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SUMMARY CHARACTERIZATIONS OF SELECTED CHEMICALS OF NEAR-TERM INTEREST

SEPTEMBER 1976

OFFICE OF TOXIC SUBSTANCES
ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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Prepared by the

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Preface

This Report includes summary characterizations of 8 chemicals of near-term interest to EPA. The characterizations are based on information available as of September 1976. As additional information and interpretations of data become available, an updating of the characterizations may be appropriate. To this end, the Office of Toxic Substances would welcome comments on the technical aspects of the Report.

BIS(CHLOROMETHYL) ETHER (BCME)

Why Should the Chemical Be of Concern at This Time?

BCME was first documented as a human carcinogen in 1972. Since then, the results of animal testing studies have shown this substance to be a potent carcinogen with a very short latent period. While no monitoring data are currently available to document an environmental problem, there has been some unsubstantiated concern about the potential formation of BCME from environmental contaminants (formaldehyde and chloride ion).

What Are the Health and Ecological Effects, and Environmental Behavior?

Several studies indicate that workers exposed to BCME as a contaminant of chloromethyl methyl ether (CMME) have a markedly increased risk of developing respiratory tract cancer, generally oat cell carcinoma. Exposure periods of two to fourteen years (average, ten) by inhalation of vapors at undefined concentrations, and an average latent period of 15 years, have been reported. In the most detailed epidemiological study of workers, a control population having similar smoking habits was identified. Comparing nonsmoker controls to nonsmoker workers, and controls who smoked with workers who smoked, cancer occurrence was determined to be at least eight times greater for the exposed workers in either instance.

Animal experiments indicate that BCME and CMME produce similar effects, but that BCME is much more toxic. A seven-hour inhalation exposure of about eight parts per million BCME is 100% lethal to rats and hamsters within 14 days. All animals exhibited significant increases in lung weight/body weight ratios. At three ppm, BCME is a potent respiratory irritant; 100 ppm incapacitates test animals and results in fatal lung damage within one or two minutes. Rats exposed for six hours to inhalation of 0.1 ppm developed respiratory cancers as early as seven months after exposure (average latency, 13 months). In dermal experiments, BCME was shown to be a moderate initiator and a potent promoter of cancer.

Available experimental data show that BCME has a half-life in water of only 10-40 seconds due to rapid hydrolysis. BCME has a half-life in air of about 25 hours, and its ability to spread in that medium may be influenced by humidity.

What Are the Sources, Environmental Levels, and Exposed Populations?

BCME is known to be a contaminant of CMME, at concentrations ranging from one to seven percent. Because CMME is produced solely as an intermediate for chemical production, manufacturing data are not recorded. CMME is used in the manufacture of ion exchange resins by several companies located in different states. However, BCME has not been detected in the finished resins.

It has been hypothesized that inadvertent formation of BCME could occur in the environment if high concentrations of formaldehyde and chloride ion are present. Tests sponsored by NIOSH have tended to negate this hypothesis.

Analysis of air samples taken inside textile plants where formaldehyde and chloride ion are present has found concentrations of approximately two ppb BCME. Concentrations of 210-1500 ppb have occurred above some laboratory formalin slurries. Environmental monitoring has not been performed.

Should BCME be released to the atmosphere from an industrial plant, it has been estimated that an exposure risk might exist for persons living within twenty miles of the site.

What Are the Technologic and Economic Aspects?

BCME has no commercial use. Patent applications for minor uses in cellulose crosslinking, in preparation of three-block styrene-butadiene-stryene polymers, and in treatment of vulcanized rubber to improve epoxy resin adhesion have been filed. Because of the well-known hazards presented by BCME, it is unlikely that these uses will become of economic importance.

CMME containing BCME as a contaminant is used almost exclusively in the production of ion exchange resins. No other use is reported. CMME could theoretically be produced free of BCME contamination; however, it would probably be neither technologically nor economically feasible. A more reasonable approach might be to develop control technology capitalizing on the relative ease of hydrolysis of BCME and CMME.

What Steps have been Taken, and What Is Being Done?

In 1972, the American Conference of Governmental Hygienists proposed a threshold limit value of one part per billion for BCME in air, which was adopted in 1974. In 1974, OSHA established stringent workplace standards for BCME and CMME. The standards are stated in terms of engineering controls, rather than as maximum time-weighted-average concentrations. The standard further provides for extensive medical surveillance and record keeping.

NIOSH has studied industrial facilities where formaldehyde and chloride ion are used to determine if BCME is inadvertently formed. These tests have provided negative results to date.

Because environmental modeling has predicted air concentrations below the detection limit, and the potential for environmental contamination appears extremely limited, no ambient air standards are contemplated.

REFERENCES

Investigation of Selected Potential Environmental Contaminants: Halothers; Final Report under EPA contract No. 68-01-2996 (available from NTIS-PB 246-356, September 1975)

Review of the Environmental Fate of Selected Chemicals; Final Report under EPA contract No. 68-01-2681 (available from NTIS-PB 238-908, January 1975).

Brown, S.M., and Selvins, S. (1973), "Lung Cancer in Chloromethyl Methyl Ether Workers", N. Engl. J. Med. 289: 693-4.

Drew, R.T.; Laskin, S.; Kuschner, M.; and Nelson, N. (1975) "Inhalation Carcinogenicity of Alpha Halo Ethers. I. Acute Inhalation Toxicity of Chloromethyl Methyl Ether and Bis(chloromethyl) Ether", Arch. Environ. Health 30, 2, 61-9.

Figueroa, W.G.; Raszokowski, R.; and Weiss W. (1973), "Lung Cancer in Chloromethyl Methyl Ethyl Workers", N. Engl. J. Med. 288, 21, 1096-7.

IARC (1974) Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Bis (chloromethyl)ether, Vol. 4, 231-238.

Kallos, G.J., and Solomon, R.A. (1973), "Formation of Bis(chloromethyl) Ether in Simulated Hydrogen Chloride-Formaldehyde Atmospheric Environments", Amer. Ind. Hyg. Assn. J., 34, 11, 469-73.

