

Title: Effects of Volatile Organic Compounds on Clay Landfill Liner Performance

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Background: In 1987 very low levels of VOCs were observed in clay borrow materials intended for use in the liner system of the expansion of the Sevenmile Sanitary Landfill, Eau Claire County, Wisconsin. These VOCs were suspected to have originated from a nearby Superfund site where similar organic chemicals had been found in soil and groundwater.

Questions were raised by the Wisconsin Department of Natural Resources (DNR) regarding the potential effects of the organic chemicals on the performance of the clay materials as a landfill liner. Potential effects on liner permeability and interactions of the organic chemicals with typical municipal landfill leachate are of concern. These issues are of concern due to the possibility of the precontamination of the clay causing leachate to pass through the liner system at an accelerated rate and thereby result in groundwater contamination.

Objectives:

- 1) To investigate the effects of organic chemicals on physical properties of the clay;
- 2) To examine the performance of the clay in transmitting and releasing organic chemicals by employing compacted clay specimens in flexible wall permeameters using clean and precontaminated clay materials; and
- 3) To evaluate the sorption capacity of clay borrow materials intended for use in the liner system using batch isotherm experiments.

Methods: The clay borrow material tested was intended for use in the liner system of the expansion of the Sevenmile Sanitary Landfill, Eau Claire County, Wisconsin. Organic chemicals selected for the analyses were: acetone, m-xylene, methylene chloride, toluene, and trichloroethylene. Acetone and m-xylene were used to precontaminate the clay. Methylene chloride, toluene, and trichloroethylene were used as a permeant solution.

Analysis of influent and effluent samples from the perimeters and of adsorption samples were conducted by headspace analysis with a capillary column and flame ionization detector on a gas chromatograph.

Analyses performed include: Static Compaction, Atterberg Limit Test, Sedimentation Test, Permeation Test, Soil Characterization Tests, Clay-organic chemical interaction index tests

Results and Discussion:

In general, the clays exhausted their organic chemical sorption capacity within 1 to 10 pore volumes. The effluent concentrations closely mirrored the influent leachate concentrations.

The "breakthrough" curves observed in the permeation experiments are generally consistent with theoretical estimates. The theory has not been confirmed for the clay and organic chemicals being studied. Some work toward this is needed.

The amount of organic chemical sorbed onto soil can be estimated using a Freundlich sorption isotherm

Conclusions:

From the soil-organic chemical index tests, the following conclusions can be drawn:

- 1) With the exception of pure acetone, the Atterberg tests showed that acetone, m-xylene, methylene chloride, trichloroethylene, and toluene at the concentrations used did not impact clay pore fluid interaction.
- 2) From sedimentation tests, addition of acetone, m-xylene, methylene chloride, trichloroethylene, and toluene tended to cause more flocculation of the suspension than distilled water. For an acetone/m-xylene mixture, maximum flocculation occurred at 40% concentration.
- 3) From sedimentation tests, the impact of methylene chloride, trichloroethylene, and toluene on sediment volume and rate of settlement was insignificant up to concentration levels of 100 ppm.

From the permeability test results, the following conclusions can be drawn:

- 1) Precontaminated clay with acetone and m-xylene at the levels studied did not appear to impact organic chemical leachate transport/adsorption adversely, when compared to clean clay.
- 2) Acetone was mostly flushed out within three pore volumes. m-Xylene was probably released at very low concentrations (below detection limit of 10 µg/L).
- 3) In general, methylene chloride, trichloroethylene, and toluene broke through within a few pore volumes. After breakthrough, effluent concentrations closely mirrored influent concentration fluctuations.

Implications/

Recommendations: Though the "breakthrough" curves observed in the permeation experiments were generally consistent with theoretical estimates, the theory has not been confirmed for the clay and organic chemicals being studied. Some work toward this is needed. It is clear, however, that retardation or attenuation of VOC's in the clay liner material was minimal.

Related Publications: Edil, T.B., Berthouex, P.M., Park, J.K., Sandstrom, L., and Zelmanowitz, S. 1989, "Effects of volatile organic compounds in clay landfill liner performance" Interim report to the Eau Claire County, Wisconsin Department of Natural Resources, and Ayers Associates, UW-Madison, 35 pp.

Key Words: Volatile organic compounds, leachate, landfill, clay liner

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Project Report: A report on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706, (608) 262-3069.