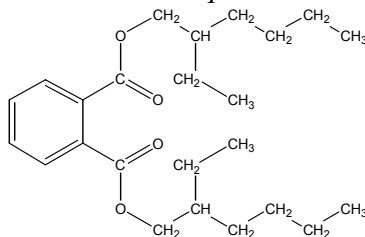


DI(2-ETHYLHEXYL) PHTHALATE

CAS No. 117-81-7

First Listed in the *Third Annual Report on Carcinogens*



CARCINOGENICITY

Di(2-ethylhexyl) phthalate (DEHP) is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (NTP 1982, IARC 1982, 1987, 2000). When administered in the diet, di(2-ethylhexyl) phthalate increased the incidence of hepatocellular carcinomas in female rats, liver neoplastic nodules or hepatocellular carcinomas in male rats, and hepatocellular carcinomas in mice of both sexes (NTP 1982, IARC 2000).

No adequate data were available to evaluate the carcinogenicity of di(2-ethylhexyl) phthalate in humans (IARC 1982, 1987). In one study, workers exposed at a production plant did not show an excess of cancer mortality; however, the number of subjects in this study was small (IARC 2000).

PROPERTIES

Di(2-ethylhexyl) phthalate is a colorless, oily liquid with a slight odor. It is slightly soluble in water (0.285 mg/L at 24°C) and carbon tetrachloride, miscible with mineral oil and hexane, and soluble in blood and body fluids containing lipoproteins. When heated to decomposition, it emits acrid smoke. Di(2-ethylhexyl) phthalate is incompatible with nitrates, strong oxidizers, acids, and alkalis (IARC 2000, HSDB 2001).

It is available in the United States in a variety of technical grades. Typical product specifications are the following: 99.0% to 99.6% minimal ester content; 0.1% maximal moisture content; and 0.007% to 0.01% acidity (as acetic acid or phthalic acid) (IARC 2000).

USE

Approximately 95% of di(2-ethylhexyl) phthalate is used as a plasticizer in polyvinyl chloride (PVC) resins for fabricating flexible vinyl products. Plastics may contain from 1% to 40% di(2-ethylhexyl) phthalate. PVC resins have been used to manufacture many products, including toys, dolls, vinyl upholstery, tablecloths, shower curtains, raincoats, garden hoses, swimming pool liners, shoes, floor tiles, polymeric coatings, components of paper and paperboard, defoaming agents, surface lubricants, disposable medical examination and surgical gloves, medical tubing, blood storage bags, flexible tubing for administering parenteral solutions, and other products. Non-PVC plasticizer use has included polyvinyl butyral, natural and synthetic rubber, chlorinated rubber, ethyl cellulose, and nitrocellulose products (ATSDR 2000, IARC 2000).

The only significant nonplasticizer use for di(2-ethylhexyl) phthalate is as a replacement for polychlorinated biphenyls in dielectric fluids for electric capacitors. The following miscellaneous uses for di(2-ethylhexyl) phthalate have been reported: as a solvent in erasable ink; as an acaricide for use in orchards; as an inert ingredient in pesticides; as a component of cosmetic products; as a vacuum pump oil; in detecting leaks in respirators; and in the testing of air filtration systems. However, several of these reported applications are believed to be no longer in use or never were carried out on a commercial scale (IARC 1982, 2000, ATSDR 2000).

Historically, di(2-ethylhexyl) phthalate has constituted approximately 50% of all the phthalate ester plasticizers used (WHO 1992). However, in recent years, the use of di(2-ethylhexyl) phthalate has diminished because of health concerns. It is no longer used in plastic food packaging or baby teething and rattles; many toy manufacturers have discontinued its use in toys, and it is being replaced by linear phthalates and other plastomers in other applications (ATSDR 2000).

PRODUCTION

Di(2-ethylhexyl) phthalate was first produced in the United States in 1939, and commercial production peaked in the mid to late 1980s. U.S. production in 1982 and 1986 was approximately 114,000 metric tons (250 million lb) and 130,000 metric tons (286 million lb) in 1982 and 1986, respectively. In 1994, production was approximately 117,500 metric tons (258 million lb) (IARC 2000). Production estimates for all dioctyl phthalates, which includes diisooctyl phthalate and di-n-octyl phthalate in addition to di(2-ethylhexyl) phthalate, ranged from 309 to 285 million lb/year from 1990 to 1998 (ATSDR 2000). However, di(2-ethylhexyl) phthalate is the single largest volume member of the dioctyl phthalates.

The U.S. International Trade Commission (USITC) listed four to six U.S. manufacturers between 1989 and 1994 (USITC 1990-1991, 1993-1995). ATSDR (2000) identified five companies, operating six facilities, as the primary U.S. producers and Chem Sources (2001) listed 38 domestic suppliers.

Import and export quantities specific for di(2-ethylhexyl) phthalate were not available. Total U.S. dioctyl phthalate imports were 18 million lb, 6 million lb, 2 million lb, and 6 million lb in 1985, 1986, 1987, and 1988, respectively. Exports of dioctyl phthalates during this time ranged from 9 million to 37 million lb (Mannsville Chemical Products Corporation 1989). In 1998, four million lb were imported, and between 14 and 27 million lb/year were exported from 1994 to 1998 (ATSDR 2000).

