine Plastics, Div. Northern Petrochemical Co.
682. Marlin Mfg. Corp.
683. Mannesmann-Meer AG
684. Marplex, W.M.F., a Hitco Co.
685. Marschall Div., Miles Laboratories, Inc.
686. Masonite Corp.
687. Matsuda Seisakusho Co
688. Matsushita Electric Works, Ltd., Plastics Molding Div
689. Matrix Controls Co
690. May & Baker, Ltd
691. Maynard Plastics, Inc., Div. Chelsea Industries
692. McKesson Chemical Co
695. McNeil-FEMCO-McNeil Corp
696. Mearl Corp
697. Mecha Design, Inc
698. Meiwa Kasei KK
700. Mereco Products
701. Merix Chemical Co
702. Merck Chemical Div., Merck & Co.
703. Metalmeccanica Plast S.p.A
704. Mica Corp
705. Michel, M., & Co., Inc.
706. Michigan Chemical Corp
707. Michigan Chrome & Chemical Co.
708. Midland-Ross Corp., Hartig-Machinery Div.
708A. Midland Ross Corp., Unit Plastics Div
709. Midwest Mfg. Corp
710. Miljac, Inc.
711. Miller, Harry, Corp
712. Millmaster Onyx Corp.
714. Mitsubishi Gas Chemical Co
715. Mitsubishi Monsanto Chemical Co.
716. Mitsubishi Plastics Industries, Ltd.
717. Mitsubishi Rayon Co
718. Mitsui Petrochemical Industries, Ltd.
718A. Mitsui Toatsu Chemicals, Inc.
719. Mobay Chemical Co., Div. Baychem Corp
720. Mobil Chemical Co., Films Dept.
722. Mobil Chemical Co., Industrial Chemicals
723. Mobil Oil Corp
724. Modern Controls, Inc
725. Modern Plastics Machinery Corp., Injection Molding Div
726. Moi (Packaging Industries Sales Corp – U.S. rep.)
727. Mokon Div., Protective Closures Co.
728. Molded Fiber Glass Co
729. Molex Products Co.
730. Monitor Equipment Corp
731. Monitor Mfg., Inc
732. Mono-Sol Div., Chris Craft Industries, Inc.
733. Montrose Chemical Div., Sobin Chemicals, Inc.
734. Mooney Chemicals, Inc.
735. Moore & Munger, Inc.
736. Monmouth Plastics, Inc
738. Monsanto Industrial Chemicals Co.
739. Montedison S.p.A
739A. Monti & Martini S.p.A.
739B. Morrell, George, Corp.
740. Morgan Industries, Inc.
741. Morris Enterprises
742. Morrison Industries, Inc.
742A. Morrison Molded Fiber Glass Co.
743. Morton Chemical Co., Div. Morton-Norwich Products, Inc
744. Moslo Machinery Co
745. Motion Indicating Devices, Inc.
746. Mount Vernon Mills, Inc.
747. Mycalex, Div. Spaulding Fibre Co., Inc.
748. N L Industries, Industrial Chemicals Div.
749. N L Industries, Titanium Pigments Div
750. NRM Corp., Sub. Condec Corp
750A. NV Chemische Fabriek v/h Dr. A. Haagen
751. NVF Co., Molded Products Div
751A. NVF Co., Technical Products Div
752. National Automatic Tool Co.
753. National Industrial Chemical Co
754. National Tel-Tronics Div., Eastern Air Devices Co.
755. Natvar Corp
757. Nelmor Co., Inc., Sub. Entwistle Co.
758. Neville Chemical Co
759. Neville-Synthese Organics, Inc.
760. New Arden Chemical Corp
761. New Britain Plastics Machine Div., Litton Industrial Products, Inc
762. New England Butt Co., Div. Wanskuck Co.
763. New England Plastics Corp.
764. Newbury Industries, Inc.
765. New England Laminates Co., Inc
766. New Jersey Zinc Co., a Gulf & Western Co.
767. Nichem
767A. Nicolet Industries, Inc.
767B. Nippon Steel Chemical Ltd.
768. Nippon Zeon Co., Ltd.
769. Nissei Plastics Industrial Co
769A. Nitto Electric Industries Co., Ltd.
770. Nopco Chemical Div., Diamond Shamrock Chemical Co.
771. Norac Co., Inc.
772. Norcross Co.
773. Nordberg Machinery Group, Rexnord Inc.
774. Nordisk Elsolation AB
774A. Normandy Products Co.
775. Norplex Div., Universal Oil Products
776. Norse Laboratories
778. Northern Petrochemical Co.
779. Northland Plastics, Inc.
780. Norton Co., Plastics & Synthetics Div.
781. Norton Laboratories, Inc.
782. Noury Chemical Corp
783. Noury & van der Lande NV
784. Nouvelle Mapre S.A
785. Novamont Corp
787. Nupla Corp
788. Nylene Corp
789. Nylon Engineering, Inc
790. Nypel, Inc
791. Officine Meccaniche Veronesi
