Bioreactor Landfills

Municipal solid waste landfills that utilize bulk liquids in an effort to accelerate the degradation of solid waste.
Historical View of Bioreactor Landfill Technology

- US EPA sponsored research as early as 1974
- Preamble to Subtitle D regulations points to some of the benefits of moisture addition
- Uncertainty about long-term performance of MSW containment systems hindered full scale operations

Bioreactor Landfills

- Bioreactor RD&D Rule allows approved states to issue variances for the introduction of bulk liquid waste and air to MSW landfills
- Liquid introduction in landfills with alternate liner systems (other than composite liners)
Bioreactor Landfill Design

- Foundations
- Liner systems
- Leachate collection systems
- Stormwater control systems
- Slope stability considerations
- Leachate management systems
- Gas extraction systems
- Capping and closure
NRMRL’s Research

- EPA ORD, OSW and LMOP CRADA with
  - Waste Management
  - Polk County Fl,
- Effects of Industrial Liquid and Various Sludge addition;
  - Bench-scale tests (modified BMP);
  - Lysimeter studies;
    - Lysimeters are currently being constructed;
    - Studies should start late 2006 early 2007;
- Design Criteria for Bioreactor Landfills;
- Bioreactor Landfill State of the Practice;
  - Project XL as well as few other bioreactor landfills.

Benefits of Bioreactor Landfills
Leachate Treatment and Management

- Leachate from active or closed cell reintroduction into bioreactor landfill cells offers an economical disposal method
Direct Wetting of Solid Waste

- Leachate can be sprayed or pumped onto the waste as it is tipped and compacted.
- Provides good means of moisture distribution.
- Potential concerns:
  - Working conditions
  - Exposure to workers
  - Runoff
Enhancement of MSW Stabilization Rate

- Moisture in the solid waste mass
  - Facilitates the movement of nutrients
  - Medium for Microbial growth
  - Acts as a seed
- Thus increasing the rate of decomposition and ultimately the stabilization rate.

Control Cells

As-Built Bioreactor Cell A
Control Cells  

As-Built Bioreactor Cell A
Increase in Landfill Gas Generation Rate

- Increase in the rate of decomposition leads to an increase in the methane and carbon dioxide generation rate
- Potential gas to energy if gas collected efficiently

Organic Matter + H₂O \Rightarrow CH₄ + CO₂

Gas Generation is Enhanced

![Graph showing gas generation over time for bioreactor landfill and traditional landfill.](image-url)
Traditional Gas Collection Systems at Landfills

- Vertical gas wells are most common method of gas collection.
Increase in Landfill Capacity (Settlement)

- Increase in the settlement rate
  - Primary settlement caused by the added weight of the liquids
  - Secondary settlement caused by the increase in the rate of organic degradation of organic matter

* Some may be lost through leachate disposal if not recirculated
Potential Long-Term Risk Reduction

• Controlled short term decomposition rather than persistent long term emission
Economics

- Increase landfill capacity
- Industrial liquids
- Leachate treatment
- Potential reduction in post closure care (PCC)
- Gas to Energy

Concerns About Bioreactor Landfills
Operational Concerns

- Increase in leachate break outs
- Increase in odor
- Increase in the potential of standing water
- Fires in aerobic systems
- Record Keeping

Design Concerns

- Slope stability
  - The increase of moisture content and the concurrent increase in gas generation may result in an increase in pore water pressure
  - High pore water pressure may lead to slope failure
- Perched liquids within the landfill
- Head on the liner
- Differential settlement
- Watering out of gas collection lines
Gas Emission

- If not collected efficiently, the increase in LFG generation rate may result in an increase surface emissions of
  - CH4
  - CO2
  - NMOC
Conclusion

• Increase in rate of degradation provides a more economical source of green energy (methane and possibly hydrogen)
• Reduce long term risk associated with MSW landfills
• Maximizes utilization of land footprint for landfilling
• Bioreactor landfills may offer a sustainable solution for long term solid waste management

Questions?

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