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

4.1 PRODUCTION

Glycol ethers consist of a large group of organic solvents that are widely used in formulating cleaning products and protective coatings (Browning and Curry 1994; Rowe and Wolf 1982; Vincent et al. 1993). 2-Butoxy-ethanol, one of the simplest glycol monoalkyl ethers, is commonly encountered and massively produced for use in several industries (Dow 1993; Gibson 1984; Rowe and Wolf 1982). Approximately 130 million pounds of 2-butoxyethanol were produced in the United States in both 1972 and 1975 (HSDB 1997). Data on production volumes between 1975 and 1983 were not found. However, there was a significant overall increase in production during that period, with 2-butoxyethanol being the largest volume glycol ether produced in 1983 (HSDB 1997); reportedly more than 230 million pounds were produced (Gibson 1984 as cited in Ghanayem et al. 1987b). Domestic production of 2-butoxyethanol reached 27 1 million pounds in 1984 (HSDB 1997) and increased to over 300 million pounds in 1986 (NIOSII 1990). A production volume of 408.5 million pounds of 2-butoxyethanol has been estimated for 1995 (CMA 1997a). Significantly lower and relatively constant production of 2-butoxyethanol acetate was reported for the period 1972-l 977, with production volumes in 1972,1975, and 1977 of 13.4 million pounds, 11 million pounds, and 11 million pounds, respectively (NIOSH 1990). More recent production data for 2-butoxyethanol acetate could not be found in the available literature.

Major producers of 2-butoxyethanol are Dow Chemical, USA (Midland, Michigan); Eastman Chemical Co., Texas Eastman Co. Division (Longview, Texas); Occidental Petroleum Corporation, Oxy Petrochemicals, Inc. (Dallas, Texas); Shell Chemical Co. (Geismar, Louisiana); and Union Carbide Corporation, Solvents and Intermediates (Seadrift, Texas) (HSDB 1997; SRI 1997; USITC 1992). The Occidental Petroleum Corporation and the Tennessee Eastman Division of the Eastman Chemical Co. (Kingsport, Tennessee) are major producers of 2-butoxyethanol acetate (HSDB 1997; SRI 1997). Recent data showing the combined production volume of 2-butoxyethanol acetate for these producers were not located. Both compounds are included in the reports of the Toxics Release Inventory (TRI) database (EPA 1995) as part of the required generic reporting of all ethylene glycol ethers. Therefore, information pertaining to the releases of the individual compounds to the environment are not available.

Ethylene glycol monoalkyl ethers are not manufactured as pure compounds but must be separated from the diethers and higher glycols (NTP 1993; NIOSH 1990). There are two common methods of producing

2-butoxyethanol: reaction of ethylene oxide with anhydrous butyl alcohol in the presence of a catalyst and direct alkylation of ethylene chlorohydrin or ethylene glycol using sodium hydroxide and an alkylating agent such as dibutyl sulfate (HSDB 1997; NOSH 1990; Rowe and Wolf 1982). By far the dominant method of 2-butoxyethanol production is treatment of butyl alcohol with ethylene oxide. Information on older products indicates that there may be a considerable difference in the purity of 2-butoxyethanol manufactured in the United States, particularly between industrial and technical formulations. Depending on the production process, manufacturer, and chemical grade of the material, 2-butoxyethanol may contain impurities such as sodium hydroxide (caustic), ethylene glycol, diethylene glycol, and diethylene glycol monobutyl ether (Dow 1958; Eastman Kodak 1988). Dowanol EB Crude, an industrial formulation, was reported to contain 0.25% sodium hydroxide (caustic) (Dow 1958). Ektasolve, a technical grade formulation with >99% purity, was reported to contain 0.2% (w/w) each of ethylene glycol, diethylene glycol, and diethylene glycol monobutyl ether (Eastman Kodak 1988). Total impurity levels in 2-butoxyethanol from different manufacturers have been reported to range from ppm levels to l-2% (w/w) (Dow 1972; Eastman Kodak 1983,1988).
2-Butoxyethanol acetate is predominantly produced by treatment of 2-butoxyethanol with acetic acid. Treatment with acetic acid anhydride or acetic acid chloride are secondary, minor methods of production.

4.2 IMPORT/EXPORT

The most recent import and export data found for 2-butoxyethanol indicate that imports into the United States increased significantly from a negligible amount in 1972 to 89,000 pounds in 1984 (HSDB 1997). Export volumes also increased significantly from 9 million pounds in 1972, to 12 million pounds in 1975, to 71 million pounds in 1984 (HSDB 1997). No quantitative import or export data were found in the available literature for 2-butoxyethanol acetate. The National Trade Data Bank (NTDB 1997) reports import/export data for monobutyl ethers of mono or di-ethylene glycols rather than specific data for 2-butoxyethanol or 2-butoxyethanol acetate.

