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# Organic Leachate Threatens Groundwater Quality

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Pollution of groundwater by organic materials leached from land disposal sites occurs extensively and is likely to pose a serious threat to groundwater quality. This conclusion was based on investigations of four wells in Oklahoma. It is important to establish regularly functioning monitoring systems in order to watch future trends in the levels of organic chemical contamination.

The presence of organic compounds in natural water is beginning to receive considerable attentions. The existence of numerous compounds creates a problem of great interest in water quality investigations. A significant quantity of chlorinated pesticide has been recovered from rivers, lakes and their sediments. A complex mixture of hydrocarbons has also been extracted from surface water. The widespread occurrence of chlorinated hydrocarbons in living organisms and in the natural environment has been clearly demonstrated.[1,2,3] Some of these organic compounds are probably of biological origin, whereas others are the product of the gradual decomposition of industrial, hospital and agricultural wastes. These organic compounds have a deleterious physiological effect on living organisms and are becoming a potential hazard to the natural environment. The recent findings of polychlorinated biphynels and phthalate esters in the water are good examples.

Polychlorinated Biphynels (PCBs) were first described in the literature in 1881, and successive commercial production was achieved by the Swam company in 1930. The present registered trademarks of mixture of PCBs for commercial uses are listed in Table 1.

PCBs are a class of chlorinated hydrocarbons. They have a ring structure and are formed from two aromatic rings. They are chemically inert, are not hydrolyzed by water and resist alkalies, acids and corrosive alkalies. They are quite stable and insoluble in water, but they are soluble in hydrocarbon solvents.[4] These properties indicate that PCBs could persist and accumulate in the environment and up through the food chain.

*PCBs have specific physical and chemical characteristics that are available for industrial uses in various forms.* PCBs are attractive as plasticizers because they are permanently thermoplastic, chemically stable and resistant to oxidizing and corrosion. These characteristics increase the plastics' workability and flexibility. Their excellent fire resistance characteristics *make PCBs valuable as additives in hydraulic fluid, heat transfer fluid and gas turbine lubricants.* In the industrially important capacitors, PCBs are added to prevent breakdown using their high dielectric strength. In general, PCBs are widely used in industry as plasticizer, dielectric fluid, acrylic resins, in sealing compounds, printing ink, rubber manufacturing, high pressure-high temperature lubricants, fungicidal insulations, anti-corrosives, nail coating, water proofing, diffusion pump fluid, stabilization of polymers, heat transfer media, coax-cable insulations, paints and varnishes, ice-preventing coating and evaporation retardent.[5]

*The toxicity and sublethal effects of the PCBs have not been thoroughly evaluated.* A number of studies on the toxicity of PCBs have been conducted, and a summary of some findings is given by Veith and Lee,[6] and J. G. Vos.[7] However, the presence of PCBs at the level of one ug/l in natural waters may pose a threat to aquatic organisms and the food chains subetained by them.

The pathways in which PCBs escape into the *ecosystem are not well known.* The most likely route in which PCBs are discharged into the environment include industrial combustion, waste disposal leaching, hydraulic system leakage and manufacturing spillage.[8] A Swedish research[9] reported that the increased amounts of PCBs in nature resulted in aerial transport from industrial smoke, municipal solid waste dumping and burning smoke.

Studies by Veith et al[10] presented evidence that PCBs were discharged from municipal and industrial wastes into the natural water. The other possibility is that PCBs could be drived from DDT under the influence of UV light.

*Phthalate Esters are* other organic compounds dispered over surface water, ground water, atmosphere, and in the human body. These compounds are produced by the reaction of phthalic anhydride and the appropriate alcohol. Approximately 850 million lb. of phthalate esters were produced in 1970, and annual production since then has been in excess of 900 million lb.[11] Among them, 75 percent of phthalate esters were used as plasticizers ending up in vinyl products that are utilized in building and construction, such as wire, cable, floorcovering, swimming pool liners, furniture upholstery and wall coverings; in automobile manufacture, such as seatcovers, floor mats and tops; in the apparel industry, such as footwear and synthetic materials; and in food packagings and medical products, such as food wrap, film, medical tubing and intravenous bags. While 15 percent of phthalate esters goes into synthetic rubber cellulose resins and other plastic products,[12] the nonplasticizer uses of phthalate esters include gasoline, additives, synthetic lubricants, pesticide carriers, cosmetics, fragrances and insect repellents.