EXPOSURE

The primary routes of potential human exposure to di(2-ethylhexyl) phthalate are inhalation, ingestion, dermal contact, and through medical procedures. A substantial fraction of the U.S. population is exposed to measurable levels of di(2-ethylhexyl) phthalate because of its widespread use in consumer products. A high-risk segment of the population consists of individuals receiving dialysis treatments or blood transfusions from sources that have contacted di(2-ethylhexyl) phthalate-containing tubing or containers. Among this population are hemophiliacs and dialysis patients. Estimates of exposure levels indicate that the former may be exposed to 1 to 2 mg di(2-ethylhexyl) phthalate/day and the latter to an average dose of 40 to 75 mg/day. Other studies have

shown exposures ranging from <5 to 155 mg/day (<0.1 to 3.1 mg/kg per day) in adult hemodialysis patients and may exceed 4 mg/kg per day in infants receiving exchange transfusions. Large-volume parenteral formulations that are administered intravenously as replenishers (i.e., fluids, nutrients, electrolytes) are packaged in flexible containers made from PVC. The estimated concentration of di(2-ethylhexyl) phthalate in intravenous fluids is 9 to 13 ppb, while reported concentrations in whole blood and plasma stored in plastic blood bags range from 14 to 120 ppm (ATSDR 2000).

Another high-risk population includes workers exposed to di(2-ethylhexyl) phthalate during the manufacture, formulation, and processing of plastics. Workers in printing and painting occupations may also be exposed. Inhalation of aerosols or mists is the primary occupational exposure route. NIOSH estimated that about 340,000 workers, including 106,900 women, were potentially exposed to di(2-ethylhexyl) phthalate in the early 1980s (ATSDR 2000, IARC 2000).

Di(2-ethylhexyl) phthalate is known to be widely distributed in the environment and has been detected in soil samples, animal and human tissues, and various forms of fish and marine life. Disposal of plastic products containing di(2-ethylhexyl) phthalate is a major source of environmental release (ATSDR 2000). EPA's Toxic Chemical Release Inventory (TRI) listed 356 industrial facilities that produced, processed or otherwise used di(2-ethylhexyl) phthalate in 1999 (TRI99 2001). These facilities reported releases of di(2-ethylhexyl) phthalate to the environment that were estimated to total approximately 1.2 million lb. Environmental releases have declined steadily from the peak of 4.9 million lb reported in 1989 to slightly more than a million lb in 1999 (TRI99 2001).

Because of its low vapor pressure, exposure to di(2-ethylhexyl) phthalate in either water or air appears to be minimal for most individuals. It is generally accepted that low levels of phthalates occur in the atmosphere throughout the United States, with higher levels near release sources. In the past, the most likely route of exposure for the general population was through contaminated food (i.e., food coming in contact with containers and wrappings containing di(2-ethylhexyl) phthalate); this exposure was estimated to provide an average intake of approximately 0.3 mg/day and a maximum of approximately 2 mg/day per individual. Di(2-ethylhexyl) phthalate has been detected in such foods as milk, cheese, fish, meat, margarine, eggs, and cereal products. However, most of the monitoring data were at least 10 years old and failed to reflect the impact of removing di(2-ethylhexyl) phthalate-containing plastics from food packaging and consumer products (ATSDR 2000).

REGULATIONS

The Toy Manufacturers of America (TMA), representing pacifier and toy manufacturers, has stated that most manufacturers already have discontinued the use of di(2-ethylhexyl) phthalate in their products. The U.S. Consumer Product Safety Commission (CSPC) staff has determined that domestic manufacturers are not using di(2-ethylhexyl) phthalate in vinyl pacifiers, and importers appear to be acquiring non-di(2-ethylhexyl) phthalate-containing pacifiers. The CSPC has therefore concluded that the estimated cancer risk from di(2-ethylhexyl) phthalate, which was primarily from pacifier use, has substantially declined. A TMA voluntary standard limits the amount of di(2-ethylhexyl) phthalate to less than 3% in pacifiers and teething rings.

EPA regulates di(2-ethylhexyl) phthalate under the Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), Superfund Amendments and

Reauthorization Act (SARA), and Toxic Substances Control Act (TSCA). Di(2-ethylhexyl) phthalate is included on lists of chemicals for which water quality criteria have been established under CWA. A reportable quantity (RQ) of 100 lb has been established for this chemical under CERCLA. Under RCRA, SARA, and TSCA, di(2-ethylhexyl) phthalate is subject to reporting and record-keeping requirements. SARA sets threshold amounts for di(2-ethylhexyl) phthalate used, manufactured, or processed at a facility. Manufacturers, importers, and processors of di(2-ethylhexyl) phthalate are required to submit to EPA copies and lists of unpublished health and safety studies under TSCA.

FDA regulates di(2-ethylhexyl) phthalate as an indirect food additive.

ACGIH recommends a threshold limit value (TLV) at 5 mg/m³ for di(2-ethylhexyl) phthalate. NIOSH recommends an exposure limit of 5 mg/m³ as a 10-hr time-weighted average (TWA) and a short-term exposure limit (STEL) of 10 mg/m³. OSHA established a permissible exposure limit (PEL) of 5 mg/m³ as an 8-hr TWA and a STEL of 10 mg/m³ for the compound. OSHA also regulates di(2-ethylhexyl) phthalate under the Hazard Communication Standard and as a chemical hazard in laboratories. Regulations are summarized in Volume II, Table 87.

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