United States
Environmental Protection
Agency

Risk Reduction
Engineering Laboratory
Cincinnati OH 45268

Research and Development

EPA/600/S2-91/040 Sept. 1991

EPA

Project Summary

Compatibility of Flexible Membrane Liners and Municipal Solid Waste Leachates

Henry E. Haxo, Jr.

In a study designed to determine the current composition of municipal solid waste (MSW) leachate and its chemical resistance with flexible membrane liners (FMLs), the literature was surveyed and limited experiments on absorption of organics by FMLs were done. The object of this survey and study was to assess how well EPA Method 9090 can evaluate the resistance of FMLs with MSW leachate. It should be noted that EPA Method 9090 was originally developed for evaluating the chemical resistance of FMLs with hazardous waste leachate. At present, it is questionable whether Method 9090 yields realistic results for judging this resistance. The Method may yield misleading results because of the instability of the MSW leachate and the low concentrations of leachate organics presently reported.

This Project Summary was developed by the principal investigators and EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in the report listed at the end of this summary. (See Project Report ordering information at back.)

Introduction

Early studies indicated that commercially available FMLs were chemically resistant to MSW leachates that contacted them. These studies employed freshly collected, shredded MSW whose leachate contained inorganic salts and volatile acids with no indication of chlorinated or aromatic organics. Adding hazardous waste from small-quantity generators and nonhazardous industrial waste to MSW may result in leachate containing measurable quantities of organics that could adversely affect FMLs and render them unserviceable. When the leachate contains sufficiently high amounts of aggressive constituents, the resistance of the FML and the leachate must be determined. Currently, EPA Method 9090 is used for this determination. Because of the instability of leachate during the 120-day exposure at 23° and 50°C called for by the Method, it may not be suitable.

We now need such information as:

- Is the chemical resistance data base (FMLs with MSW leachates sufficient to approve commercially available FMLs without EPA Method 9090 testing?
- Is there a level of an organic's concentration (or a mixture's concentration) above which the testing is required?
- How do the changing characteristics of MSW leachate affect FMLs during long-term exposure?
- If Method 9090 testing is necessary, how credible are the data?

These are questions that must be answered; the literature search and limited experiments summarized here are a beginning.

The literature was examined to determine data on composition and characteristics of MSW leachate; data on resistance of commercial FMLs with MSW leachate; and the sufficiency of available data to warrant blanket approval of commercial FMLs for use as liners in MSW landfills. Limited experiments were done to study the partitioning of low concentrations of the organic constituents found in MSW leachate to commercially available FMLs.

Composition of Leachates

From the literature review (and the limited experiments), MSW leachate is found to be a highly complex mixture of inorganics, organics, and bacteriological constituents; usually generated in an anaerobic MSW landfill environment; highly oxidizable and unstable; and subject to rapid compositional changes when removed from the MSW environment. There are limited data on MSW leachate generated from recently constructed landfills and on the presence of low concentrations of priority pollutants and other organics that may be absorbed by FMLs.

Before 1980, information of the composition of leachate included analyses for trace metals, organic acids, and many of the dissolved organics. More recent analyses show the presence of a variety of volatile organics and priority pollutants.

In the one study (done in the 1970's but reported between 1982 and 1988) concerned with the resistance of MSW leachate and FMLs, the leachate was analyzed for organic acids, COD, total volatile and nonvolatile solids, and Ph, but not for aromatics, hydrocarbons, chlorinated hydrocarbons, or other priority pollutants. The parameters peaked at about 1 yr and decreased to 10% of peak at 4-2/3 yr. The maximum effects on the FML's properties occurred at 1 yr and then tended to return to original values. No data were available on currently produced FMLs based on high-density polyethylene (HDPE).

Threshold Concentration and Solubility Parameter

The concept of a threshold concentration was considered to be the lowest concentration at which significant effects on FML properties occurred and at which maximum adsorption and equilibrium occurred. An organic dissolved in an aqueous solution partitions until equilibrium concentration (in the solution and in the FML) is reached. The ratio of the concentration of the dissolved organic in the FML over that in the water would equal the partitioning coefficient. Over a practical concentration range (low), this coefficient would remain constant and the coefficient would be determined by the solubility parameter pairs (the organic and the water; the organic and the FML). As the concentration or organics in the leachate changes, the equilibrium would change and so would the concentration in the FML. A threshold concentration, then, would be unique to the combination of FML and the organic or combination of organics.