Kuschner, M.; Laskin, S.; Drew, R.T.; Cappiello, V.P.; and Nelson, N. (1975), "Inhalation Carcinogenicity of Alpha Halo Ethers. III. Lifetime and Limited Period Inhalation Studies with Bis(chloromethyl) ether at 0.1 ppm", Arch. Environ. Health, 30, 2, 73-7.

Laskin, S.; Kuschner, M.; Drew, R.T.; Cappiello, V.P.; and Nelson, N. (1971), "Tumors of the Respiratory Tract Induced by Inhalation of Bis(chloromethyl) Ether", Arch. Environ. Health, 23, 2, 135.6.

Laskin, S.; Drew, R.T., Cappiello, V.; Kuschner, M., and Nelson, N. (1975), "Inhalation Carcinogenicity of Alpha Halo Ethers. II. Chronic Inhalation Studies with Chloromethyl Methyl Ether", Arch. Environ. Health, 30, 2, 70-2.

Sakabe, H. (1973), "Lung Cancer Due to Exposure to Bis(chloromethyl) Ether", Ind. Health., 11, 3, 145-8.

Tou, J.C., and Kallos, G.J. (1974), "Aqueous Hydrochloric Acid and Formaldehyde Mixtures for Formation of Bis(chloromethyl) Ether", Amer. Ind. Hyg. Assn., J. 35, 7, 419-22.

38 FR 10929. "Emergency Temporary Standard on Certain Carcinogens" (1973)

39 FR 23559. "Rules and Regulations: Bis(chloromethyl) Ether" (1974)

Why Should the Chemical Be of Concern at This Time?

The National Cancer Institute has reported that oral administration of chloroform causes liver tumors in mice, and kidney and thyroid tumors in rats. The National Organics Reconnaissance Survey (April 1975) reported that chloroform was found in all chlorinated drinking water samples examined in the study.

What Are the Health and Ecological Effects and Environmental Behavior?

Chloroform is a central nervous system depressant once used as an inhaled anesthetic for surgical procedures. At typical anesthetic exposure levels, chloroform has caused liver and kidney damage and fatal cardiac arrhythmias.

Occupational exposure to airborne chloroform has been found to result in central nervous system depression and has been implicated in liver damage.

The adverse central nervous system, liver, and kidney effects of inhaled chloroform have been demonstrated in laboratory animal studies. Male rats developed dose-related malignant kidney tumors and female rats developed mostly benign thyroid tumors. Dose-related malignant liver tumors were observed in both male and female mice.

What Are the Sources, Environmental Levels, and Exposed Populations?

The annual commercial production of chloroform has generally ranged between 230 and 302 million pounds for the period 1970 through 1975. Chloroform is used in manufacturing other compounds, particularly refrigerants, aerosol propellants, and plastics. Chloroform is also a common industrial solvent and extractant. Significant past uses, now being discontinued as a result of the NCI study, included its incorporation into some cough syrups, throat lozenges, toothpastes, mouth washes, and liniments. Chloroform has also been used as a grain fumigant; this use is currently being challenged.

With the phasing out of chloroform use in cosmetics, medicaments, and as a fumigant, the primary loci of human exposure are workplace environments, ambient air, and drinking water. The current OSHA standard limits airborne concentrations of chloroform to a time-weighted average of 10 ppm. Ambient air concentrations of chloroform of 1-15 ppb in the vicinity of industrial sources have been identified.

In the National Organics Reconnaissance Survey and a similar study conducted by EPA Region V, chloroform was found in virtually all chlorinated drinking water samples at concentrations of from less than 1 µg/l to 360 µg/l. Although chloroform may come from industrial effluents or the breakdown of other chlorinated contaminants, chloroform was seldom detected in untreated water. A series of polybromochloromethanes such as chloroform, bromoform, and bromodichloromethane are produced by the "haloform reaction" when chlorine is used to disinfect water which contains natural humic substances which have methyl ketone functional groups.

What Are the Technological and Economic Aspects?

The reduction or elimination of chloroform from drinking water would require modification of current chlorine disinfection practices or the institution of alternative disinfection technology. Such changes could result in poorer microbiological quality of the finished water and/or the production of other potentially toxic by-products. Increased capital and operational costs, economic dislocations, personnel training, and improved analytical instrumentation may be involved. Disinfection accounts for about 10% of current chlorine production.

What Steps Have Been Taken and What is Being Done?

OSHA is now in the process of reviewing the 1974 chloroform standard. Indications are that the exposure level will be lowered considerably.

In June 1976, the Food and Drug Administration issued a regulation which, effective July 29, 1976, prohibits the use of chloroform as an ingredient in drugs and cosmetics. FDA also has proposed a regulation to prohibit use of chloroform in human food, but this regulation has not yet been finalized.

In April 1976, EPA issued a notice of presumption against the continued registration of chloroform for use as a pesticide. Rebuttals to this presumption are now being reviewed.

EPA issued an advance notice of proposed rulemaking on control options for organic chemicals in drinking water in July 1974. These include establishment of a maximum contaminant level for general organic indicators, and establishment of designated treatment techniques to control chloroform and/or total organics. Interim Drinking Water Standards which became effective in June 1976, may be amended, or chloroform may be incorporated into the Revised Drinking Water Standards scheduled to become effective in March 1979. As mandated by the Safe Drinking Water Act, the National Academy of Sciences is conducting a major study for EPA of the health effects related to contaminant levels of many toxicants in drinking water, including chloroform. EPA is also conducting research to identify sources, distribution, treatment techniques, and health effects of a variety of organic contaminants in drinking water.

The EPA Office of Water Supply is exploring the control of chloroform production by either removing the humic substances before chlorination or substituting ozonation for chlorination to reduce total organic carbon in water systems and for disinfection.

REFERENCES

Data from National Organics Reconnaissance Survey, Water Supply Research Laboratory, EPA (April 15, 1975).