792. Ogden Sales, Inc.
794. Olin Corp., Chemical Div
795. Olin Corp
796. Olin Corp., Plastics Div
797. Olympia Tool & Machine Co.
798. Omega Engineering, Inc.
799. Opticon Chemical, Div. Dynalysis Inc
800. Optimum Machinery Sales, Ltd
801. Orbit, Inc
802. Orbitex, Inc
803. Ore & Chemical Corp
805. Osaka Soda Co
806. Osborn Mfg. Corp
806A. Otalite Co., Ltd
807. Owens-Corning Fiberglas Corp
808. PFD/Penn Color, Inc
809. PPG Industries, Inc., Chemical Div.
810. PPG Industries, Inc., Coating & Resins Div.
811. PVO International, Inc
811A. Pacific Plastic Pipe Co
812. Pacific Resins & Chemicals, Inc., Plastics Div.
812A. Pacific Vegetable Oil Corp
813. Package Machinery Co., Reed-Prentice Div
814 Packaging Industries Sales Corp.
815 Pak-A-Matic Equipment, Ltd.
816 Pall Corp
817. Pan Chemical Corp
818. Pantasote Co
819. Paramount Industries, Inc
820. Parnall & Sons, Ltd
822. Partlow Corp
823 Pasadena Hydraulics, Inc
824 Passaic Color & Chemical Co
825 Pathex (Canada) Ltd
827 Pearsall Chemical Co.
827A. Peerless Plastics, Inc
828 Petron Corp
829 Pemco Products, SCM Corp.
830 Penick, S.B., & Co., Parsons-Plymouth Chemical Group
831. Pennsylvania Industrial Chemical Corp
832 Pennwalt Corp., Harchem Div
833 Pennwalt Corp., Lucidol Div
834. Pennwalt Corp., Plastics Dept.
835. Penreco, Inc., Div. of Pennzoil Co
836. Permali, Inc
837. Perstorp AB Pack, Industrial Products Div.
839. Pfizer Inc., Special Chemicals Dept.
840 Pfizer Inc., MPM Div
841 Philadelphia Gear Corp
842. Philadelphia Quartz Co
842A. Philips, NV
843. Phillips Petroleum Co
843A. Phillips Products Div., Phillips Petroleum Co.
844 Photobell Co., Inc
845. Pierrefitte-Auby S.A
846 Pigment Dispersion, Inc
847. Plamvo GmbH
848 Plastex Co., Div. Standard Oil of Ohio
849. Plastics Equipment & Assessories Co., Ltd.
850 Plastic Fabrication, Inc.
851 Plastics Laminating Corp
853 Plastic Molders Supply Co
857 Plastics Engineering Co
858 Plasticolors, Inc.
860. Plastifoam Corp
861. Plastigage Corp
862 Plastimac s.r.l
863. Plastimation, Inc
864 Plastimer, S.A.
865 Plasti-Vac, Inc.
866 Plastomer Corp
867. Plumb Chemical Corp
868. Podell Industries, Inc
869. Poloron Products, Inc
870. Polychemical Co., Ltd
871. Poly Foam, Inc
871A. Polygon Co., Div. Plas-Steel Products Inc.
872. Poly-Plax Films, Inc
872A. Polychemicals, Div. of Stepan Chemical Co.
873 Polychrome Dispersions, Inc
874. Polymer Corp., Polypenco Div
875 Polymer Dispersion Industries
876. Polymer Machinery Corp
877. Polyplastex United, Inc
878. Polyplastics Co., Ltd
879 Polysar Plastics, Inc
880 Polytex Industrial Finishes Corp.
881. Polytherm Plastics, Div. Polysar Plastics, Inc.
882 Porter, H. K. Co
883 Potters Industries, Inc.
884 Power Instrument & Control Supply Corp.
885 Precision Laminates Corp
886 Precision Polymers, Inc
887. Premier Thermo Plastics Co.
888 Premix, Inc.
890. Price-Driscoll Corp
891 Prideaux, Don, & Assoc
892. Princo Instruments, Inc
895. Products & Systems Mfg Co.
895A. Pultrusions Corp
896. Purethane Div., Easton RS Corp
897 Pylam Products Co
898 Pyrometer Instrument Co
899. Pyro-Serv Instrument Co
900. Quaker Oats Co., Chemicals Div
901. Quinn, K.J., & Co
902 RdF Corp
903. RPM Sales, Inc.
903A. Radiation Technology, Inc.
904. Rainier Plywood Co
905. Fainville Co
906. Ram Chemicals
908. Raybestos Manhattan, Inc., Equipment Sales Div
909. Raychem Corp., Plastics & Chemicals Div
911. Reed Plastics Corp
912. Reeve Electronics, Inc.
913. Reeves Bros., Inc.
914. Reeves Bros. Canada, Ltd.
916. Refined Onyx, Div. Millmaster Onyx
916A. Rehau Plastics of Canada Ltd
917. Reichhold Chemicals, Inc.
918. Reichhold Chemicals, Inc., Reinforced Plastics Div.
919. Reifenhauser U.S. Sales Corp
920. Reinforced Plastics, Inc.

