A Publication of the ENVIRONMENTAL RESEARCH AND EDUCATION FOUNDATION

RESEARCH BULLETIN

Environmental Research and Technologies for the Future *Issue 1, Volume 1 Summer 2003 www.erefdn.org*

Bioreactor Landfills —Viable Technology for the Future

ABSTRACT: *EREF's Bioreactor Research Examines the Technology's Viability and Its Potential to Significantly Reduce Operational Costs while Enhancing the Environment*

Bioreactor landfills have the potential to provide a more sustainable approach to managing municipal solid waste (MSW) because they essentially become a waste processing facility much like a compost facility. Traditional landfills are constructed to minimize the entry of water, which is the limiting factor in waste biodegradation because the microbes present in the waste need water to function and degrade the waste. Conversely, bioreactor landfills add water and/or air to the waste, which accelerates the biodegradation of waste. The water required to stimulate the microbes, and therefore increase waste degradation, can be obtained through leachate recirculation, from liquid wastes, or surface waters.

One of the first indications that accelerated degradation of landfilled waste occurred under higher moisture conditions was at the Collier County Landfill in Florida. During excavations of existing cells, the county discovered that organic waste in some of the cells had completely degraded within 10 years, except for larger pieces of wood and non-degradable items. The accelerated rate of decomposition was attributed to the high rainfall rates and warmer ambient temperatures.

At the same time, numerous landfills started to recirculate leachate as a method to treat leachate and reduce costs. Operators of these leachate recirculation landfills observed accelerated waste degradation rates and increased air space as a result of waste degradation and densification.

More recently, laboratory work in columns containing waste demonstrated the feasibility of the process. In addition, research to determine the viability of a bioreactor operation was performed at a number of MSW landfills where a portion of a previously filled landfill was converted to a bioreactor cell. This research attempted to determine degradation rates, increases in air space, and leachate and gas quantity and quality.

Based on the research, the potential benefits of a bioreactor landfill may include:

- Shorter time periods (7-10 years) over which air and water emissions are generated compared to 30 or more years in a conventional landfill;
- Shorter post-closure (10-15 years) care periods compared to 30 or more years for a conventional landfill;
- Reduced leachate disposal cost because all leachate treatment and disposal costs are eliminated;
- Greater waste densities (from about 1,300 lbs/yd^3 to 1,900 lbs/yd^3);
- Increase in landfill air space by about 33 percent because of increased waste densities; and
- Quicker return of the property to a productive end-use.

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Full-scale bioreactor landfill allows direct evaluation of design and operation.

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Because of the increased interest in operating bioreactors, U. S. EPA initiated a review of its landfill regulations when bioreactor operations are used. Also, EPA has initiated a project to track bioreactor landfills. The data collected will be used to determine whether new projects address new areas of research or are duplicative of previous research.

However, basic bioreactor landfill research and full-scale demonstrations are needed because the science of operating a bioreactor landfill is not fully understood. Presently, there is a need to understand the basic chemical, biological and physical processes in order to define where and under what conditions a bioreactor landfill will work effectively. Additionally, the bioreactor technology needs to be better demonstrated at full-scale for technology acceptance in a risk adverse industry. Most existing bioreactor landfills are retrofits of dry-tomb landfills and are not instrumented to produce performance data. A full-scale system allows direct evaluation of design and operating parameters.

In the fall of 2001, EREF awarded a substantial multi-year grant to Michigan State University (MSU) for the development and operation of a bioreactor cell at the Northern Oaks Recycling and Disposal Facility in Harrison, Michigan. A 1.5-acre bioreactor cell was constructed at the landfill with a capacity of approximately 160,000 yd^3. The cell was equipped with horizontal leachate recirculation and gas extraction pipes within each ten-foot lift.

Seth Maher (MSU) reads moisture probes installed in the bioreactor landfill cap.

Within each lift, monitoring systems were installed to evaluate moisture distribution within the waste and temperature, gas and leachate production and quality, making the bioreactor cell one of the most heavily instrumented cells operating under bioreactor conditions. Waste settlement and densification will be monitored using a series of settlement plates. The volumes of leachate and liquid added and removed are monitored as well as its inorganic and organic quality. Weather data is continuously monitored utilizing an on-site weather station. Periodically, liquid and gas samples are analyzed for both organic and organic constituents. Gas samples are also collected periodically and analyzed for gas composition and production rate.

The status of the MSU bioreactor project is:

- Bioreactor cell construction (liner, and leachate collection system) was completed in February 2002;
- All lifts were filled with waste as of April 2003;
- Environmental monitoring devices have been installed in all lifts as of April 2003; and
- Monitoring of environmental parameters and settlement is occurring monthly.

Reem Musleh (MSU) uses gas chromatography to measure the volatile organic acids in leachate samples.

Data from the site will start to become available early next year. However, monitoring of the bioreactor cell will be a long-term project (i.e., seven to ten years) and should provide data to answer some of the basic questions about this technology.

The bioreactor project has the potential to save landfill owners/operators significant amounts of money because of increases in available air space, shorter post-closure care periods, elimination of leachate treatment costs, and ability to accept liquid wastes. In addition, the project is providing a valuable educational experience to the participating graduate students from MSU who will be the waste management professionals of the future.

For more detailed information about this bioreactor landfill project, go to www.erefdn.org/bioreactorswana2003paper.pdf

For further information on the Foundation's other projects, visit us at www.erefdn.org or call 703-299-5139 x11.