Environmental Protection Agency, Science Advisory Board, "A Report Assessment of Health Risk from Organics in Drinking Water by an Ad Hoc Study Group to the Hazardous Materials Advisory Committee", April 30, 1975.

Enviromental Protection Agency, "Preliminary Assessment of Suspected Carcinogens in Drinking Water," Report to Congress, December 1975.

IARC Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Man, 1 International Agency for Research on Cancer, Lyon, France (1972).

Report on Carcinogenesis Bioassay of Chloroform, National Institutes of Health, National Cancer Institute (1976).

National Institute for Occupational Safety and Health, "Criteria for a Recommended Standard: Occupational Exposure to Chloroform," HEW Publication No. (NIOSH) 75-114 (1974).

Roe, F.J.C. et al., (1968) "Tests of Chloroform and 8-Hydroxquinoline for Carcinogenicity Using Mice, "Brit. Emp. Cancer Campaign, 46: 13

Rudali, G., UICC Monograph 7: 138-143 (1967).

41 FR 14588. "Notice of Presumption Against Continued Registration of Pesticide Product-Chloroform (Trichloromethane)" (April 6, 1976)

41 FR 15026. "Chloroform as an Ingredient of Human Drug and Cosmetic Products: Proposed Revision of Labelling Requirements" (April 6, 1976)

41 FR 15029. "Chloroform in Contact with Food: Proposal to Amend Food Additive Regulation" (April 6, 1976)

41 FR 26842. "Chloroform as an Ingredient of Human Drug and Cosmetic Products (Final Regulations)" (June 29, 1976)

41 FR 28991. "Advance Notice of Proposed Rulemaking on Control Options for Organic Chemical Contaminants in Drinking Water" (July 14, 1976)

HEXACHLOROBUTADIENE

Why Should the Chemical Be of Concern at This Time?

Recently, the Dow Chemical Company released data from a lifetime study showing that hexachlorobutadiene is carcinogenic in rats. Although hexachlorobutadiene (HCBD) is not an article of substantial commercial importance, 7-12 million pounds are produced annually as a by-product of chlorination processes. In 1974, the FDA reported finding HCBD residues as high as 4.5 ppm in fish samples. In 1975, monitoring data developed by EPA revealed the presence of HCBD in air, water, and soil near production and disposal sites.

What Are the Health and Ecological Effects and Environmental Behavior?

Research conducted by the Dow Chemical Company shows that HCBD is carcinogenic in rats, producing adenoma and adenocarcinomas of the kidney. This chemical also produces alterations in the kidney, brain, heart, and liver of exposed animals.

Hexachlorobutadiene effectively destroys narrow leafed plants, insects and nematodes. Kidney and liver damage have been noted in bass exposed to 32 ppb HCBD for 10 days. The growth rate of *Daphnia* is adversely affected at concentrations as low as 15 ppb. The hepatopancreas in crayfish is adversely affected after 10 days in water containing 3.7 ppb HCBD.

Although detected at concentrations as high as 240 ppb in industrial impoundments, the level of hexachlorobutadiene detected in the aquatic environment is generally below 5 ppb. Organisms accumulate 7-7000 times the concentration found in the water column. Further accumulation up through the food chain is minimal.

Hexachlorobutadiene may enter the atmosphere from contaminated soil and water. HCBD is a persistent chemical remaining in soil for at least 3 years.

What Are the Sources, Environmental Levels and Exposed Population?

Hexachlorobutadiene can be used as an insecticide, herbicide, algicide, accelerator for vulcanizing rubber, dielectric in transformers, organic solvent, chemical intermediate, and co-polymer. However, HCBD has not been deliberately manufactured in the United States since 1970. In 1974, 0.2-0.5 million pounds of HCBD were imported to the U.S. from Germany for unspecified use. In addition 7-12 million pounds of HCBD are produced per year as a by-product of manufacturing perchloroethylene, trichloroethylene, carbon tetrachloride, and chlorine.

HCBD is being released into the environment near production and disposal sites. Levels ranging from 0.05-460 μg/m^3 in air, 0.04-230 μg/l in water, 0.04-33.0 μg/g in sediment and 0.001-980 μg/g in soil have been reported. FDA, surveying residue levels of HCBD in food within a 25 mile radius of perchloroethylene or trichloroethylene plants, found that 34% of the fish (0.01-1.20 ppm) and 1 of 20 milk samples (1.32 ppm) contained residues. Individuals living within the immediate vicinity of 83 locations suspected of producing HCBD and related sites used for the disposal of industrial sludges, or consuming food originating from these areas are thought to be exposed to this chemical.

What Are the Technologic and Economic Considerations?

The major routes of environmental release for hexachlorobutadiene are linked to the production, storage, transport, and disposal of industrial wastes. Land disposal is being used and can be improved without a substantial increase in cost. Unfortunately, burial does not ensure the total containment of this persistent chemical; landfill monitoring indicates that volatilization results in at least a fractional release. High temperature incineration, the ultimate disposal method, is being used by selected companies despite high initial capitalization costs. Effluent discharges can be reduced at minimal cost by controlling suspended solids.

What Steps Have Been Taken and What is Being Done?

No regulatory actions have been completed to date. EPA is planning to develop a water quality criteria document and subsequent effluent guideline for hexachlorobutadiene in accordance with the recent consent decree.

REFERENCES

An Ecological Study of Hexachlorobutadiene (HCBD). EPA, Office of Toxic Substances Report No. 560/6-76-010, April 1976.

Kociba, R.J., et al. Results of a Two-year Chronic Toxicity Study with Hexachlorobutadiene (HCBD) in Rats. August 9, 1976. Report of the Toxicology Research Laboratory, Dow Chemical Company, Midland, Michigan.

Sampling and Analysis of Selected Toxic Substances, Task IB: Hexachlorobutadiene. EPA, Office of Toxic Substances Report No. 560/6-76-015, June 1976.