Table B-1. PRODUCT LIST (Cont.)

921. Reiss Associates, Inc.
923. Rempac Foam Corp.
924. Ren Plastics
925. Resart-IHM AG
926. Research, Inc.
926A. Resopal Werk H. Rommler GmbH
927. Reynolds Metals Co., Packaging & Can Div.
928. Rexene Polymers Co., Div. Dart Industries, Inc.
928A. Rex Roto Corp.
929. Rezolin, Div. Hexcel
930. Rheinstahl AG Maschinbau, Henschel Plastics Machinery
931. Rheinstahl Plastics International, Ltd.
932. Rheinische Stahlwerke Maschinenbau
933. Rhodia, Inc., Polyimide Div.
934. Rhone-Poulenc-Textile
935. Rhone-Poulenc, Soc. des Usines Chemiques
936. Richardson Co., Polymeric Systems Div.
937. Ridat Engineering Co.
938. Rika Kogyo Co.
940. Rilsan Corp.
940A. Risho Kogyo, Ltd.
941. Riverdale Color Corp.
942. Robertshaw Controls Co., Fulton Sylphon Div.
943. Robertshaw Controls Co., Industrial Instrumentation Div.
944. Robintech, Inc.
945. Rocheleau Tool & Die Co.
947. Rodgers Plastics Equipment Div., Package Machinery Co.
948. Rogers Anti-Static Chemicals, Inc.
949. Rogers Corp.
950. Rohm & Haas Co.
951. Rolenn Mfg.
952. Rolf Kestermann Maschinenfabrik
953. Rona Pearl Div., Whittaker Corp.
954. Rosemount, Inc.
955. Rostone Corp.
956. Rowland Products, Inc.
957. Royal Plastics Corp.
958. Royle, John, & Sons
959. Rubatex Corp.
960. Rubbermaid Industrial Products Corp.
961. Ruco Div., Hooker Chemical Corp.
962. Rumianca S.p.A.
963. Ruscoe, W.J., Co.
963A. S. F. Plastics, Inc.
964. SGL Industries, Inc.
965. SIDEL
966. SIEMAG, Siengener Maschinenbau GmbH, Plastics Processing Machinery Dept.
967. S.P.R.E.A.
968. S.&S. Machinery Co., Div. New Machine Tool
969. Samafor
970. Sandoz Colors & Chemicals
971. Sandretto F.lli
972. Sangamo Electric Co.
973. Sangamo Weston Controls, Ltd.
974. Sanjo Seiki Co.
974A. Sanyu Resin Co., Ltd.
975. Savage Mfg. & Sales, Inc.
976. Schenectady Chemicals, Inc.
977. Schloemann-Siemag
978. Schori Process Corp.
979. Schramm Fiberglass Products, Div. High Strength Plastics Corp.
980. Schulman, A., Inc.
982. Scott Bader Co.
983. Scott Paper Co., Foam Div.
984. Scranton Plastic Laminating, Inc.
984A. Sedco Corp.
985. Sedo Corp.
986. Seidl Maschinenfabrik KG
987. Seismograph Service Corp., Seiscor Div.
988. Sekisui Chemical Co., Ltd., Foam Products Div.
989. Senshey, Inc., Div. Nihon Dennetsu Keiki Co.
990. Sensotec, Inc.
990A. Sentinel/Triulzi (Packaging Industries Inc.—U.S. rep.)
991. 7-K Color Corp.
992. Shakespeare Co.
993. Shamban, W.S., & Co.
994. Shaw, Francis, & Co.
995. Shell Chemical Co.
995A. Shell International Chemical Co., Ltd.
996. Shepherd Chemical Co.
997. Sherwin Williams Chemicals, Div. Sherwin-Williams Co.
998. Shima Trading Co., Ltd.
998A. Shin-Etsu Chemical Industries Co., Ltd.
999. Shin-Kobe Electric Machinery Co., Ltd.
1000. Showa Denko Co., Ltd.
1000A. Showa Highpolymer Co., Ltd.
1001. Showa Yuka K.K.
1002. Shuman Co.
1003. Sigma Instruments (Canada), Ltd.
1004. Siberline Mfg. Co.
1005. Simco Co.
1006. Simplomatic Mfg. Co.
1007. Simpson Electric Co., Div. American Gage & Machine Co.
1008. Simpson Extruded Plastics
1010. Singer Co., Climate Control Div.
1011. Singer Co., GPE Controls Div.
1012. Slocum Industries, Plastic Machinery Div.
1013. Smith Chemical & Color Co., Inc.
1014. Sobin Chemicals, Inc.
1015. Societa Italiana Resine
1015A. Societe La Cellophane
1016. Solar Chemical Corp.
1017. Solid Controls, Inc.
1018. Solvay & Cie S.A.
1018A. Some Industries, Inc.
1018B. Somar Mfg. Co., Ltd.
1019. Sommer, Dr. Ing. Fritz, Nachf
1020. Sommers Plastic Products Div., Whittaker Corp.
1022. Spaulding Fibre Co., Industrial Plastics Div.
1023. Spaulding Fibre Co., Insurok Div.
1024. Specialty Products Co.
1025. Spectra-Polymer, Inc.
1026. Square D Co.
1027. St. Joe Minerals Corp.
1028. St. Lawrence Hydraulic Co.
1029. Stallman, M.H., Co.
1030. Stanchel Engineering Co.
1031. Stauffer Chemical Co., Specialty Chemicals Div.
1031A. Stauffer Chemical Co., SWS Silicones Div.
1032. Stepan Chemical Co.
1033. Stepan Chemical Co., Resin Dept.
1034. Sterling, Inc.
1035. Sterling Controls, Inc., Div. National Mfg. Co.
1036. Sterling/Davis Electric
1037. Sterling Extruder Corp.
1038. Sterling Div., Reichhold Chemicals, Inc.
1038A. Stevens Paper Mills, Inc.
1039. Stewart Bolling & Co., Div. Intercoole Automation, Inc.
1040. Sticht, Herman, H., Co.
1041. Stokes Div., Pennwalt Corp.
1042. Strong Plastics, Inc.
1043. Structural Fiberglass, Inc.
1044. Strux Corp.
1046. Sumitomo Bakelite Co., Ltd.
1047. Sumitomo Chemical Co.
1047A. Sumitomo Naugatuck Co., Ltd.
1048. Sun Chemical Corp., Chemicals Div.
1049. Sun Chemical Corp., Pigments Div.
1050. Sund-Akesson AB
1051. Sund-Borg Machines Corp.
1052. Sunshine Scientific Instruments, Inc.
1053. Swedlow, Inc.
1054. Swift Chemical Co.
1055. Swiss Insulating Works, Ltd.
1057. Synthane-Taylor Corp., an Alco Standard Co.
1058. Synthetic Products Co., Div. Dart Industries, Inc.
1059. Synres-Almoco V.
1060. Syscon International, Inc.
1061. Szekely, S., & Sons Co.
1062. Tabata Industrial Machinery Co.
1062A. Taita Chemical Co., Ltd.
1063. Talley Industries, Inc.
1064. Tamms Industries Co., Chemical Div.
1065. Tanabe Plastics Machinery Co.
1066. Tavannes Machines Co., S.A.