EPA Method 9090

The EPA Method 9090 test reliability assesses the resistance of FMLs with hazardous wastes, leachates, and waste liquids; problems exist, however, when determining the true resistance of a specific FML with a specific MSW leachate. A detailed analysis of the leachate is needed to determine the organics (especially chlorinated and aromatic hydrocarbons that have solubility parameters close to most FML) and their concentrations. With the use of solubility data and a detailed analysis, the amount absorbed by an FML could be estimated and the absence or low concentration of these species would indicate EPA Method 9090 need not be performed.

But the problem is that MSW leachate is highly oxidizable and unstable, and methods to preserve the leachate were not found in the literature. To protect the leachate from bacteriological changes, the sample must be cooled and stored at +5°C immediately after collection. The Method 9090 compatibility test is done at 23° and 50°C when biological activity can result in continuous property changes. Because the objective is to maintain in-service conditions as much as possible, additional experimentation should be done to assess means to stabilize the leachate. The concentrations of dissolved constituents reflect the composition of the leachate in service; the leachate should maintain a constant concentration of these constituents affecting FMLs during extended service.

Many of the constituents of MSW leachate are readily oxidizable, and many organics (such as chlorinated organics) resist degradation over long periods of time. These are the organics that remain after other constituents are degraded and that are generally more aggressive to FMLs.

Under the present EPA Method 9090, equipment should be modified to ensure anaerobic conditions and stabilization of leachates.

Laboratory Experiments

Because of the uncertainties surrounding the resistance of FMLs and MSW leachate, limited laboratory experiments were done. This work involved measuring the absorption of three dilute, aqueous solutions or organics commonly found in MSW leachate (toluene, trichloroethylene [TCE], and methyl ethyl ketone [MEK] by four representative polymers (linear low-density polyethylene [LLDPE]; polyvinyl chloride [PVC]; chlorinated polyethylene [CPE]; and a fabric-reinforced, low-water-adsorption chlorosulfonated polyethylene [CSPE-R]. In the tests, the changing concentrations of organics in the solutions were measured until they became relatively constant. The FML specimens were then analyzed (GC headspace procedures) to determine the amount and type of organics absorbed by the specimens.

The three experiments were designed to simulate FMLs in contact with MSW leachate: what was the weight increase, how much organics were absorbed; and what effect did the swelling have on the tensile properties of the FMLs.

In the first experiment, the solvents were dissolved at low concentrations (500 ppm) in DI water. At equilibrium, the MEK remained in the water and the TCE and toluene partitioned to the PVC.

In the second experiment, the concentrations of volatile organics in each test cell were measured by GC analysis. In all cases, the MEK showed little change—thus little partitioning of MEK from the water phase to the FMLs had occurred. The concentration of toluene and TCE in the water significantly dropped, and thus partitioning to the FMLs had occurred.

Experiment three was done to confirm experiment two and to measure the effect on tensile properties of FMLs, with one specimen cut from the machine direction and one from the transverse. The results confirmed those of experiment two and also showed that tensile stresses showed losses of up to 25% to 30% at 100% and 200% elongation.

Results

Based on the present data base, it is questionable whether blanket approval can be given for all FMLs used to construct lining systems for MSW disposal facilities. At the same time, it is also questionable whether EPA Method 9090, as presently performed, will yield realistic results for judging the resistance of lining materials with MSW leachates. Furthermore, EPA Method 9090 may yield misleading results considering the instability of MSW leachate and the low concentrations of many of the organics reported in analyses of currently produced MSW leachates.

The full report was submitted in fulfillment of Work Assignment No. 24, Contract No. 68-03-3413, by PEI Associates, Inc., under the sponsorship of the U.S. Environmental Protection Agency.

☆U.S. GOVERNMENT PRINTING OFFICE: 1991 - 548-028/40071

Henry E. Haxo, Jr., is with Matrecon, Inc., Alameda, CA
***Robert E. Landreth** is the EPA Project Officer (see below).*
The complete report, entitled "Compatibility of Flexible Membrane Liners and Municipal Solid Waste Leachates" (Order No. PB91- 231 522; Cost: $17.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection
Agency

Center for Environmental
Research Information
Cincinnati, OH 45268

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT No. G-35

Official Business
Penalty for Private Use $300

EPA/600/S2-91/040