Survey of Industrial Processing Data, Task I: Hexachlorobenzene and Hexachlorobutadiene Pollution from Chlorocarbon Processes. EPA, Office of Toxic Substances Report No. 560/3-75-003, June 1975.

Why Should the Chemical be of Concern at This Time?

The carcinogenicity of several lead salts has been demonstrated in laboratory animals; there is an absence of adequate human data. The potential for lead poisoning in sensitive populations is a major concern, particularly in children, pregnant mothers, and occupationally-exposed workers in urban environments where elevated levels of lead in air, dustfall, and soil represent a significant additional source of lead intake. A single episode of lead poisoning in a child may result in brain damage ranging from a subtle learning disability to an extensive mental handicap.

What Are the Health and Ecological Effects and Environmental Behavior?

Clinical effects of lead poisoning include acute and chronic central nervous system damage, peripheral nerve paralysis, kidney damage, and damage to blood formation processes which may lead to anemia. The risk of clear-cut clinical effects is greatest when blood lead levels increase above 80 µg/100g whole blood, and at lower blood levels when anemia prevails. Mild poisoning may be reversible if exposure to lead is discontinued. Maternal over-exposure may have greater toxic effects on the fetus than on the mother.

Common sources of livestock lead poisoning include lead-based paints, storage batteries, used motor oil and airborne lead contamination of hay and pasture vegetation from smelting and other lead industries. A daily lead intake of 6-7 mg/kg body weight has been suggested as the minimum level giving rise to poisoning in cattle. Two to three percent of our waterfowl population die annually from lead poisoning primarily due to spent lead shot.

What Are the Sources, Environmental Levels, and Exposed Populations?

U.S. consumption of lead was 1.6 million short tons in 1974. Major uses included storage batteries (53 percent), gasoline additives (16 percent), pigments (seven percent), ammunitions (five percent), solder (four percent), and cable covering (three percent). The elevated atmospheric levels of lead in our larger cities are primarily attributable to motor vehicle combustion of leaded fuel additives. About 180,000 tons of lead are emitted to air annually from motor vehicle combustion of fuel additives. Other sources of lead pollution include coal and fuel oil combustion, lead smelting, incineration of solid wastes, and lead paints.

Ambient air lead levels average 1-3 $\mu g/m^3$ in urban areas, 0.1-0.5 $\mu g/m^3$ in suburban areas, and less than 0.05 $\mu g/m^3$ in rural areas, except in the vicinity of point sources and heavy traffic. The levels of lead in natural waters and finished drinking water rarely exceed 0.05 mg/l except in areas of lead ore deposits and point source discharges.

The average daily oral intake of lead is estimated at 300 µg for adults, and 130 µg for children. Childhood and infant pica has resulted

in numerous cases of lead poisoning from the ingestion of peeling lead paint and other lead-containing substances, and the inhalation of street dust. Illicitly distilled whiskey and consistent consumption of game animals previously wounded by lead bullets or shot are potentially hazardous dietary sources.

Occupational health supervision has limited the magnitude of industrial exposures. However, incidents of lead poisoning still occur where medical surveillance and exposure controls are inadequate, as recently seen in an auto battery plant in Visalia, California, and a pigments plant in Beltsville, Maryland.

What Are the Technologic and Economic Aspects?

Substitutes are readily available for lead chromate pigments in highway paints and for lead shot. The economic impact of banning lead chromate paint for highway markings would fall primarily on the producers of lead chromate. The economic impact of actions to promote recycle of lead batteries should be minimal, if any, since the rate of recycle is currently high, and the industry is willing to receive all used lead batteries it can get. EPA has specified standard methods for analysis of total lead in water, and is currently considering methods for air and other media.

What Steps Have Been Taken and What Is Being Done?

FDA has limited lead in paints to less than 0.5 percent by weight for use on residential surfaces accessible to children, has proposed a tolerance level (0.3 ppm) for lead in evaporated milk and an action level (7 μg/ml) for leachable lead in pottery and enamelware, and is considering limitations below 0.5 ppm for lead in other canned foods. OSHA has proposed an action level of 50 $\mu g/m^3$ and a permissible exposure limit of 100 $\mu g/m^3$ during an average eight hour work period for lead and its compounds. CPSC is currently undertaking a review of the "safe" level of lead in paints.

Under the FWPCA, EPA has established effluent limitation guidelines on lead discharges from several industrial point source categories. Fifteen lead compounds have been designated as hazardous substances under Section 311(b) of the FWPCA. Under Title I of the MPRSA special care is required in ocean dumping or other disposal of lead and its compounds. Interim Primary Drinking Water Standards under the SDWA set a maximum contaminant level for lead of 0.05 mg/l.

Pursuant to Section 111 of the Clean Air Act, EPA has established standards of performance for primary and secondary lead smelters. Lead has been added to the list of air pollutants under Section 108(a) of the Clean Air Act, and the issuance of a national ambient air quality standard for lead is planned.

Final regulations promulgated on December 6, 1973, controlling the amount of lead additives in gasoline have been reinstated. Lead levels in gasoline must meet the 1.4 g/gal limitation beginning October 1, 1976.

REFERENCES

Kornreich, M.R., A Preliminary Assessment of the Problem of Carcinogens in the Atmosphere, The Mitre Corporation, McLean, Virginia, April 1975, MTR - 6874.

Lead: Airborne Lead in Perspective, National Academy of Sciences, Washington, D.C., 1972.

New Lead Limits for Canned Foods Being Considered by FDA, Food Chemical News, May 31, 1976, p. 14-15.

Toxicology of Metals - Volume I, Health Effects Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 1976, EPA, 600/1-76-018.

Weinstein, H., "A Battery Plant and Lead Poisoning", New York Times, June 6, 1976, p. 1.

38 FR 28610, 10/15/73 (Ocean Dumping).

39 FR 42740, 12/6/74 (Poisonous or Deleterious Substances in Peanuts, Evaporated Milk, Fish and Shellfish: Proposed Rules).