1068. Taylor Instrument Process Control Div., Sybron Corp.
1068A. Tec-Air, Inc.
1069. Techni-Search, Inc.
1069A. Teijin Chemicals, Ltd.
1070. Teknor Apex Co.
1071. Teledyne Taber
1072. Tennant, C., Sons, & Co. of N.Y., Onmi Div.
1073. Tenneco Advanced Materials, Inc.
1074. Tenneco Chemicals, Inc., Tenneco Intermediate Div.
1076. Tenor Co.
1077. Testing Machines, Inc.
1078. Tetrahedron Associates, Inc.
1079. Texstar Plastics
1079A. Tex-Trude, Inc.
1080. Thalco, Uniglass Industries, Div. United Merchants & Mfgs., Inc.
1081. Thermal Systems, Inc.
1082. Thermo Cote, Inc.
1083. Thermo Electric
1084. Thermofil, Inc.
1085. Thermoforming, S.p.A.
1086. Thermoform Tooling Co.
1087. Thermtrol Corp.
1088. Thiokol Chemical Corp., Chemical Div.
1089. Thoreson-McCosh, Inc.
1090. 3M Co.
1091. Thundering Banshee Research & Development Corp.
1091A. Ticona Polymerwerke GmbH
1092. Tioxide of Canada, Ltd.
1093. Tohoku Polymers Co.
1094. Tokyo Shibaura Electric Co., Chemical Products Div.
1094A. Toray Industries, Inc.
1094B. Toray Silicone Co., Ltd.
1095. Toshiba Machine Co.
1095A. Toyobo Co., Ltd.
1096. Toyo Kagaku Co.
1097. Toyomenka (America), Inc., Machinery Dept.
1098. Tra-Con, Inc.
1100. Transmares Corp.
1101. Triulzi S.p.A.
1102. Trubor Mfg. Co.
1103. Trueblood, Inc.
1104. Tryion Chemicals Div., Emery Industries
1105. Turner Machinery, Ltd.
1106. Tyler Machinery Co.
1107. UCB s.a., Chemical Div.
1107A. UCB-Ftal
1108. UOP Chemical Div., Universal Oil Products Co.
1109. USI-Clearing, Div. U.S. Industries, Inc.
1110. USM Corp., Machinery Div.
1111. USS Chemicals, Div. U.S. Steel Corp.
1112. Ube Cycon, Ltd.
1113. Ugine Kuhlman of America, Inc.
1114. Uhlich, Paul, & Co.
1115. Uniloy Div., Hoover Ball & Bearing Co.
1116. Union Camp Corp.
1117. Union Carbide Corp., Chemicals & Plastics Div.
1118. Union Carbide Corp., Films-Packaging Div.
1119. Uniroyal, Inc.
1123. United Electric Controls Co.
1124. United Foam Corp.
1125. United Mineral & Chemical Corp.
1126. United Plastics Corp.
1127. United Sensor & Control Corp.
1128. U.S. Borax & Chemical Corp.
1129. U.S. Bronze Powders, Inc.
1130. U.S. Chemical & Plastics
1131. U.S. Gypsum Co.
1132. U.S. Industrial Chemicals Co., Div. National Distillers & Chemicals Corp.
1134. U.S. Peroxygen Div., Witco Chemical Corp.
1134A. U.S. Pipe & Foundry Co.
1135. U.S. Polymeric, Div. ARMCO Steel Corp.
1136. U.S. Synthetics Corp.
1136A. Unitika, Ltd.
1137. Universal Dynamics Corp.
1138. Universal Machinery & Equipment Co.
1139. Universal Oil Products Co., Chemical Div.
1140. Upjohn Co., CPR Div.
1141. Upjohn Co., Polymer Chemicals Div.
1142. Valchem Div., United Merchants & Mfrs., Inc.
1143. Valley Metallurgical Processing Co. of N.J.
1144. Van Dorn Plastics Machinery Co., Div. Van Dorn Co.
1145. Vanderbilt, R. T., Co., Vanstay Dept.
1146. Velsicol Chemical Corp.
1147. Ventron Corp., Chemicals Div.
1148. Veresit Sacin
1148A. Verson Allsteel Press Co.
1150. Vickers Div., Sperry Rand Corp.
1151. Victory Engineering Corp.
1152. Vimm Corp.
1153. Vinylplex, Inc.
1154. Vistron Corp., Film Div.
1155. Vistron Corp., Sub. Standard Oil Corp. of Ohio
1156. Voltek, Inc.
1157. WER Industrial, Div. Emerson Electric Co.
1158. Wabash Metal Products Co.
1159. Wacker-Chemie GmbH
1160. Wako Pure Chemical Industries, Ltd.
1160A. Wakefield Engineering, Inc.
1161. Wallace & Tiernan Div., Pennwalt Corp.
1161A. Ward, Blenkinsop & Co., Ltd., (Aceto Chemicals—U.S. rep.)
1162. Ware Chemical Corp.
1163. Warren Components Corp.
1164. Watson-Standard Co.
1165. Wayne Machine & Die Co.
1166. Weather Measure Corp.
1168. Weed Instrument Co.
1168A. Wehco Plastics, Inc.
1169. Welding Engineers, Inc.
1170. Weldotron Corp.
1171. Welex, Inc.
1172. Wellman, Inc., Plastics Div.
1173. Werner & Pfleiderer Corp.
1174. West Instrument Div., Gulton Industries, Inc.
1174A. Western Plastics Co.
1175. Westinghouse Electric Corp., Industrial Plastics Div.
1175A. Westinghouse Electric Corp., Distribution & Control Equipment Div.
1175B. Westinghouse Electric Corp., Insulating Materials Div.
1176. Westlake Plastics Co.
1177. Weston Chemical, Div. Borg-Warner Corp.
1177A. Westvaco Co.
1178. Westwood Chemical Co.
1179. Wheaton Industries, General Machinery Div.
1180. White Chemical Co.
1181. Whitlock, Inc.
1182. Whittaker, Clark & Daniels, Inc.
1183. Whittaker Corp., Lenoir Coatings & Resins Div.
1184. Whittaker Corp., Mol-Rez Div.
1185. Whittaker Corp., R & D Div.
1186. Whittaker Corp., Thermoplastics Div.
1187. Wiegand, Edwin L., Div. Emerson Electric Co.
1188. Williams International, Inc.
1189. Williamson Corp.
1190. Williams-White & Co.
1191. Wilson Instrument, Div. Acco
1192. Wilson-Martin Div., Wilson Pharmaceutical Chemical Corp.
1193. Wilson Products Co., Div. Dart Industries, Inc.
1194. Witco Chemical Corp., Isocyanate Products Div.
1195. Witco Chemical Corp., Organics Div.
1196. Witco Chemical Corp., Polymer Div.
1197. Woodall Industries, Inc.
1198. Woodward Plastics Corp.
1199. Wright, P.M., Electrical Co.
1200. XCEL Corp.
1202. Yarway Corp.
1203. Zed Industries
1204. Zenith Products Co.
1205. Zeus Industrial Products, Inc.
1206. Zurn Industries, EEMCO Div.

