DRAFT

PCB EFFLUENT STANDARDS

The homolog distribution of the various chlorinated biphenyl molecules present in the commercial materials currently being manufactured and used has been defined above. From this presentation and in the production and distribution data reviewed by Nisbet and Sarofim (1972), it is apparent that the manufacture and use of the more highly chlorinated isomers is decreasing. This change in homolog composition is particularly important. It has been demonstrated in controlled biodegradation tests that biphenyl, monochlorobiphenyl, dichlorobiphenyl, trichlorobiphenyl and tetrachlorobiphenyl are readily assimilated and rapidly metabolized to the ultimate products of aerobic metabolism, carbon dioxide and water. As a result of the complete metabolism in a normal biological system, mono-, di-, tri- and tetrachlorobiphenyl do not contribute significantly to the tissue burdens of the environmentally present chlorinated biphenyls.

The rapid metabolism of these lower chlorinated isomers and their lack of importance as contributors to the chlorinated biphenyl tissue burdens is evidenced in the results of numerous studies. Risebrough (1972) reported that the chlorine composition of the PCB detected in Atlantic Ocean zooplankton was approximately 54%. He concluded "It might be expected therefore that biphenyls with fewer chlorine atoms would predominate in

planktonic samples unless these compounds were selectively degraded." Similar findings in freshwater and marine fishes were reported by Zitko (1971) and Jensen, et al., (1969). The disappearance of the lower chlorinated isomers in extracts of tissues from birds (Bailey and Bunyan, 1972) and mammals (Grant et al. 1971) would also indicate metabolic breakdown of the lower chlorinated homologs. The formation of 4-chloro-4'-hydroxybiphenyl from 4-chlorobiphenyl in rabbits has been reported (Block and Cornish, 1959). It has also been suggested that hydroxylation of the lower chlorine homologs is a general metabolic pathway, resulting in complete degradation, in birds and mammals. As a result of the relatively rapid and complete degradation of the chlorinated biphenyls containing less than four chlorine atoms per molecule, their contribution to the effluent should not be used in measuring polychlorinated biphenyl effluent from a facility. Utilizing the gas chromatographic system described elsewhere, only the responses of materials with retention times identifying homologs with more than four chlorine atoms should be included in the measurement of the PCB effluent.

The Water Quality Criteria (WQC) chronic limits for the PCBs are established by applying accumulation factors to the maximum acceptable concentration of PCB in tissues from aquatic species deemed most sensitive or most critical in the ecosystem. For the marine system, this level was established as the maximum acceptable concentration of PCB's

in whole fish that are consumed by fish-eating birds and mammals divided by the upper PCB concentration factor for marine fish. The allowable PCB residue in these forage fish was set a 0.5 mg/kg (ppm). Although this level is only one-tenth the FDA proposed temporary tolerance for PCB residues (5 ppm) in fish for human consumption or in animal feed components, it is equivalent to the proposed tolerances for complete animal feeds. The assumption that selected fish comprise the total diet of marine birds and mammals has been made for purposes of calculating the proposed PCB effluent standard. The accumulation factor that was selected was 30,000. This value is supported by studies with marine fishes and by studies with fresh water species (Stallings and Mayer, 1972). The tolerable chronic limit was then calculated to be:

$$\frac{0.5 \text{ mg/kg}}{30{,}000} = 0.0167 \text{ µg/l.}$$

In presenting information in support of the proposed limits in fresh water, the EPA presented data suggesting that salmon embryos were the most sensitive aquatic organism that might encounter PCB's. It was stated that embryo mortality might occur at PCB concentrations of 500 µg/l (0.5 mg/kg) in salmon eggs. Furthermore, it was indicated that this level in the egg was associated with body tissue concentrations

of approximately 5 µg/g (5 mg/kg). From these PCB residue values, it can readily be seen that the minimum threshold (0.5 mg/kg) for embryo mortality in this most sensitive species would not be reached until the whole body concentration had reached the proposed maximum allowable residue (5.0 mg/kg) in edible fish. It can also be seen that the minimum threshold (0.5 mg/kg) for the selected, most sensitive, aquatic organism is the same as the selected allowable PCB residue in marine forage fish (0.5 mg/kg). In contrast to the accumulation factor of 30,000 selected for marine fish, the EPA selected an accumulation factor of 200,000 for fresh water fish. This factor has no extrapolatable relationship to either the residues of PCB in salmon eggs or to PCB residues of fresh water forage fish. The only published report of an accumulation factor of the magnitude selected was that for the hepatopancreas of the pink shrimp, Penaeus durarum, (Nimmo et al, 1971). Even though an accumulation of 204,000 in the hepatopancreas had occurred, a nearly complete elimination of PCB from that tissue was achieved when the shrimp were placed in water free of added PCB. The equilibrum whole body accumulation plateau indicated an approximate accumulation factor of 22,000 (Nimmo et al, 1971). These results (Nimmo et al, 1971) are in agreement with those reported by Stalliggs and Mayer (1972), and with the studies of Ryther (1972), Greichus et al (1973) and Crump-Wiesner, et al (1973)

