# Active Municipal Waste Landfill Operation: A Biochemical Reactor

by

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## Abstract

The practice of landfilling of solid waste has evolved to produce a complex engineered facility. So-called advances in the design and operation of the modern landfill have resulted in a tendency to place waste material in a water-tight vessel, creating an environment which inhibits waste degradation. Under proper conditions, the rate of municipal solid waste biodegradation in a landfill can be stimulated and enhanced. Environmental conditions which most significantly impact biodegradation include pH, temperature, nutrients, absence of toxins, moisture content, particle size, and oxidation-reduction potential. One of the most critical parameters to MSW biodegradation has been found to be moisture content. Moisture content can be most practically controlled via leachate recirculation. Leachate recirculation provides a means of optimizing environmental conditions within the landfill providing enhanced stabilization of landfill contents as well as treatment of moisture moving through the fill.

Laboratory and pilot-scale studies have shown that moisture control permits rapid stabilization of waste, enhanced gas production, and improved leachate quality; reducing long-term environmental consequences and liability of waste storage and improving the economics of landfilling. Several dozen landfills have initiated efforts to recirculate leachate and full-scale documentation of the efficiency of this practice is now becoming possible.

This document describes experiences with bioreactor landfill operations from laboratory to full-scale. Studies which document the impact of bioreactor operation have been provided and operating and design criteria based on state-of-the-art facilities are described.



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## Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce envcironmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and ground water; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and ;made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

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## List of Abbreviations

| | |
|---|---|
| AA | -- acetic acid |
| BOP | -- biological methane potential |
| BOD | -- biochemical oxygen demand |
| C | -- Celsius |
| COD | -- chemical oxygen demand |
| CSWMA | -- Coastal Solid Waste Management Authority |
| CSWMC | -- Central Solid Waste Management Center |
| d | -- day |
| DSWA | -- Delaware Solid Waste Authority |
| ft | -- feet |
| ha | -- hectare |
| kg | -- kilograms |
| l | -- liters |
| lbs | -- pounds |
| LFG | -- landfill gas |
| lpm | -- liters per minute |
| m | -- meters |
| MSW | -- municipal solid waste |
| NA | -- data not available |
| NYSERDA | -- New York State Energy Research and Development Authority |
| SC | -- specific conductivity |
| SUTRA | -- Saturated and Unsaturated Transport |
| TDS | -- total dissolved solids |
| TOC | -- total organic carbon |
| tpd | -- tons per day |
| TPD | -- metric tons per day |
| TS | -- total solids |
| TSS | -- total suspended solids |
| TVA | -- total volatile organics |
| TVS | -- total volatile solids |
| USGS | -- United States Geological Service |
| USEPA | -- United States Environmental Protection AGency |

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