# 4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

## 4.1 PRODUCTION

Propylene glycol is produced commercially from the hydration of propylene oxide (Merck 1989). Propylene glycol also is produced by the liquid-phase high pressure reaction (600 atmospheres) of synthetic gas in the presence of a rhodium cluster complex (Kirk-Othmer Encyclopedia of Chemical Technology 1978).

The companies that produce propylene glycol in the United States, their production sites, and the annual capacities in millions of pounds for 1993 (the most recent year for which figures are available) are shown below (SRI 1993).

| Company | Production Site | Capacity |
|---|---|---|
| ARCO Chemical Company | Bayport, TX | 374 |
| Dow Chemical USA | Freeport, TX | 250 |
| | Plaquemine, LA | 150 |
| Eastman Chemical Company | South Charleston, WV | 72 |
| Olin Corporation | Brandenburg, KY | 70 |
| Texaco Chemical Company | Port Neches, TX | 120 |
| **Total Production** | | **1,036** |

Over the past few years, production of propylene glycol has remained relatively constant at a level of approximately 1,000 million pounds per year (SRI 1989, 1991, 1993, 1995). The production volumes were 935, 1,000, 980, and 1,036 million pounds in 1989, 1991, 1993, and 1995, respectively.

There is no information on facilities that manufacture or process propylene glycol in the United States available in the Toxic Release Inventory because information on this chemical is not required to be reported (EPA 1995c).

## 4.2 IMPORT/EXPORT

Propylene glycol has been imported into the United States in ever increasing quantities over the last several years. Import volume increased from 198,031 kg (0.4 million pounds) in 1992, to 2,167,664 kg (4.8 million pounds) in 1993, to 5,249,265 kg (11.6 million pounds) in 1994 (NTDB 1995).

Propylene glycol also has been exported over the last several years with export volume greatly exceeding the import volume in any given year. Export volume for propylene glycol has declined slightly since 1990, but has averaged 77,000,000 kg per year (170 million pounds per year). Export volumes for propylene glycol were 94,606,830 kg (209 million pounds), 64,850,502 kg (143 million pounds), 62,940,802 kg (139 million pounds), 81,531,357 kg (180 million pounds), and 78,997,747 kg (174 million pounds) in 1990, 1991, 1992, 1993, and 1994, respectively (NTDB 1995).

## 4.3 USE

Propylene glycol has been used extensively in many different industrial applications because of its chemical and physical properties. Propylene glycol dissolves in water and is miscible with alcohol, acetone, chloroform, and other organic solvents; has the capacity to hold large amounts of heat before boiling; and lowers the freezing point of water (EPA 1987a; Lewis 1993). In addition, propylene glycol is hygroscopic, is suitable for use as an industrial humectant, and possesses excellent solvent properties (Lewis 1993; Merck 1989; Rowe and Wolf 1982). Approximately 41% of all propylene glycol produced is used for unsaturated polyester resin production, 29% is exported, 11% is used in foods, pharmaceutical products, and cosmetics, 7% is used in semi-moist pet food, 4% is used as a humectant for tobacco, 4% is used in functional fluids, and 4% is for miscellaneous uses (HSDB 1995b).

The major use of propylene glycol is as an intermediate in the manufacture of cross-linked polyesters and hydroxylated polyester resins. In the airline industry, ethylene glycol has been used as a base component of de-icing fluids for aircraft, runways, and taxiways (Klecka et al. 1993; Kirk-Othmer Encyclopedia of Chemical Technology 1978). Propylene glycol is a solvent and humectant for various pharmaceuticals, hair colorant formulations, and food and tobacco products (Kirk-Othmer Encyclopedia of Chemical Technology 1978; Merck 1989). In addition, the use of small amounts of propylene glycol is permitted in foods as an anticaking agent, antioxidant, dough strengthener, emulsifier, processing aid, stabilizer and thickener, surface active agent or texturizer (EPA 1979). In veterinary medicine, propylene glycol is used in oral medications for ruminants and as a solvent for various drugs (Merck 1983). As a nontoxic antifreeze, propylene glycol is used in breweries and dairy establishments and as an inhibitor of fermentation and mold growth (Merck 1989). The chemical has been used as an emollient in pharmaceutical and cosmetic creams because it readily absorbs water. Propylene glycol has even been used in vapor form as an air sterilizer in hospitals and public buildings, and in veterinary applications to protect animals against the spread of airborne bacteria and influenza virus (Kirk-Othmer Encyclopedia of Chemical Technology 1978; Rowe and Wolf 1982). Used as a mist, propylene glycol is deployed as a special effect fog/smoke during theatrical performances, rock concerts, private parties, and in fire training programs to simulate fire fighting conditions (Rossol 1993).

## 4.4 DISPOSAL

Propylene glycol is currently listed as a Generally Recognized as Safe (GRAS) additive in foods (FDA 1982) and is not listed as a toxic substance under Section 313 of the Emergency Planning and Community Right-to Know Act under Title III of the Superfund Amendments and Reauthorization Act (EPA 1995c).

Two methods for treatment of waste water containing propylene glycol include a methane fermentation process and a newly developed biotreatment process that uses mixed cultures of bacteria to degrade the compound. The methane fermentation process has proven to be a reliable as well as cost and energy efficient method for the treatment of domestic sludges and certain industrial waste water containing propylene glycol and other organic compounds (Chou et al. 1979). Propylene glycol in effluents from propylene oxide production plants contains both high biological oxygen demand/chemical oxygen demand (BOD/COD) loads and high chloride concentrations. The high salinity poses problems to waste water treatment such as activated sludge and activated carbon absorption processes A novel and economically viable propylene glycol biotreatment process recently has been developed that uses a mixed culture of engineered bacterial species from the genera *Pseudomonas* and *Aerobacter*. The *Pseudomonas* use propylene glycol to produce volatile acids, while *Aerobacter* were effective in degrading the volatile acids to carbon dioxide and water (Raja et al. 1991).

A new encapsulated biooxidation method has shown potential for the remediation of soil contaminated with propylene glycol (Vesper et al. 1994). The encapsulated biooxidation method proposes that sodium percarbonate encapsulated in polyvinylidene chloride be inserted in subsurface soil by a method called hydraulic fracturing. Oxygen slowly released from the encapsulated sodium percarbonate increases the number of glycol-degrading organisms. In a laboratory experiment conducted over a 30-day period at 12 °C that simulated subsurface soil temperatures, the concentration of propylene glycol was reduced lo-fold and the number of propylene glycol degrading organisms increases 10-fold compared to live controls without the encapsulated sodium percarbonate. This method is expected to remediate soils contaminated with glycols via enhanced aerobic biodegradation in subsurface soils. The hydraulic fracturing technique that would be used to deliver the encapsulated sodium percarbonate to the subsurface soils involves creating horizontal pancake-shaped fractures that are 5 meters in diameter and 1-2 cm in thickness. These fractures are stacked vertically in the subsoil, and granular material is injected into each fracture (Vesper et al. 1994). The advantage of this method is that oxygen can be delivered deep into contaminated subsurface soil and then made available slowly to stimulate bacterial growth.