Chemical Products Synopsis (CPS)

Since 1976

by Mannsville Chemical Products

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CHEMICAL PRODUCTS SYNOPSIS is an on-going reporting service which provides accurate, in-depth, cost effective commercial research on 220 individual chemical commodities (see reverse side for a detailed list of chemical products covered). The unique format of these SYNOPSIS reports puts the detailed and useful market information you need at your finger tips in a convenient, easy to use format. Each report is a 1,800+ word, two-page market overview, providing clear, concise, useful market information.

Each SYNOPSIS provides information on a particular chemical, focusing on US markets (which are mostly similar to world markets). Each report has the following sections:

Focus (brief overview)	**Availability** (producer/site capacity for most products)
Outlook	**End uses**
Pricing	**Manufacturing** (description of technology/process)
Supply & demand	**Environmental aspects**

The information contained in the CHEMICAL PRODUCTS SYNOPSIS reports is obtained from a wide range of resources including interviews with producers and other industry participants, government and trade association reports and studies, other published information sources, and analysis of overall business and economic trends.

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EPOXY RESINS

FOCUS....Epoxy resins are a family of high performance synthetic thermoset polymers. Most epoxy resins are made from bisphenol A (BPA) and epichlorohydrin. Liquid epoxy resins are the foundation of the industry since most epoxy resins are initially produced as liquid and can then be modified into solid epoxy resins or solutions through the addition of incremental BPA or solvents. In the US, only three companies produce unmodified liquid epoxy resins, but many companies produce and market modified epoxies made from purchased unmodified liquid resin. Epoxy resins are generally combined with other chemical additives to create inert, chemically stable, or "cured" products. Once cured, epoxy resins have attractive attributes such as outstanding adhesion, corrosion and chemicals resistance, high strength and toughness, temperature stability, electrical insulation and easy processability. Epoxy resins are used in coatings, electrical and electronic applications including printed circuit boards, construction, adhesives, and composites for use in a variety of industries. The protective coating industry consumes over 50% of annual US epoxy demand.

Demand for epoxy resins is highly influenced by overall economic conditions. Typically, epoxy resin demand growth has slightly exceeded GDP growth. In the US, epoxy resin demand growth has been unsteady since demand reached a peak in 2000. The economic recession in 2001 resulted in a sharp reduction in epoxy demand and the market has not yet been able to return to the 2000 level, although US sales and captive use approached this level in 2004, aided in part by a 20% increase in export volumes. In 2003, the epoxy resin market experienced a difficult year. Demand was down, in large part due to weak industrial production and weak business investment, and margins faced severe pressure from rising raw material and energy costs. Traditionally high growth markets including powder coatings, electrical laminating, and industrial maintenance markets remained depressed. Demand improved considerably in 2004, with US sales and captive use rising by 12%, as US economic growth accelerated. As demand improved, price increases were also implemented to improve the profitability of the business. In 2004, all major applications contributed to growth. Demand reportedly remained relatively healthy in 2005, although apparent US consumption is believed to have declined somewhat after the large jump in 2004. Lower sales volumes of basic epoxy resins in the coatings, construction, and adhesives markets, as well as reduced volumes of electronic laminates products, were reported in 2005.

OUTLOOK....Assuming continued steady economic growth, US epoxy resin demand growth is forecast to be in the range of 3% per year over the next several years. With principal end use markets in building and construction, transportation, machinery, and electrical and electronics markets, demand will remain highly dependent on general economic growth.

Globally, epoxy resin demand growth has been projected at 4 6% per year, fueled by strong growth in Asia, particularly China. Overall growth in the range of 1.5 times GDP growth will be driven by above average growth in electronics and electrical laminates, composites where growth will be spurred by material substitution and increased use in the energy sector, and in the flooring and aggregates market. The largest market, the protective coatings segment, is expected to show growth at or slightly above GDP levels.

PRICING....Prices for unmodified liquid epoxy resins are influenced by typical supply/demand factors and raw material cost pressures (benzene for bisphenol A and propylene and chorine for epichlorohydrin). Actual sales values are negotiated, but actual pricing data for merchant sales are not available. There are a wide variety of modified and specialty epoxy products with differing price levels, some as high as $3.00/pound or more for specialty resins.

Although precise market prices are not available, prices have been on the upswing for several years. While higher raw material values have been the principal force behind increases, a tightened market balance and the need to improve margins for future reinvestment in the epoxy chain have also supported higher prices. Because of volatile feedstock costs, producers have moved away from quarterly price protection mechanisms. Little relief is expected in feedstock costs, and further price increase attempts will likely be made in 2006/2007.