showing equilibrum bioamagnification factors between water and fish ranging between 1000 and 75,000 and would support the acceptance of 30,000 as a reliable accumulation factor to be used for fresh water forage fish. Therefore, using the same protective criteria for birds and mammals consuming fresh water forage fish as the EPA proposed for marine birds and mammals, the acceptable tolerable chronic limit can be calculated to be:

$$\frac{0.5 \text{ mg/kg}}{30{,}000} = 0.0167 \text{ µg/l}.$$

Arbitrary safety factors were applied to the tolerable chronic limit to establish the so-called "critical chronic limit" which was then used to compute the maximum allowable effluent. These safety factors were proposed to account for a multitude of variables, including non-point sources, multiple discharges and industrial growth. The safety factors proposed were identical for 7 of the 9 materials for which effluent standards were prepared. These safety factors, resulting in approximately two-fold reductions, are so small as to be of no beneficial toxicological consequence. Furthermore, the acceptable (WQC) tolerable chronic limits and total weight discharges are based upon maximum biomagnification factors and the maximum allowable effluent concentrations are based upon the most sensitive species. Therefore, these limits do not require further correction by the imposition of any arbitrary safety factor.

Proposed Effluent Standard

As a result of the information reviewed above, the following PCB effluent concentrations and daily loads would be justified as amounts that would not result in any harm to the most sensitive organism in the environment, or to humans.

a) Effluent Concentration (critical acute limit):

Water Body	Max. Allowable Effluent Conc.
F. W. Stream	280 ug/l
F. W. Lake	280 ug/l
Estuary	10 ug/l
Coastal	10 ug/l

b) Daily Load:

Water Body	Safe Chronic Limit
F. W. Stream	0.0167 ug/l
F. W. Lake	0.0167 ug/l
Estuary	0.0167 ug/l
Coastal	0.0167 ug/l

Calculation:

5.4 x CFS x Safe Chronic Limit in ppm = lbs/day ÷ 2.205=kg/day

F. W. Stream $5.4 \times (1 \times 10^{4}) \times (0.017 \times 10^{-3}) = 0.918$ lbs/day = 0.416 kg/day

F.W. Lake $5.4 \times (1 \times 10^{4}) \times (0.017 \times 10^{-3}) = 0.918$ lbs/day = 0.416 kg/day

Estuary $5.4 \times (1 \times 10^{4}) \times (0.017 \times 10^{-3}) = 0.918$ lbs/day = 0.416 kg/day

Coastal $5.4 \times (1 \times 10^{4}) \times (0.017 \times 10^{-3}) = 0.918$ lbs/day = 0.416 kg/day

References Cited

Bailey, S. and P. T. Bunyan (1972). Interpretation of Persistence and Effects of Polychlorinated Biphenyls in Birds. NATURE, 236:34-3.

Block, W. D. and H. H. Cornish (1959). Metabolism of Biphenyl and 4-chlorobiphenyl in the Rabbit. J. BIOL. CHEM. 234: 3301-.

Crump-Wiesner, H.J. H. R. Feltz and M. L. Yates (1973). A Study of the distribution of polychlorinated biphenyls in the aquatic environment. J. RES. U.S. GEO. SURVEY, 1: 603-607.

Duke, T. W., J. I. Lowe and A. J. Wilson, Jr., (1970). A polychlorinated biphenyl (Aroclor 1254®) in the water, sediment and biota of Escambia Bay, Florida. BULL. ENVIRON. CONTAM. TOXICOL. 5: 171-180.

Grant, D. L. W. E. J. Phillips and D. C. Villeneuve (1971). Metabolism of a polychlorinated biphenyl (Aroclor® 1254) mixture in the rat. BULL. ENVIRON. CONTAM. TOXICOL. 6:102.

Greichus, Y. A., A. Greichus and R. J. Emerick (1973). Insecticides, polychlorinated biphenyls and mercury in wild cormorants, pelicans, their eggs, food and environment. BULL. ENVIRON. CONTAM. TOXICOL. 9: 321-328.

Hansen, D. J., P. R. Parrish, J. I. Lowe, A. J. Wilson, Jr. and P. D. Wilson (1971). Chronic Toxicity, Uptake and Retention of Aroclor® 1254 in Two Estuarine Fishes. BULL. ENVIRON. CONTAM. TOXICOL. 6: 113-119.

Jensen, S., A. G. Johnels, M. Olsson and G. Otterlind (1969). DOT and PCB in marine animals from Swedish waters. NATURE, 224: 247-250.

Nimmo, D. R., R. R. Blackman, A. J. Wilson, Jr., and J. Forester (1971). Toxicity and distribution of Aroclor® 1254 in the pink shrimp Penaeus duorarum. MARINE BIOL. 11, 191-197.

Ryther, J. H. (1972). The use of flowing biological systems in aquaculture, sewage treatment, pollution assay, and food-chain studies. Woods Hole Oceanographic Institution, Woods Hole, Mass. Unpublished Manuscript.

Risebrough, R. W. (1972). PCB Residues in Atlantic Zooplankton. BULL. ENVIRON. CONTAM. TOXICOL. 8: 345-355.

Zitko, V. (1971). Polychlorinated biphenyls and organochlorine pesticides in some freshwater and marine fishes. BULL. ENVIRON. CONTAM. TOXICOL. 6: 464-470.