40 FR 45934, 10/3/75 (Lead: Occupational Exposure; Proposed Standard).

40 FR 53421, 11/18/75 (Secondary Lead Smelters).

40 FR 59566, 12/24/75 (National Interim Primary Drinking Water Regulations).

40 FR 59960, 12/30/75 (Hazardous Substances).

41 FR 2332, 1/15/76 (Standards of Performance: Primary Copper, Zinc, and Lead Smelters).

41 FR 14921, 4/6/76 (Addition of Lead to List of Air Pollutants).

41 FR 28352, 7/9/76 (Lifting of Suspension of Enforcement of Regulations for Control of Lead Additives in Gasoline).

40 CFR 80, Revised as of July 1, 1975 (Regulation of Fuels and Fuel Additives).

40 CFR 413.10; 40 CFR 415.60; 40 CFR 415.340; 40 CFR 415.440; 40 CFR 420.110; 40 CFR 421.40; 40 CFR 421.70; 40 CFR 426.110; 40 CFR 426.130, Revised as of July 1, 1975. (Effluent Limitations Guidelines - various industrial categories)

PHTHALIC ACID ESTERS (PAE's)

Why Should the Chemical Be of Concern at This Time?

Recently, widespread attention has been focused on the possibility that phthalic acid esters (PAE's) may be used by capacitor manufacturers as a substitute for PCB's. Phthalic acid esters appear to be persistent in air, water and soils; however, they can be degraded by microbial action. PAE's are now widely found in the environment, and appear to bioaccumulate in the food chain.

What Are the Health and Ecological Effects, and Environmental Behavior?

Di-2-ethylhexyl phthalate (DEHP), a commonly used plasticizer in PVC, has been found in the lung, liver, spleen, and blood of patients transfused with blood stored in PVC bags. Shock lung syndrome was observed in some patients who had been transfused with large amounts of blood. DEHP has also been shown to contaminate milk collected using PVC pipe. Beating chick embryo heart cells ceased functioning on exposure to 4 µg/ml DEHP in culture medium. Within 24 hours, virtually all the cells were dead and disintegrating. Other PAE plasticizers reduce the rate of beating, but do not result in cell death, at this level. Interperitoneal administration of DEHP to rats (amount and/or concentration unspecified) resulted in peritonitis-like irritation of the viscera, and a finding that 25% of the dose remained in the body after 13 days.

DEHP added to diets (fat-free and 4% fat) at 0.1% resulted in increased DEHP concentrations in hearts and epididymal fat pads of male weanling rats after 44 days. Teratogenicity studies using eight different PAE's related the frequency of skeletal abnormalities directly to water-solubilities of the compounds, and assigned gross malformations to the most and least water soluble. Dimethoxyethel phthalate was distinctly the most teratogenic; it and DEHP most frequently caused gross deformities. Absence of tails, anophthalmia, and twisted hind legs were the most common gross malformations; elongated and fused ribs and abnormal skull bones were the most common skeletal anomalies. DEHP was found to be the most mutagenic of the eight compounds in dominant-lethal tests.

DEHP accumulates in various fish and aquatic insect species (250 to 3900 times ambient within 7 days), and inhibits reproduction in most. Radiological bioassays indicate a halflife of 3 days in *Daphnia magna*. Some bioaccumulation in the food chain has been observed, but not thoroughly documented.

A survey of 147 Russian workers exposed to PAE vapors at concentrations ranging from 1.7 to 66 mg/m^3 reported high incidence of numbness and weakness in the extremities, autonomic-sensory polyneuritis, elevated threshold of pain, depression of deep tendon reflexes, and hypertension, particularly among those who had worked with PAE's for six or more years.

The foregoing information relates to ortho-phthalate only. Health and toxicology data are not clearly related to the specific isomer or its metabolites; mechanisms are not known. Para-phthalates are believed to cause effects similar to those

described above, but this has not been demonstrated. Behavior of the meta-phthalates is undocumented.

What Are the Sources, Environmental Levels, and Populations Exposed?

In 1972, about 1.15 billion pounds of PAE's were produced as plasticizers by 23 companies at 26 U.S. locations. The basic production method for PAE's is to react phthalic acid or anhydride with an alcohol or phenolic compound. PAE's were first produced in the 1920's, and came into widespread use in the 1930's. About 80% of the plasticizer production has been used in the production of polyvinyl chloride (PVC) plastics for use in building and construction products, automobile and home furnishings, clothing, food coverings, and medical products. About twenty percent is used in production of other plastics. Other uses include carrier or dispersion media for pesticides, cosmetics, and dyes, and account for a small amount of total PAE production.

PAE's have been found in the Gulf of Mexico (0.6 ppm) and near the mouths of the Merrimack and Charles Rivers (0.88 to 1.9 ppb). Upstream in the Charles, concentrations as high as 11.27 ppb have been noted. Samples taken from a bay of Lake Superior, in a rural-industrial area, were found to contain 0.3 ppm. Air samples taken near an incinerator at Hamilton, Ontario, have shown the presence of three PAE's at concentrations ranging from 300 $\mu g/m^3$ to 750 $\mu g/m^3$.

Normally stable PAE's are liberated from vinyl upholstery fabrics and other thin-vinyl products, particularly at temperatures over 25 degrees C. The air inside new cars has been found to contain PAE's in the mg/l range.

What Are the Technologic and Economic Aspects?

The State of Michigan found that nearly all of the PAE's being released into waste streams could be removed by improvements in industrial housekeeping involving little capital expenditure by the companies. Whether emissions to the atmosphere could be eliminated by control technology is not known. The question of worker exposure is, similarly, not yet answerable.

What Steps Have Been Taken, and What is Being Done?

Until recently, the level of concern with phthalic acid esters and their isomers in the environment has not been such that EPA control appeared needed. The State of Michigan has used State laws and authorities delegated under Federal law to request that manufacturers modify their processes to eliminate the discharge of phthalic acid esters with waste effluents. The plant managers of the affected industries have viewed the approach as helpful and easily complied with.