4.3 USE

2-Butoxyethanol is used extensively in the production of cleaning agents and as a general solvent because it exhibits properties of both alcohols and ethers (Gibson 1984 as cited in Ghanayem et al. 1987b). It is used in formulating industrial and household cleaners, metal cleaners, silicone caulks, and protective surface coatings such as spray lacquers, quick-dry lacquers, enamels, varnishes, and latex paints (Dow 1993; HSDB 1997; Lewis 1993; NIOSH 1990; Rempel et al. 1991; Tichenor and Mason 1988; Vincent et al. 1993). It is also

used in inks, degreasers, paint thinners, and paint stripping formulations (Hahn and Werschulz 1986; Lehmann et al. 1986; Yamano et al. 1991). 2-butoxyethanol has optimum properties (i.e., well-balanced distribution of hydrophilic and hydrophobic groups, complete miscibility with water at room temperature, and an appropriate rate of evaporation) for the production, storage, and application of aqueous coating systems (Appelt 1990). 2-Butoxyethanol is also a component of dry-cleaning compounds (Lewis 1993). In the textile industry, 2-butoxyethanol is used as a dye component to prevent spotting during fabric printing and dyeing (HSDB 1997; Lewis 1993). 2-Butoxyethanol is also used in liquid soaps and cosmetics (Rowe and Wolf 1982). Based on information provided to the IDA, 2-butoxyethanol was found in 111 cosmetic products in 1994 at concentrations up to 10% (Cosmetic Ingredient Review Expert Panel 1996). The emulsifying properties of soap are improved when 2-butoxyethanol is included in the formulation as a mutual solvent for "soluble" mineral oils (Lewis 1993). Functioning as a coupling agent, the compound stabilizes immiscible ingredients in metal cleaning products, textile lubricants, hydraulic fluids, cutting oils, and liquid household cleaning products (HSDB 1997; NIOSH 1990; Rowe and Wolf 1982; Vincent et al. 1993). 2-Butoxyethanol is used as a chemical intermediate in the synthesis of acetate esters as well as phthalate and stearate plasticizers (Dow 1993; HSDB 1997); it is also used as a component of some adhesives (FDA 1993a). In 1972, the use pattern for 2-butoxyethanol was as follows: solvent for protective coatings, 41%; other solvent uses, 3 1%; solvent for metal cleaners and liquid household cleaners, 18%; synthesis of 2-butoxyethanol acetate, 9%; and synthesis of di(2-butoxyethyl) phthalate, 1% (HSDB 1997). The pattern for consumption in 1984, which did not include household cleaners was as follows: coatings solvents, 65%; intermediates, 20%; and miscellaneous solvents, 15% (HSDB 1997). Minor applications include the use of 2-butoxyethanol as a solvent or co-solvent in pesticide formulations (Dow 1993; Leaf 1985 as cited in NIOSH 1990) and automotive brake fluids (Leaf 1985 as cited in NIOSH 1990). Nearly half of the more than 740 products containing 2-butoxyethanol marketed in the United States in 1977 were intended for household use; the average concentration of 2-butoxyethanol in these household products was 2.8% (Consumer Products Safety Commission 1977). The concentration of 2-butoxyethanol used in industrial and household window cleaning agents has been found to range from 1% to 30% by volume (Vincent et al. 1993).

2-Butoxyethanol acetate is primarily used as a high-boiling, retarder solvent (i.e., an active, slow-evaporating solvent which ensures smooth film formation) for nitrocellulose lacquers, acrylic enamels, epoxy resins, and multicolor lacquers (Leaf 1985 as cited in NIOSH 1990; Lewis 1993). 2-Butoxyethanol acetate is also a film-coalescing aid for polyvinyl acetate latex and is used in some ink and spot remover formulations (Leaf 1985 as cited in NIOSH 1990; Lewis 1993). In addition, the chemical is used in inks, degreasers, paints, and paint thinner formulations (Lehman et al. 1986) and as a component of some adhesives (FDA 1993a). The

concentration of 2-butoxyethanol acetate as a retarder solvent in coating formulations is generally l-5% by volume (Leaf 1985 as cited in NIOSH 1990). Current information on the use pattern for 2-butoxyethanol was not located in the available literature.

4.4 DISPOSAL

Regulations governing the treatment and disposal of wastes containing 2-butoxyethanol or 2-butoxyethanol acetate are detailed in Chapter 7. A recommended method of disposal for small amounts of 2-butoxyethanol involves mixing the compound with more flammable solvents to improve combustion, and then atomizing the mixture in an incinerator (IRPTC 1985). In a preliminary investigation of the photodegradation of 2-butoxy-ethanol, Minero et al. (1989) concluded that in the presence of semiconductor particles (titanium dioxide [(TiO_2]), degradation is very rapid and effective. A qantitative formation of carbon dioxide was observed. Their investigation also concluded that under the proper conditions, an iodine-doped organic polymer (polyphenylacetylene) can catalyze 70-l 00% photooxidation of 2-butoxyethanol (Minero et al. 1989). No data were found in the available literature on the amounts of 2-butoxyethanol or 2-butoxyethanol acetate disposed of in the United States.