APPENDIX C

COMPANY PRODUCT LIST

Table C-1. COMPANY/PRODUCT LIST

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Akzona, Inc. Armak Co. subsid. Armak Indust. Chems. Div.	Philadelphia, PA	2-Butoxyethyl oleate 2-Butoxyethyl stearate n-Butyl oleate n-Butyl stearate Dibutyl tartrate Ethylene glycol monomethyl ether stearate Isobutyl palmitate Isobutyl stearate Isopropyl myristate Isopropyl oleate Isopropyl palmitate Isopropyl stearate Ricinoleic and acetylricinoleic acid esters (unspecified)	
Ashland Oil, Inc. Ashland Chem. Co., div. Chem. Products Div.	Mapleton, IL	n-Butyl stearate Isopropyl myristate Isopropyl palmitate Polymeric plasticizers Triethylene glycol di (caprylate-caprate)	7+

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
BASF Wyandotte Corp. Colors and Chems. Group	Kearny, NJ	Di(2-ethylhexyl) phthalate	36+
Borg-Warner Corp. Borg-Warner Chems. Chemicals Div.	Morgantown, WV	Triphenyl phosphate	
Chemical & Pollution Sciences, Inc. CPS Chem. Co. Div.	Old Bridge, NJ	Butyl cyclohexyl phthalate	
CPC International Inc. S. B. Penick & Co., div. Parsons-Plymouth Div.	Lyndhurst, NJ	Isopropyl myristate Isopropyl palmitate Isopropyl stearate	
Chemol, Inc.	Greensboro, NC	n-Butyl oleate n-Butyl stearate Glyceryl monostearate	
Cindet Chems., Inc.	Greensboro, NC	n-Butyl oleate	
Continental Oil Co. Conoco Chems. Div.	Aberdeen, MS	Phthalic anhydride esters (unspecified)	14+

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Cyclo Chemicals Corp.	Miami, FL	Diisohexyl decyl adipate	
Diamond Shamrock Corp. Diamond Shamrock Chem. Co. Process Chems. Div.	Cedartown, GA	n-Butyl stearate Glyceryl monoricinoleate Isobutyl oleate Isobutyl palmitate Isobutyl stearate 1,2-Propylene glycol mono-ricinoleate	
	Charlotte, NC	n-Butyl oleate n-Butyl stearate	
	Harrison, NJ	n-Butyl stearate Glyceryl monoricinoleate Isobutyl oleate Isobutyl palmitate Isobutyl stearate 1,2-Propylene glycol mono-ricinoleate	
	Richmond, CA	Di-n-butyl phthalate Dibutyl sebacate Di (2-ethylhexyl) glycolate Di (2-ethylhexyl) phthalate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Diamond Shamrock Corp. Diamond Shamrock Chem. Co. Process Chems. Div.(Cont.)	Richmond, CA	Di (2-ethylhexyl) sebacate Di n-octyl adipate Glyceryl monoricinoleate Iso-octyl isodecyl adipate Sebacic acid esters (unspecified)	
Dow Chem. U.S.A.	Midland, MI	Di-tert-octyldiphenyl oxide Isopropylidenediphenoxypropanol	
Eastman Kodak Co. Eastman Chem. Products, Inc., subsid. Tennessee Eastman Co., div.	Kingsport, TN	n-butyl n-octyl phthalate Di-n-butyl phthalate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) phthalate Di (2-ethylhexyl) terephthalate Diethyl phthalate Di (2-methoxyethyl) phthalate Dimethyl phthalate Polymeric plasticizers Sucrose acetate isobutyrate	64+

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Eastman Kodak Co. Eastman Chem. Products, Inc., subsid. Tennessee Eastman Co., div. (Cont.)	Kingsport, TN	Triacetin Triethyl phosphate Tri-n-octyl trimellitate Tripropionin	
Eastman Kodak Eastman Chem. Products, Inc., subsid. Texas Eastman Co., div.	Longview, TX	224 Trimethyl pentanediol-1,3-diisobutyrate	
El Paso Natural Gas Co. El Paso Products Co., subsid.	Odessa, TX	Dimethyl adipate	
Emkay Chem. Co.	Elizabeth, NJ	Isopropyl myristate	
Emery Indust., Inc.	Cincinnati, Ohio	Bis (hydroxyethyl) azelate Bis (hydroxyethyl) dimerate n-Butyl stearate Di (2 ethylbutyl) azelate Diethylene glycol dinonanoate Di-n-hexyl azelate	18+

*Source: Directory of Chemical Producers, 1976
+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Emery Indust., Inc.(Cont.)	Cincinnati, Ohio	Diisodecyl azelate Diiso-octyl azelate Dimethyl azelate Dimethyl tridecanoate Dipropylene glycol dinonanoate Epoxidized esters (unspecified) Glyceryl mono-oleate Glyceryl trioleate Isodecylnonanoate Isopropyl isostearate Isopropyl myristate Isopropyl oleate Isopropyl palmitate Propylene glycol dinonanoate Polymeric plasticizers n-Propyl oleate Tetrahydrofurfuryl oleate Triethylene glycol dinonanoate Trimethylol propane trinonanoate	
Emery Ind. Inc., Western Operations	City of Commerce, CA	Methyl octadecadienoate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Exxon Corp. Exxon Chem. Co., div Exxon Chem. Co. U.S.A.	Baton Rouge, LA	Diisodecyl phthalate Diisohexyl phthalate Diisononyl phthalate Di tridecyl phthalate Triisononyl trimellitate	59+
FMC Corp. Chem Group Indust. Chem. Div.	Nitro, WV	Cresyl diphenyl phosphate Triaryl phosphate, mixed Tri (2-butoxyethyl) phosphate Tri-p-cresyl phosphate Tri-n-butyl phosphate Triisopropylphenyl phosphate Trixylyl phosphate	29* (1975)
	Bayport, TX	Epoxidized soya oils	9+
Givaudan Corp. Chems. Div.	Clifton, NJ	Isopropyl myristate Isopropyl palmitate	

