4. PRODUCTION, IMPORT, USE, AND DISPOSAL

4.1 PRODUCTION

Acrolein is manufactured as an end-use product and as an unisolated intermediate in the production of acrylic acid. Acrolein is manufactured by air oxidation of propylene via the following reaction (Hess et al. 1978):

$$CH_3CH{=}CH_2 + 0_2 \rightarrow CH_2{=}CHCHO + H_20$$

Companies that currently produce acrolein as an unisolated intermediate are: BASF Corp., Freeport, TX; Hoechst Celanese Corp., Clear Lake, TX; Rohm and Haas, Deer Park, TX; and Union Carbide, Taft, LA (Nemec and Bauer 1978; SRI 1988; USITC 1988). During 1988, these companies produced a combined total of 1.1 billion pounds of acrylic acid (USITC 1988). Based on this figure, the production volume of unisolated acrolein in the United States during 1988 has been estimated to be 0.9 billion pounds, assuming 100% yield of acrylic acid from acrolein. Where less than 100% yield of acrylic acid is achieved, the unreacted acrolein is probably recycled back into the reaction chamber. Between 1959 and 1980, Shell Chemical Co. in Norco, TX, produced acrolein for captive consumption in the manufacture of glycerin. Production of acrolein at this facility ceased when the plant was shut down (CMR 1981). A 4-5% increase in the production of acrylic acid is expected through 1991 (CMR 1987), and a corresponding increase in the production of unisolated acrolein is expected. In 1978, domestic manufacturing plants produced approximately 354 million pounds of acrolein (Anderson 1983). Approximately 308 million pounds were produced as an unisolated intermediate in acrylic acid production, 24 million pounds were used in the manufacture of glycerin, 20 million pounds were used in the manufacture of methionine and related compounds, and 2 million pounds were used for miscellaneous purposes.

4.2 IMPORT

During 1972, United States imports and exports of acrolein were negligible (HSDB 1988). No further information regarding the import or export of this compound was located.

4.3 USE

The largest single use for acrolein is as an unisolated intermediate in the manufacture of acrylic acid, most of which is converted to its lower alkyl esters. Acrolein is also used as a herbicide and algicide in irrigation waters and drainage ditches; as a biocide in cooling water towers and water treatment ponds; in the control of algae, weeds, and mollusks in recirculating process water systems; to control microbial growth in feed lines used in subsurface wastewater injection; as a slimicide in the paper industry; as a biocide in oil wells and liquid petrochemical fuels; in the cross-linking of protein collagen in leather tanning; as a tissue fixative in histological samples; as a starting material in the manufacture of Union

Carbide's ERL-4221 bis-epoxide (which is used to make electrical insulators); in the manufacture of colloidal forms of metals; in the production of perfumes; as a warning agent in methyl chloride refrigerant; and as an intermediate in the manufacture of methionine and its hydroxy analogue, glutaraldehyde, ally1 alcohol, •-picoline, and tetrahydrobenzaldehyde (Hawley 1981; Hess et al. 1978; IARC 1985; Windholz 1983). Isolated, refined acrolein is used mainly as a biocide and intermediate in the production of methionine and its methoxy analogue, which are protein supplements used in poultry feed. Acrolein has been used to make modified food starch, synthetic glycerine, acrolein homopolymer, several copolymers (e.g., with acrylic acid, acrylonitrile, and acrylic esters), as well as polymers formed by reaction with formaldehyde, guanidine hydrochloride, and ethylene diamine. It has also been used in military poison gas mixtures (IARC 1985).

4.4 DISPOSAL

Prior to implementing land disposal of waste residues (including waste sludge), environmental regulatory agencies should be consulted for guidance on acceptable disposal practices (HSDB 1988). Materials containing concentrated acrolein may be incinerated by: rotary kiln incineration, with a temperature range of 820-1,600°C and a residence time of seconds; fluidized bed incineration, with a temperature range of 450-980°C and a residence time of seconds; and liquid injection', with a temperature range of 650-1600°C and a residence time of 0.1-2 seconds (HSDB 1988). Materials containing small amounts of acrolein may be disposed of by neutralization (if needed), followed by secondary biological treatment or by submerged combustion (to concentrate the waste) followed by incineration (Hess et al. 1978; OHM-TADS 1988). On-site combustion is an option for disposal if the spill site is in a very remote, inaccessible area, and there is danger of subsequent discharge if other methods of disposal are attempted. Local, state, and federal (RCRA) approval must be obtained before burning on site (OHM-TADS 1988).

Acrolein has been identified as a hazardous waste by the Environmental Protection Agency, and the disposal of this compound is regulated under the federal Resource Conservation and Recovery Act (RCRA). Specific information regarding federal regulations concerning disposal of hazardous wastes through land treatment, landfilling, incineration, thermal treatment, chemical/physical/biological treatment, underground injection, and deep sea injection are provided in the Code of Federal Regulations (40 CFR 190 to 399). Release of acrolein in wastewater is regulated under the Clean Water Act by the National Pollutant Discharge Elimination System (NPDES). Information regarding effluent guidelines and standards for acrolein may be found in 40 CFR 122, 40 CFR 125, 40 CFR 413, 40 CFR 4.23, and 40 CFR 433. Pursuant to RCRA Section 3004(g)(5), EPA has proposed to restrict the land disposal of acrolein (Federal Register 1989b). Acrolein may be land

disposed only if prior treatment standards have been met, or if disposal occurs in units that satisfy the statutory no migration standard (Federal Register 1989b). Proper guidelines and standards are outlined in the Federal register (1989b).