The manufacturers of blood bags and DEHP-plasticized PVC transfusion equipment have voluntarily shifted to use of other materials.

REFERENCES

Corcoran, Eugene F., "Gas-Chromatographic Detection of Phthalic Acid Esters," Environmental Health Perspectives, No. 3:13-5, 1973.

Graham, P.R., "Phthalate Ester Plasticizers: Why and How They Are Used," Environmental Health Perspectives, No. 3:3-12, 1973.

Hites, Roland A., "Phthalates in the Charles and the Merrimack Rivers," Environmental Health Perspectives, No. 3:17-21, 1973.

Mayer, Foster L., Jr., and Sanders, Herman O., "Toxicology of Phthalic Acid Esters in Aquatic Organisms," Environmental Health Perspectives, No. 3:153-158, 1973.

Metcalf, R.L., et al., "Uptake and Fate of Di-2-ethyl Ketyl Phthalate in Aquatic Organisms and in a Model Ecosystem," Environmental Health Perspectives, No. 4:27-34, 1973.

Milkov, L.E., et al., "Health Status of Workers Exposed to Phthalate Plasticizers in the Manufacture of Articficial Leather and Films Based on PVC Resins, "Environmental Health Perspectives, No. 3:175-179, 1973.

Stalling, David L., Hogan, James W., and James W., and Johnson, James L., "Phthalate Ester Residues - Their Meatbolism and Analysis," Environmental Health Perspectives, No. 3:159-173, 1973.

POLYCHLORINATED BIPHENYLS (PCB's)

Why Should the Chemical Be of Concern at this Time?

Polychlorinated biphenyls (PCB's) are persistent in the environment and bioconcentrate in the food chain. The PCB concentrations in sport and commerical fish in many of our fresh water areas exceed the FDA's temporary tolerance level. The existing environmental levels in some of our waters are high enough to have an effect on the reproduction of some fish species. In the laboratory, PCB's have caused tumors in rats, mice and dogs, and at low levels they have been shown to cause reproduction failures in primates. PCB's have been detected in over 90 percent of the samples of human adipose tissue and human milk.

What Are the Health and Ecological Effects, and Environment Behavior?

In 1968, more than 1000 cases of PCB poisoning were diagnosed in Japanese families that used rice oil contaminated with PCB's. The disease was characterized by swelling of the upper eyelids, visual impairment, acne-like formations, and heightened pigmentation of the skin. In addition, PCB's have been shown to adversely affect the reproduction of several animal species. In 1972, the Federal Interdepartmental Task Force on PCB's concluded that these chemicals pose a serious threat to human health because of their highly persistent nature and their tendency to bioaccumulate in the food chain.

What Are the Sources, Environmental Levels, and Exposed Populations?

Since 1971, Monsanto Corporation, the sole producer of PCB's in the United States, has voluntarily restricted the sale of PCB's to manufacturers of "closed" electrical equipment. In 1975, approximately 21 million pounds were used in capacitor manufacturing, and 11 million pounds were used by transformer manufacturers. Another 500,000 pounds are imported each year, primarily for use in the investment casting industry. U.S. PCB production has declined from a high of 85 million pounds in 1970 to a low of 40 million pounds in 1974.

Although the water levels are generally low, high concentrations of PCB's have been found in fish and sediments. Sediments appear to be the primary environmental sink, and they can be slowly released into the surrounding water over a period of many years.

The National Human Monitoring Program for Pesticides found that the proportion of human adipose tissue showing traces of PCB's increased from 50.7 percent in 1970 to 90.9 percent in 1974. A study in Michigan has shown that persons who eat sport fish show a higher blood level of PCB's than those who do not consume fish.

EPA is working toward the development of better analytical methods for air measurements.

What Are the Technical and Economic Aspects?

Sixty percent of the approximately 1.25 billion pounds of PCB's used in the United States since 1930 are in service today, mainly in transformers and capacitors. It is estimated that 290 million pounds are in landfills or dumps, and 150 million pounds are free in the environment. Only an estimated 55 million pounds have been destroyed by incineration or degradation.

PCB substitutes may cost more and may not have the flame resistance of PCB's. This could influence the development of electrical equipment and change the national fire codes.

What Steps Have Been Taken, and What Is Being Done?

The Toxic Substances Control Act gives the EPA Administrator the authority to regulate the manufacturing, processing, distribution, and use of PCB's. It also requires that the Agency prescribe methods of disposal and marking for PCB's and articles containing PCB's. The law mandates that all manufacturing and processing will be stopped by January 1, 1979.

In July, 1976, EPA published the proposed effluent regulation for PCB's. EPA has proposed regulations for PCB's under Section 311, hazardous materials spills, and is preparing a regulation for PCBs pretreatment under Section 307(b) of FWPCA.

The Food and Drug Administration has announced that they are considering lowering the tolerance level for PCB's in certain foods. The present tolerance levels were finalized in July, 1973, and included 5.0 ppm for the edible portion of fish and shellfish and 0.2 ppm for baby food.

NIOSH has prepared a draft criteria document which recommends lowering the workplace exposure standard for PCB's. This document should be released to OSHA this year.

On April 1,. 1976, EPA published guidelines for the disposal of PCB's under Section 209 of the 1965 Solid Waste Disposal Act.

REFERENCES

Environmental Health Perspectives, Experimental Issue Number One, April, 1972. National Institute of Environmental Health Sciences.

Kornreich, M., et al, Environmental Impact of Polychlorinated Biphenyls, May 1976, Mitre.

National Conference on Polychlorinated Biphenyls. November 1975, Chicago, Illinois, Sponsored by Environmental Protection Agency, March 1976.

PCB's and The Environment, Interdepartmental Task Force on PCBs, ITF-PCB-72-1, March 20, 1972.

PCB's in The United States Industrial Use and Environmental Distribution, Task I. EPA, Office of Toxic Substances, Report No. 560/6-76-005, February 25, 1976.