*Source: Directory of Chemical Producers, 1976
+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Glyco Chems., Inc.	Williamsport, PA	Glyceryl monoricinoleate	
The B. F. Goodrich Co. B. F. Goodrich Chem. Co., div.	Avon Lake, OH	Di (2-ethylhexyl) adipate Di (2-ethlyhexyl) phthalate Diisodecyl phthalate	16+
W. R. Grace & Co. Hatco Group Hatco Chemical Div.	Fords, NJ	n-Butyl 2-ethylhexyl phthalate n-Butyl isodecyl phthalate Di-n-butyl phthalate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) phthalate Diisobutyl adipate Diisobutyl phthalate Diisodecyl adipate Diisodecyl phthalate Dimethyl adipate Dimethyl sebacate Polymeric plasticizers Tri (2-ethylhexyl) trimellitate	113+
Guardsman Chems., Inc.	Grand Rapids, MI	Polymeric plasticizers	

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
The C. P. Hall Co.	Chicago, IL	2-Butoxyethyl oleate Butoxyethyl pelargonate n-Butyl oleate n-Butyl stearate Di (2-butoxyethyl) sebacate Di-n-butyl phthalate Dibutyl sebacate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) azelate Di (2-ethylhexyl) sebacate Diisobutyl adipate Diisobutyl azelate Diisodecyl adipate Diiso-octyl adipate Diiso-octyl azelate Glycerol diacetate Glyceryl monoricinoleate Glyceryl trioleate Lauric acid esters (unspecified) Polyglycol phthalate esters Polymeric plasticizers Sebacic acid esters Triethylene glycol di (caprylate-caprate)	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Henkel Inc. Standard Chem. Products Div.	Charlotte, NC	n-Butyl stearate	
Hercules, Inc. Synthetics Dept.	Louisiana, MO	Polymeric plasticizers	5+
E. F. Houghton & Co.	Philadelphia, PA	Glyceryl mono-oleate Glyceryl monostearate Glyceryl monotallate	
	South San Francisco, CA	Glyceryl monostearate Glyceryl monotallate	
Inolex Corp. INOLEX Chem & Personal Care Div.	Philadelphia, PA	Adipic acid esters (unspecified) 2-Butoxyethyl stearate n-Butyl oleate n-Butyl stearate Glyceryl mono-oleate Glyceryl monostearate Glyceryl trioleate Iso-octyl palmitate Isopropyl myristate	

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Inolex Corp. INOLEX Chem & Personal Care Div (Cont.)	Philadelphia, PA	Isopropyl oleate Isopropyl palmitate Isopropyl stearate Polymeric plasticizers n-Propyl oleate Tri (2-ethylhexyl) trimellitate	
International Minerals & Chem. Corp. Chem. Group Sobin Chems., Inc., Subsid. Montrose Chem. Div.	Newark, NJ	Cresyl diphenyl phosphate Dimethyl isophthalate Tri-p-cresyl phosphate	5*
International Minerals & Chem. Corp. Chem. Group Commercial Solvents Corp., subsid.	Terre Haute, IN	n-Butyl stearate Di-n-butyl phthalate Tri-n-butyl phosphate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Interstab Chems. Inc.	New Brunswick, NJ	Di-n-hexyl phthalate Octylene glycol diglycolate Octyl epoxy tallate	
Kay-Fries Chems. Inc.	Stony Paint, NY	Diethyl phthalate Dimethyl phthalate	
Kewanee Indust., Inc. Millmaster Onyx Corp., subsid. A. Gross and Co., div.	Newark, NJ	n-Butyl oleate n-Butyl stearate Glyceryl mono-oleate Glyceryl monostearate Glyceryl trioleate n-Propyl oleate	
Monsanto Co. Monsanto Indust. Chems. Co.	Bridgeport, NJ	n-Butyl benzyl phthalate Iso-octyl benzyl phthalate	>225+ **
	Everett, MA	Dicyclohexyl phthalate Di (2-ethylhexyl) adipate Isobutyl cyclohexyl phthalate	

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

** Estimated total capacity for all locations, includes 23 Gg/yr for phosphates.

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Monsanto Co. Monsanto Indust. Chems. Co.	St. Louis, MO	Butyl chloroacetate n-Butyl phthalyl butyl glycolate N-Cyclohexyl-p-toluene-sulfonamide Diethyl phthalate Diisobutyl phthalate Dimethyl phthalate Diphenyl phthalate Ethyl-phthalyl ethyl glycolate N-Ethyl o- and p-toluene-sulfonamide Methyl phthalyl ethyl glycolate Phenoxy plasticizers	
	Sauget, IL	Cresyl diphenyl phosphate Tri-p-cresyl phosphate Triphenyl phosphate	23* (1975)