Phthalate esters also have specific characteristics that could increase the flexibility and permanence to the polymer of polyvinyl chloride (PVC), diethylhexyl phthalate (DEHP), diisooctyl phthalate (DIOP) and diisodecyl phthalate (DIDP). Enjay Chemical company, Monsanto Chemical company and Union Carbride *company manufacture phthalate esters in* the United States.

Although the acute toxicity of phthalate esters is low, a cumulative toxic effect over a period of time may endanger aquatic communities, terrestrial and even human life. Extensive studies from Rubin and Jaeger[13] showed that the quantity of DEHP extracted from the blood of test rats grown in plastic package bag increased linearly with times. Studies by Metcalf et al[14] also indicated that DEHP was hardly metabolized by algae, daphnae, mosquito larve, snails and claims that the chronic toxicity of DEHP closely resembles DDT in rate of uptake and storage. The studies also showed that DEHP is partitioned strongly in the lipids



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of plants and animals and is therefore concentrated through food chains. There are also other subtle effects of phthalate esters that are significant. All the esters studied to some degree produced embryo toxicity, skeletal deformities and teratogenic effects.[15]

Comprehensive investigations were performed from 1973 to 1974, to elucidate the nature and extent of groundwater pollution by organic compounds leached from landfills. Three of the wells used in this study were test wells in or adjacent to the landfill site near Norman, Oklahoma. The fourth well was selected as a control well and is located approximately one mile northwest of the landfill site. Groundwater was sampled by modified low-flow carbon adsorption procedures incorporating an all glass-teflon system to preclude introduction of extraneous organics.[16] Column chromatography, solubility separation and gas chromatography-mass spectrometry were employed for separation, identification and quantitation of individual compounds in organic extracts.

A wide variety of organic compounds were identified by this study as pollutants of groundwater. The emphasis on the report has been focused on PCBs and phthalate esters. Data obtained from this study indicated that more than five kinds of esters of phthalic acid existed in groundwater. Three of them, identified with reasonable certainty on the basis both of mass spectra and GC retention times, were diethyl phthalate (4.1 ug/l), diisobutyl phthalate (0.1 ug/l) and dioctyl phthalate (2.4 ug/l). Others were tentatively identified as di-n-butyl phthalate, butylcarbobytoxymethyl phthalate, and dicyclohexyl phthalate.

The source of these compounds was apparently manufactured products discarded in the landfill. Through slow decay these products contributed certain levels of organic pollutants in the aquifers.

Evaluations of data collected from mass spectrometry and GC-MS procedures likewise failed to produce any evidence to indicate the presence of PCBs in groundwater. It is probable that PCBs are very insoluble in water and could be largely adsorbed on a soil particle within a short distance of the point of deposition. This undetectable amount of PCBs in groundwater was not significant to the water supply, but it would undoubtly effect the terrestrial ecosystem.

**Table 1. Trademarks and Manufacture of Mixture of PCBs**

| Trademark | Company | Country |
|---|---|---|
| Arochlor | Monsanto | U.S.A. |
| Chlorextol | Allis-Chalmers | U.S.A. |
| Dykanol | Cornel-Dubilier Division Federal Pacific Electric | U.S.A. |
| Inerteen | Westinghouse | U.S.A. |
| Nollamol | Wagner Electric | U.S.A. |
| Pyramol | General Electric | U.S.A. |
| Therminol | Monsanto | U.S.A. |
| Clophen | I.G. Farbenidustrie | Germany |
| Fenclor | Caffaro | Italy |
| Pyralene | Prodelec | France |
| Kannechlor | Kanegafuchi | Japan |

The environmental problems arising from the tremendous quantities of organic compounds used in all sorts of products are now being brought into focus. The potential for long-term pollution of aquifers by industrial organic chemical leached from discarded manufactured products could someday reach the threshold of natural tolerance and upset the balance of natural ecosystems. The recent decision by the Monsanto Chemical company to cease production of Arochlor and the new proposal by the Food and Drug Administration (FDA) to prohibit the uses of certain plastic food packaging and other food contact materials made with vinyl chloride are realistic steps to prevent the spread of organic contamination over the natural environment. ■

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