Selikoff, Irving J., Ed. Environmental Research: An International Journal of Environmental Medicine and the Environmental Sciences, Volume 5, Number 3, September 1972.

TRICHLOROFLUOROMETHANE (F-11) AND DICHLORODIFLUOROMETHANE (F-12)

Why Should the Chemical Be of Concern at This Time?

The continued release of F-11 and F-12 may at some time in the future result in a significant depletion of stratospheric ozone. Stratospheric ozone absorbs incoming high energy ultraviolet radiation from the sun, particularly in that region of the spectrum associated with adverse health effects, notably skin cancer. The absorption of ultraviolet radiation by stratospheric ozone also establishes the temperature distribution of the stratosphere which may be an essential factor in weather and climate patterns. The preponderance of investigations since 1974, including a National Academy of Sciences study published in September 1976, have supported the ozone depletion predictions and recognized the eventual need for some form of limitations on the continued release of F-11 and F-12.

What Are the Health and Ecological Effects, and Environmental Behavior?

F-11 and F-12 are chemically stable, volatile, and quite insoluble in water. When released, they accumulate in the troposphere, the lower portion of the atmosphere, where they do not appear to undergo any significant destruction. Minor sinks, such as dissolution in ocean surface waters, ion-molecule interactions, and photodissociation may exist for the fluorocarbons, but existing data indicate that the current atmospheric burden of F-11 and F-12 roughly accounts for the total amount of these compounds released to date (i.e., since about 1930). It has now been shown that F-11 and F-12 diffuse upward into the stratosphere. There, intense solar radiation can remove some or all of the chlorine atoms from these compounds. Chlorine atoms catalyze decomposition of ozone molecules by initiating free radical chain reactions. The National Academy of Sciences has predicted that continued release of F-11 and F-12 at current rates will, within a century or so, result in ozone depletion of 2-20%, with a median estimate of 7% depletion.

The health and ecological effects of such an ozone depletion have not been fully defined. Qualitatively, the effects of ozone depletion are seen as possible increases in human skin cancer; adverse impacts on the growth and yield of economically important crops; adverse effects on plants, insects, and animals; disruption of local ecosystems, and weather and climate changes due to increased ultraviolet radiation and/or perturbation of the stratospheric temperature structure.

What Are the Sources, Environmental Levels, and Exposed Populations?

In 1974, U.S. production of F-11 and F-12 was 341 million pounds and 487 million pounds, respectively. United States production accounts for about half of the total world production of these compounds. Virtually all of the F-11 and F-12 produced has been, or at some future time will be, released to the atmosphere. With aerosol propellants (about 80% of F-11 consumption and about 60% of F-12 consumption) the release occurs within a year or so after production. Refrigerant

use (about 5% of F-11 consumption and about 30% of F-12 consumption) involves a delay of about a decade or so from the time of production to atmospheric release. The remaining consumption of these compounds as foam blowing agents also results in ultimate release to the atmosphere.

No natural sources of these compounds are known to exist. Ambient air levels of F-11 and F-12 are about 80 parts per trillion by volume (ppt v/v) and 120 ppt v/v, respectively. Concentrations are higher over areas of high population and industrial activity, and are also higher in the northern hemisphere than in the southern hemisphere. Calculations of the total atmospheric burden indicate that almost all of the F-11 and F-12 produced to date resides in the troposphere, with the only significant removal mechanism being diffusion into the stratosphere.

Because ozone depletion is a global effect, it could impact on the total world population. The particular effects may be different for certain groups. With respect to skin cancer: light-skinned people are at greater risk than dark-skinned people; the effects of increased ultraviolet on agricultural crops may be more significant at certain latitudes than others; and effects of climate changes may be more significant in some areas than others.

What Are the Technologic and Economic Aspects?

Suitable alternative delivery systems are available for fluorocarbon-propelled aerosol products. Although some economic dislocations could be expected from a shift to these alternatives, the overall economic effects would probably be negligible. For refrigerant use, where F-12 is the principal compound of concern, there does not appear to be a suitable and feasible way to replace the refrigerant already in use with a substitute substance, nor is there, at this time, a process for capturing and disposing of spent refrigerant. However, modification of condensers to use refrigerants other than F-11 and F-12 in devices manufactured in the future is possible. Some foam blowing agent uses of F-11 and F-12 can be replaced by other materials; those foam blowing uses where F-11 and F-12 are retained in the foam to impart desired thermal properties to the final product may be difficult to replace.

What Steps Have Been Taken, and What Is Being Done?

The National Academy of Sciences has now completed its evaluation of the fluorocarbon/ozone question. Both government- and industry-sponsored research into the ozone depletion theory and the possible effects of ozone depletion on man and the environment are continuing. EPA has now begun the rulemaking procedures for future fluorocarbon regulatory action under the Toxic Substances Control Act.

The U.S. Food and Drug Administration has announced procedures for removing F-11 and F-12 from drugs and cosmetic products, and the Consumer Product Safety Commission plans to regulate use of these compounds as propellants in household products.

REFERENCES

Chemical Technology and Economics in Environmental Perspectives: Technical Alternatives to Selected Chlorofluorocarbon Uses, prepared by Midwest Research Institute for Office of Toxic Substances, EPA. (Available through NTIS, PB 251 146, February 1976).

Environmental Hazard Assessment Report: Major One- and Two-Carbon Saturated Fluorocarbons. Review of Data, Office of Toxic Substances, EPA. (Available through NTIS, PB 257 371, August 1976).

Fluorocarbons and the Environment, Report of Federal Task Force on Inadvertent Modification of the Stratosphere (IMOS), NSF 75-403, June 1975.

Fluorocarbons-Impact on Health and Environment, Hearings before the Subcommittee on Public Health and Environment of the Committee on Interstate and Foreign Commerce, House of Representatives, 93rd Congress, Second Session, Dec. 11 and 12, 1974, Serial No. 93-110.

