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Treatment of Hazardous Wastes

Most observers agree that the past performance of the Environmental Protection Agency in cleaning up Superfund sites has been uninspired. In what has been called a "shell game," the net result has largely been to move hazardous waste from one spot to another or to cover the waste with a clay blanket. There has been little net destruction of the waste and hence little in the way of permanent solutions to a set of nasty problems.

Every waste dump is different in geometry, geology, and content of organic and inorganic chemicals. Organic chemicals are the most feared, most complex substances present. Technology exists to deal with part of the organic wastes (incineration), and research results are pointing the way toward dealing with much of the remainder (biodegradation). Where applicable—for example, wastes in drums—incineration can achieve essentially complete destruction. Even the most stable halogen-containing aromatic chemicals are destroyed at 1260°C. Major chemical companies have been using this procedure successfully, achieving as much as 99.9999+ percent destruction. Currently, for lack of incinerator capacity, there is a 2-year backlog of wastes to be burned. To avoid possible problems during transport to incinerators and to increase capacity, EPA should devote some of its funds to the construction of mobile incinerators to be used at Superfund sites.

Much of the organic chemical wastes have been dumped into landfills. Dilution with dirt is such that incineration is often not practical. Field experience and research indicate that biodegradation could come to have an important role. For example, benzene, toluene, xylenes, and other hazardous aromatic chemicals are found in many waste dumps and also in leakage from gasoline tanks. These chemicals and many other hydrocarbons can be oxidized in situ to CO_2 and H_2O by microorganisms provided that they are furnished with such inorganic nutrients as phosphate and ammonium nitrogen, plus oxygen. At the site of a large gasoline spill, accompanying extraction and injection of water, nutrients were added and oxygen was provided in the form of dilute H_2O_2. A population of organisms (2×10^2 per gram of soil) capable of using gasoline as a carbon and energy source increased to more than 10^6 per gram of soil, and 65 percent of the hydrocarbons disappeared after 164 days.

Among the individual organic chemicals most prevalent at Superfund dumps are trichloroethylene, chloroform, tetrachloroethylene, and 1,1,1-trichloroethane. No organisms have been found that can grow using these substances as sole energy and carbon sources. However, the compounds can be degraded by bacteria whose growth is supported by another metabolite. As one example, methanogenic organisms (anaerobes), when supplied acetate, slowly degraded tetrachloroethylene and 1,1,1-trichloroethane, as well as chloroform and carbon tetrachloride.* A different set of organisms has destroyed halogenated hydrocarbons under aerobic conditions. This time, the energy and carbon source was methane, and 12 halogenated aliphatic hydrocarbons were degraded to some extent.† Similar treatment of ^{14}C-labeled trichloroethylene showed fairly rapid total destruction. Products included CO_2 and biomass; no halogenated organic compound remained.‡

In terms of practical applications, there is a long history of use of aerobes in oxidizing many hydrocarbons such as those in oil or gasoline. However, the most troublesome components of Superfund dumps are the small halogenated hydrocarbons. Priority should be accorded to expanding laboratory investigations dealing with these substances. In addition, field experiments should be conducted using injection coupled with withdrawal of nutrient streams under both anaerobic and aerobic conditions.

The public does not welcome the establishment of waste dumps for toxic chemicals removed from somewhere else. As currently authorized sites are filled, EPA will find that it has no real alternative but to deal with the contents of most sites in situ. Prospects are good that multidisciplinary applications of science and engineering can be effective.

—PHILIP H. ABELSON

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*E. J. Bouwer and P. L. McCarty, *Biotechnol. Bioeng.* **27**, 1564 (1985). †J. M. Henson, J. W. Cochran, J. T. Wilson, R. S. Kerr, in preparation. ‡M. M. Fogel, A. R. Taddeo, J. Fogel, *Appl. Environ. Microbiol.* **51**, 720 (1986).