AVERAGE PRICE RANGE EPOXY RESIN (Unmodified) LIQUID
Dollars Per Pound Bulk Tanks Delivered

	HISTORICAL										*	PROJECTED	
	1980	1985	1990	1995	2000	2001	2002	2003	2004	2005	*	2006	2008
Trade List	1.07	1.31	1.31	1.41	1.41	1.41	1.40	1.40	1.40	1.60E	*	1.80E	1.80

List prices are year end published prices. Current list prices are in the range of $1.40 $1.80 per pound. The published list price has not changed for several years. Actual sales values are negotiated.

SUPPLY AND DEMAND.... Millions of Pounds....Estimated....Domestic US

	HISTORICAL										*	PROJECTED	
	1980	1985	1990	1995	2000	2001	2002	2003	2004	2005		2006	2008
Production	315	385	499	632	693	601	655	578	645	615E	*		
Imports	6	12	18	41	133	104	107	97	103	116	*		
Exports	35	42	84	158	150	168	189	171	206	210E	*		
Demand	286	355	433	515	676	537	573	504	542	521E	*	540	575
Sales/Captive Use	484	620	669	597	620	587	658	na			*		

Production, export, and sales & captive use data through 1998 are from Society of the Plastics Industry reports. Data since 1999 are from reports of the APC Plastics Industry Producers' Statistics Group, as compiled by Association Survey Resource, LLC. Sales and captive use data include export sales. Imports are from Census Bureau reports. Census Bureau export figures are believed to include large volumes of modified resin and are therefore considered overstated.

AVAILABILITY....The US and global epoxy resin markets have been characterized as balanced with periods of tightness in recent years. A variety of factors have caused this situation including improved demand, limited investment in new capacity, and tightness in the supply of the raw materials epichlorohydrin and particularly bisphenol A. A balanced to tight market is expected to persist for the next few years unless demand falters. Raw material bisphenol A markets are also expected to remain tight which could affect epoxy resin markets. Additionally, short term shortages may develop if demand spikes upward because producers have reportedly been attempting to limit inventory levels for economic reasons. With above average growth forecast for China, Asia will likely be the region where a large share of new capacity will be constructed in the future.

Sample chemical product synopsis

PRODUCERS AND CAPACITIES EPOXY RESINS MILLIONS OF POUNDS

PRODUCER	LOCATION	2006 CAPACITY*
Dow Chemical	Freeport, TX; Torrance, CA	355
Hexion Specialty Chemicals	Deer Park, TX	340
Huntsman Advanced Materials	McIntosh, AL	215
TOTAL		910

Based on announced capacities and trade estimates. * Capacities include total capacity to make the various forms of epoxies, including unmodified liquid resins. Dow Chemical, Hexion and Huntsman are the dominant global producers of unmodified liquid epoxy resins. Hexion Specialty Chemicals was formed in 2005 when Apollo Management merged Borden Chemical, Resolution Performance Products, and Resolution Specialty Materials. The epoxy resin business of Hexion had formerly operated under Resolution Performance Products which was formed in 2000 when Apollo Management acquired the business from Shell Chemical. Hexion had filed a registration statement for a proposed initial public offering of its common stock in 2006, but in mid-2006 suspended those plans. Huntsman Corporation indirectly owns 90.3% of Huntsman Advanced Materials LLC. Both Dow Chemical and Hexion are back integrated to raw materials epichlorohydrin and bisphenol A. In 2004, Dow announced the closing of its epoxy resin plant at Sarnia, ON, Canada which produced solid epoxy resins and epoxy vinyl ester resins.

END USES....Epoxy resins provide toughness, corrosion resistance, adhesion and electrical insulation, among other properties. These resins are inherently brittle and require modifiers to reduce brittleness. Epoxy resins are used for a variety of high-end coating applications which require the superior strength and durability of epoxy. Epoxy resins are also the fundamental building blocks of many types of material, such as formulated composite resins and structural adhesives. Epoxy resins also have significant use in laminating printed circuit boards and for encapsulating electrical devices. Epoxy resins are available as liquid, solution, or solid material. Curing agents commonly used to convert epoxies to thermosets include anhydrides, aliphatic amines, polyamides, Lewis acids, and others.