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Monsanto Co. Monsanto Indust. Chems. Co.	Texas City, TX	Di (2-ethylhexyl) phthalate Di(heptyl, nonyl, undecyl) phthalate Diundecyl phthalate	
N. L. Indust. Inc. Ind. Chems. Div.	Bayonne, NJ	Butyl acetoxystearate n-Butyl acetylricinoleate n-Butyl ricinoleate Ethylene glycol monohydroxy stearate Ethylene glycol monoricinoleate Glyceryl tri (acetylricinoleate) Glyceryl triacetyl stearate Glyceryl tri (9-epoxy-12-acetoxystearate) Methyl acetylricinoleate Methyl octadecadienoate Pentaerythritol monoricinoleate Propylene glycol monohydroxy-stearate	
National Starch and Chem. Corp. Proctor Chem. Co., subsid	Salisbury, NC	n-Butyl stearate 2-Ethylhexyl stearate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Neville Chem. Co.	Anaheim, CA	Coumarone-indene plasticizer	
	Neville Island, PA	Coumarone-indene plasticizer	
Northwest Indust. Inc. Velsicol Chem. Corp., subsid.	Chattanooga, TN	Di-ethylene glycol dibenzoate Dipropanediol dibenzoate Neopentyl glycol dibenzoate Polyethylene glycol dibenzoate Triethylene glycol dibenzoate Tri methylolethane tribenzoate	
Occidental Petroleum Corp. Hooker Chem. Corp., subsid RUCO subsid.	Hicksville, NY	Di(2 ethylhexyl) adipate Diisodecyl adipate Diisodecyl maleate n-Octyl n-decyl trimellitate Polymeric plasticizers Triethylene glycol dicaprylate Triethylene glycol di (caprylate-caprate) Tri (2-ethylhexyl) trimellitate Tri isononyl trimellitate	9+

*Source: Directory of Chemical Producers, 1976
+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Occidental Petroleum Corp. Hooker Chem. Corp., subsid. Hooker Chems. and Plastics Corp., subsid. Electrochemical and Specialty Chems. Div.	Niagara Falls, NY	Methyl dichlorostearate Methyl pentachlorostearate	
Pfizer, Inc. Chems. Div.	Greensboro, NC	Acetyl tri (n-butyl) citrate Acetyl triethyl citrate Adipic acid esters (unspecified) Di-n-butyl phthalate Dibutyl sebacate Dicyclohexyl azelate Dicyclohexyl phthalate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) azelate Di (2-ethylhexyl) phthalate Di (2-ethylhexyl) sebacate Diethyl phthalate Di-n-hexyl azelate Diisodecyl adipate Diisodecyl phthalate Diiso-octyl adipate	9+

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Pfizer, Inc. Chems. Div. (cont.)	Greensboro, NC	Diiso-octyl isophthalate Diiso-octyl and mixed dioctyl phthalates Dimethyl isophthalate Dimethyl phthalate Dipropylene glycol dinonanoate Hexyl isodecyl phthalate Hexyl iso-octyl phthalate Iso-octyl isodecyl adipate Iso-octyl isodecyl phthalate Iso-octyl palmitate Polyethylene glycol adipate Polymeric plasticizers Tricyclohexyl citrate Triethyl citrate Tri (2-ethylhexyl) citrate Tri-n-butyl citrate Tri (2-ethylhexyl) trimellitate Triisodecyl trimellitate Triisononyl trimellitate Tri-n-octyl trimellitate Tri (n-octyl/n-decyl) trimellitate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
PVO International, Inc.	Boonton, NJ	n-Butyl stearate Glyceryl trioleate Iso-octyl palmitate Isopropyl myristate Isopropyl palmitate Polymeric plasticizers Triethylene glycol di (caprylate-caprate)	
	Richmond, CA	Methyl octadecadienoate	
Reichhold Chems., Inc.	Carteret, NJ	n-Butyl n-decyl phthalate n-Butyl n-octyl phthalate n-Butyl ricinoleate Di [2-(2-butoxyethoxyl) ethyl] adipate Di (2-butoxyethyl) adipate Di (2-butoxyethyl) sebacate Di n-butyl fumarate Di n-butyl maleate Di n-butyl phthalate Dibutyl sebacate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) azelate Di (2-ethylhexyl) phthalate Di (2-ethylhexyl) sebacate Diisobutyl adipate Diisodecyl adipate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Reichhold Chems., Inc.(Cont)	Carteret, NJ	Diisodecyl phthalate Diiso-octyl and mixed dioctyl phthalates Diiso-octyl monoisodecyl trimellitate Di tridecyl phthalate Epoxidized soya oils Epoxidized tall oils Iso-octyl isodecyl adipate Iso-octyl isodecyl phthalate 2-Methoxyethyl acetylricinoleate n-octyl n-decyl adipate n-octyl n-decyl phthalate Polymeric plasticizers Triiso-octyl trimellitate	
Richardson - Merrell, Inc. J. R. Baker Chem. Co., subsid.	Phillipsburg, NJ	Di-n-butyl phthalate	
Robinson-Wagner Co., Inc.	Mamaroneck, NY	Butyl myristate n-Butyl stearate Diisopropyl adipate Isopropyl laurate Isopropyl myristate Isopropyl palmitate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Rohm and Hass Co.	Philadelphia, PA	Adipic acid esters (unspecified) Di-n-butyl phthalate Di (2 ethylhexyl) adipate Di (2-ethylhexyl) sebacate Diisodecyl adipate Diiso-octyl adipate Di (n-octyl/decyl) adipate Epoxidized esters (unspecified) Epoxidized soya oils n-octyl n-decyl adipate Polymeric plasticizers	
Rohm and Hass Tennessee Inc. subsid.	Knoxville, TN	Di (n-octyl/decyl) adipate Di (2 ethylhexyl) adipate Epoxidized soya oils Polymeric plasticizers	
Scher Brothers, Inc.	Clifton, NJ	Diisopropyl adipate Isopropyl isostearate Isopropyl laurate Isopropyl myristate Isopropyl palmitate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
The Sherwin-Williams Co. Sherwin-Williams Chems. Div.	Chicago, IL	Di-n-butyl phthalate	
Standard Oil Co. (Indiana) Amoco Chems. Corp., subsid.	Texas City, TX	Naphthalene, alkylated	
Stauffer Chem. Co. Specialty Chem. Div.	Gallipolis Ferry, WV	Cresyl diphenyl phosphate Di (2-methoxyethyl) phthalate Tri-p-cresyl phosphate Tri (2-butoxyethyl) phosphate Tri-n-butyl phosphate Triphenyl phosphate Tris (β-chloroethyl) phosphate Tris (dichloropropyl) phate	16* (1975)
Su Crest Corp. Breddo Food Products Corp. subsid. Dolton Mfg. Div.	Dolton, IL	Glyceryl mono-oleate Glyceryl monostearate	
Sybron Corp. The Tanatex Chem. Co., div.	Lyndhurst, NJ	Dimethyl phthalate	