Halocarbons: Effects on Stratospheric Ozone, Panel on Atmospheric Chemistry, Committee on Impacts of Stratospheric Change, Assembly of Mathematical and Physical Sciences, National Research Council; National Academy of Science, September 1976.

Halocarbons: Environmental Effects of Chlorofluoromethane Release, Committee on Impacts of Stratospheric Change, Assembly of Mathematical and Physical Sciences, National Research Council; National Academy of Sciences, September 1976.

Preliminary Economic Impact Assessment of Possible Regulatory Action to Control Atmospheric Emissions of Selected Halocarbons, prepared by Arthur D. Little, Inc. for Office of Air Quality Planning and Standards, EPA. (Available through NTIS, PB 247 115, September 1975).

Why Should the Chemical Be of Concern at this Time?

Reports of hepatoangiosarcoma, a very rare liver cancer, in workers exposed to VCM resulted in the initial awareness of a potential environmental problem. A stringent workplace standard was subsequently adopted by OSHA; however, VCM has been detected in the environment beyond the fences of plants manufacturing or using VCM and fabricating products from polyvinyl chloride (PVC).

What Are the Health and Ecological Effects, and Environmental Behavior?

Vinyl chloride inhalation has been shown to cause cancer in both sexes of three species of rodent. Angiosarcoma of the liver has been induced in rats, hamsters and mice. In rats and mice, this induction was at exposure levels as low as 50 ppm, the lowest level at which studies have thus far been conducted. In one experiment, mice exposed to 50 ppm VCM for four hours per day, five days per week, for a twelve month period, developed nephroblastomas and liver angiosarcomas after 135 weeks. A second experiment produced angiosarcomas after 26 weeks of exposure to 50 ppm, seven hours per day, five days per week (latency period not specified). Multiple cancer risk was shown, with involvement of the brain, lungs, kidneys, and mammary glands.

No definitive dose-response data have been developed; thus, there are uncertainties as to the adverse effects on man at these concentrations. The latency period between exposure to low levels of vinyl chloride and the diagnosis of cancer appears to be about 20 years.

As of June 1975, NCI had confirmed 27 cases of hepatoangiosarcoma among occupationally exposed workers (15 in the United States, and 12 in Europe and Canada). An additional 11 cases have been reported, but not confirmed.

The physical characteristics of VCM have precluded serious environmental problems. The volatility and reactivity of VCM have prevented its accumulation in the biosphere, including aquatic systems.

What Are the Sources, Environmental Levels, and Exposed Populations?

Vinyl chloride is produced at eleven plants in the United States. Total production capacity is 6.8 billion pounds per year. Virtually all of the VCM is polymerized into polyvinyl chloride (PVC) at approximately forty plants, and more than 8,000 plants fabricate products from PVC. The principal uses of PVC are in building materials (39%), home furnishings (10%), electrical insulation (7%), packaging materials (7%), recreational equipment (6%), apparel (5%), and transportation equipment (5%). About five percent of production is exported, and 16 percent is applied to miscellaneous uses. Manufacture of VCM and PVC and fabrication of PVC products result in the emission of about 220 million pounds of VCM to the atmosphere each year.

It has been estimated that 4.6 million people live within five miles of plants producing VCM and PVC. Monitoring results indicate that persons

living in the immediate vicinity of these plants may be exposed to average daily concentrations of less than one part per million. Some 24-hour concentrations have ranged from one to three ppm, with occasional peak exposures as high as 33 ppm.

What Are the Technical and Economic Aspects?

EPA has estimated that the cost for existing plants to install the equipment needed to meet the air emission standard will total $198 million, of which $183 is for PVC plants. An additional $70 million per year will be required to maintain and operate the equipment. The air standard also established an effluent standard. It is estimated that this will require $83 million in equipment costs, and $17 million per year for operation and maintenance.

It was estimated that imposition of the air standard would result in a 7.3 percent increase in the price of PVC resins, and this would prompt a 3.5 percent increase in the price of consumer goods containing PVC.

What Steps Have Been Taken, and What Is Being Done?

Stringent workplace standards were promulgated by OSHA in December 1974, and revised in March 1975.

Limitations on air emissions of vinyl chloride were proposed under Section 112 of the Clean Air Act. These standards are applicable to manufacturers of vinyl chloride and ethylene dichloride by the oxychlorination process, and to polymerizers of PVC.

The Office of Water Supply is conducting studies to determine if VCM should be regulated under the Safe Drinking Water Act.

Vinyl chloride is one of the sixty-five chemicals presently under study for control under the provisions of the Federal Water Pollution Control Act.

REFERENCES

Dynamic Behavior of Vinyl Chloride in Aquatic Ecosystems. EPA, Office of Research and Development Report No. 600/3-76-001, January 1976.

Epidemiology Studies, Task III: Vinyl Chloride. EPA, Office of Toxic Substances Report No. 560/6-75-002, November 1975.

Scientific and Technical Assessment Report on Vinyl Chloride and Polyvinyl Chloride. EPA, Office of Research and Development Report No. 600/6-75-004, June 1975.

Standard Support and Environmental Impact Statement: Emission Standard for Vinyl Chloride. Volume 1. EPA, Office of Air Quality Planning and Standards Report No. 450/2-75-009, October 1975.

Toxicity of Vinyl Chloride - Polyvinyl Chloride. January 1975. Annals of the New York Academy of Sciences, Volume 246.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report includes summary characterizations of 8 chemicals of near-term concern to EPA. The report summarizes (a) health and ecological effects and environmental behavior, (b) sources, environmental levels and exposed populations, (c) technologic and economic aspects and (d) steps that have been taken and are being taken.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Bis(Chloromethyl) Ether, Chloroform, Hexachlorobutadiene, Lead and Its Compounds, Phthalic Acid Esters, Polychlorinated Biphenyls, Trichlorofluoromethane (F-11) and Dichlorodifluoromethane (F-12), Vinyl Chloride		

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