Coatings account for more than one half of epoxy resin demand. Maintenance & marine coatings, powder coatings, container coatings, and automotive primers are the dominant applications. Powder coatings are used for appliances, automotive, pipes, etc. Powder coatings utilize solid epoxy resins. Epoxy resins are also used in electrocoatings for automotive, appliances and general industry, in heavy duty floor coatings, in metal packaging coatings, in ambient cured coatings for marine, large steel structures, and shipping containers, and in waterborne coatings.

Epoxy resin-based adhesives are the second-largest end use. These adhesives find widespread use in the construction, automotive, aerospace, and electronics industries. Epoxies are also used to repair cracks in concrete and as binders in a variety of applications.

Epoxy resins are used in making fiber reinforced laminates and composites. Composites are used by the aerospace industry and the military in fuselage sections, wing skins and structural panels for satellites. The epoxy resins are generally combined with glass, carbon or aramid fibers and used in filament winding, resin transfer molding, or prepreg applications. Composites are also used by the automotive industry, in sporting goods such as skis and snowboards, in boat construction, wind energy units, and industrial applications. Printed circuit board manufacture is a principal use for epoxy laminates; other electrical laminate uses are also found. Also in the electrical and electronics industry, epoxies find use in electrical casting resins, molding compounds and encapsulation.

In civil engineering, epoxy products are used in bridge and canal construction, concrete enhancement, and corrosion protection.

END USE PATTERN 2005 ESTIMATE

DERIVATIVE	PERCENT
Protective Coatings	52
Adhesives and Bonding	16
Reinforced Laminates/Composites	11
Flooring, Paving, Aggregates	8
Tooling, Castings & Molded Items	4
Miscellaneous	9

MANUFACTURING....The major commercial epoxy resin is obtained using bisphenol A and epichlorohydrin (epi) as the reactants. Other epoxy resins include brominated, phenoxy, cycloaliphatic and novalac epoxy resins. Liquid epoxy resins may be synthesized by a two step reaction of an excess of epi to BPA in the presence of an alkaline catalyst. The reaction consists initially in the formation of the dichlorohydrin of BPA and further reaction via dehydrohalogenation of the intermediate with a stoichiometric quantity of alkali. The use of a large excess of epi minimizes the formation of higher molecular weight species. The pure diglycidyl ether of BPA is a crystalline solid with a weight per epoxide of 170. The typical commercial unmodified liquid resins are viscous liquids with an epoxy equivalent weight of ca 188.

Two general methods produce higher molecular weight epoxies. In the taffy process, bisphenol A reacts directly with epi in the presence of a catalytic amount of caustic. Molecular weight is governed by the ratio of epichlorohydrin to bisphenol A. The taffy process is generally employed for only medium molecular weight resins. The polymerization reaction results in a highly viscous product and the condensation reaction becomes very dependent on agitation. At the completion of the reaction, the heterogeneous mixture consists of an alkaline brine solution and a water resin emulsion, and recovery of the product is accomplished by separation of phases, washing of the taffy resin with water, and removal of water under vacuum. The other method, known as the advancement process, is generally preferred since it can be used to directly prepare high molecular weight resins. In this process, liquid epoxy resin (crude diglycidyl ether of bisphenol A) is chain reacted in the presence of a catalyst to yield higher molecular weight products.

ENVIRONMENTAL ASPECTS....Epoxy resins, by themselves, are generally considered to be non-hazardous. However, in 1995 the EPA issued final rules limiting emissions of hazardous air pollutants from the epoxy manufacturing processes. These rules were designed to remove as much as 105 million pounds per year of pollutants, mainly epichlorohydrin, from the atmosphere.

To the best of our knowledge, the information contained herein is accurate. However, we do not assume any liability whatsoever