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Teknor Apex Co.	Hebronville, MA	Di (2-ethylhexyl) adipate Di (2-ethylhexyl) isophthalate Di (2 ethylhexyl) phthalate Di n-hexyl phthalate Di tridecyl phthalate Diisodecyl adipate Diisodecyl phthalate Diiso-octyl adipate Diiso-octyl and mixed dioctyl phthalates 2-Ethylhexyl isodecyl phthalate Isodecyl tridecyl phthalate Iso-octyl isodecyl phthalate n-Octyl n-decyl adipate n-Octyl n-decyl phthalate Phenoxy plasticizers Phthalic anhydride esters (unspecified) Polymeric plasticizers	
Tenneco Inc. Tenneco Chems., Inc. Organics and Polymers Div.	Chestertown, MD	Di-n-butyl phthalate Epoxy plasticizers Low temperature plasticizers Maleate plasticizers	27+

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Tenneco Inc. Tenneco Chems., Inc. Organics and Polymers Div. (Cont.)	Chestertown, MD	Nuoplaz ® plasticizers Phthalate plasticizers Polymeric plasticizers Vinyl plasticizers	
1975 Directory lists the following products as being manufactured at Chestertown,MD.:			
		Di (2-ethylhexyl) adipate Di (2-ethylhexyl) azelate Di (2-ethylhexyl) sebacate Diisodecyl adipate Diisooctyl adipate n-octyl n-decyl adipate polymeric plasticizers proprietary plasticizers	
	Fords, NJ	Tri (2-butoxyethyl) phosphate Tri-n-butyl phosphate Tri (2-ethylhexyl) phosphate	Not available

*Source: Directory of Chemical Producers, 1976

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
Thiokol Corp. Chem. Div.	Moss Point, MS	Di [2-(2-butoxyethoxyl) ethoxyl] methane Di [2-(2-butoxyethoxyl) ethyl] adipate	
Union Carbide Corp. Chems. and Plastics Div.	Institute and South Charleston, WV	Tetraethylene glycol di (2-ethylhexanoate) Triethylene glycol di-(2-ethylbutyrate) Tri (2-ethylhexyl) phosphate	Not available
	Taft, LA	Epoxidized soya oils 2-Ethylhexyl epoxytallates	27-36+
Union Camp Corp. Chem. Products Div.**	Dover, OH	n-Butyl oleate n-Butyl stearate Dibenzyl sebacate Di-n-butyl phthalate Dibutyl sebacate Dicapryl phthalate Di (2-ethylhexyl) sebacate Dimethyl sebacate Isopropyl myristate Isopropyl palmitate Polymeric plasticizers	

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

**Essentially shut down, 1975.

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
United States Steel Corp. USS Chems., div	Neville Island, PA	n-Butyl n-octyl phthalate Di-n-butyl phthalate Dibutyl sebacate Di (2-ethylhexyl) adipate Di (2-ethylhexyl) phthalate Di (2-ethylhexyl) sebacate Di n-hexyl phthalate Diisodecyl adipate Diisodecyl phthalate Diiso-octyl adipate Diiso-octyl and mixed dioctyl phthalates Di tridecyl phthalate n-Hexyl n-octyl n-decyl adipate n-Hexyl n-octyl n-decyl phthalate n-Octyl n-decyl adipate n-Octyl n-decyl phthalate n-Octyl n-decyl trimellitate Tri (2-ethylhexyl) trimellitate Triiso-octyl trimellitate	91+
Van Dyk & Co., Inc.	Belleville, NJ	Diisopropyl adipate	

*Source: Directory of Chemical Producers, 1976

+Source: Chemical Economics Handbook, 1974

Table C-1. COMPANY/PRODUCT LIST (Continued)

Company*	Location*	Products*	Estimated Capacity (Gg/yr)
White Chem. Corp.	Bayonne, NJ	Dimethyl adipate Dimethyl sebacate	
Witco Chem. Corp. Argus Chem. Corp., subsid Halby Div.	New Castle, DE	Epoxidized linseed oil	
Witco Chem. Corp. Argus Chem. Corp., subsid	Taft, LA	Epoxidized soya oils n-Octyl epoxy stearate Octyl epoxy tallate	14+

*Source: Directory of Chemical Producers, 1976
+Source: Chemical Economics Handbook, 1974

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
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4. TITLE AND SUBTITLE	5. REPORT DATE
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7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Carol May Thompson	
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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The catalog of Industrial Process Profiles for Environmental Use was developed as an aid in defining the environmental impacts of industrial activity in the United States. Entries for each industry are in consistent format and form separate chapters of the study. The Plasticizer Industry includes manufacturers who produce primary synthetic organic plasticizers. Manufacturers who refine or otherwise upgrade natural plasticizers such as mineral oil or castor oil are not included. Plasticizers are materials which are added to organic polymers to facilitate processing, to modify the properties of the product, or both. In many cases, the distinction between plasticizers and other additives, such as extender oils, flame retardants, processing aids and lubricants are often blurred. Three process flow sheets and three process descriptions have been prepared to characterize the industry. Within each process description available data have been presented on input materials, operating parameters, utility requirements and waste streams. Data related to the subject matter, including company and product data, are included as appendices.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Air Pollution Control	07C
Plasticizers	Water Pollution Control	11I
Synthetic Organic Plasticizers	Solid Waste Control	13B
Organic Plasticizers	Organic Chemicals	
Natural Plasticizers	Stationary Sources	
Process Description		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
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