Chemical Products Synopses

Acetaldehyde
Acetic Acid
Acetic Anhydride
Acetone
Acetylene
Acrylamide
Acrylates
Acrylic Acid
Acrylonitrile
Adipic Acid
Alkylamines
Alkylaryl Sulfonates
Aluminum Chloride (Anhydrous)
Aluminum Chloride (Hydrous)
Aluminum Sulfate
Ammonia
Ammonium Chloride
Ammonium Nitrate
Ammonium Sulfate
Aniline
Antimony Oxide
Argon
Ascorbic Acid
Barium Carbonate
Benzene
Benzoic Acid
Benzyl Alcohol
Benzyl Chloride
Bisphenol A
Borax
Boric Acid
Bromine
Butadiene
1,4-Butanediol
Butanol
Butyl Acetate
Calcium Bromide
Calcium Carbonate
Calcium Chloride
Calcium Hypochlorite
Calcium Phosphates
Caprolactam
Carbon Activated
Carbon Black
Carbon Dioxide
Carbon Disulfide
Carboxymethylcellulose
Castor Oil
Caustic Potash
Caustic Soda
Cellulose Acetate Flake
Chlorine
Chloroacetic Acid
Chloroform
Chlorosulfonic Acid
Chromic Acid
Citric Acid
Coconut Oil
Copper Sulfate
Cresols & Cresylic Acid
Cumene
Cyclohexane
Cyclohexanone
Decyl Alcohols
Diacetone Alcohol
Diammonium Phosphate
Dichlorobenzene
Dicyclopentadiene
Diethylene Glycol
Dioctyl Phthalate
Dodecyl Alcohols
Dodecylbenzene
Epichlorohydrin
Epoxy Resins
Ethanol
Ethanolamines
Ethyl Acetate
Ethylbenzene
Ethyl Chloride
Ethylene
Ethylenediamine
Ethylene Dichloride
Ethylene Glycol
Ethylene Oxide
2-Ethylhexanol
Ferric Chloride
Ferrous Sulfate
Fluorocarbon Solvents
Fluorocarbons
Formaldehyde
Formic Acid
Fumaric Acid
Furfural
Glycerine
Glycol Ethers
Hexamine
Hydrazine
Hydrochloric Acid
Hydrofluoric Acid
Hydrogen
Hydrogen Cyanide
Hydrogen Peroxide
Hydroquinone
Iodine
Iron Oxides
Isopropanol
Isopropyl Acetate
Lactic Acid
Lime
Linseed Oil
Lithium Carbonate
Magnesium Oxide
Magnesium Sulfate
Maleic Anhydride
Malic Acid
Manganese Sulfate
Melamine
Menthol
Methanol
Methylamines
Methyl Bromide
Methyl t-Butyl Ether
Methyl Chloride
Methyl Diphenyl Diisocyanate
Methyl Ethyl Ketone
Methyl Isobutyl Ketone
Methyl Methacrylate
Methylene Chloride
Alpha-Methylstyrene
Monochlorobenzene
Monosodium Glutamate
Morpholine
Naphthalene
Nitric Acid
Nitrobenzene
Nitrogen
Nonylphenol
Organoperoxides
Oxygen
Pentachlorophenol
Pentaerythritol
Perchloroethylene
Phenol
Phosgene
Phosphoric Acid (Thermal)
Phosphoric Acid (Wet)
Phosphorus
Phosphorus Oxychloride
Phosphorus Pentasulfide
Phosphorus Trichloride
Phthalic Anhydride
Platinum
Polycarbonate Resins
Polyethylene (HD)
Polyethylene (L/LLD)
Polyethylene Terephthalate (PET)
Polylactic Acid (PLA) New!
Polypropylene
Polystyrene
Polyvinyl Alcohol
Polyvinyl Chloride
Potassium Carbonate
Potassium Chloride
Potassium Permanganate
Potassium Sulfate
Propanol
Propionic Acid
Propylene
Propylene Glycol
Propylene Oxide
Salicylic Acid
Silicones
Soda Ash
Sodium
Sodium Acetate
Sodium Bicarbonate
Sodium Bisulfate
Sodium Bisulfite/Metabisulfite
Sodium Chlorate
Sodium Chloride
Sodium Dichromate
Sodium Fluoride
Sodium Hexametaphosphate
Sodium Hydrosulfide
Sodium Hydrosulfite
Sodium Hypophosphite
Sodium Propionate (Propionates)
Sodium Silicate
Sodium Sulfate
Sodium Sulfite
Sodium Thiosulfate
Sodium Tripolyphosphate
Sorbitol
Soya Oil
Strontium Carbonate
Styrene
Sulfur
Sulfur Dioxide
Sulfuric Acid
Talc
Tall Oil
Terephthalic Acid
Tetrahydrofuran
Tetrapotassium Pyrophosphate
Tetrasodium Pyrophosphate
Titanium Dioxide
Toluene
Toluene Diisocyanate
1,1,1-Trichloroethane
Trichloroethylene
Tricresyl (Triaryl) Phosphate
Triethylene Glycol
Trimethylolpropane
Urea
Vinyl Acetate
Vinyl Chloride
Xanthan
o-Xylene
p-Xylene
Zinc Oxide
Zinc Sulfate