

**BIOREACTOR LANDFILLS:
AN INNOVATIVE TECHNOLOGY
FOR SUSTAINABLE MANAGEMENT
OF SOLID WASTE**

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Bioreactor Landfills

- Municipal solid waste landfills that utilize bulk liquids in an effort to accelerate the degradation of solid waste.
- With proper design and operations bioreactor landfills offer a sustainable technology for solid waste disposal.

EPA's ORD proposed the following definition:

- “A landfill designed and operated in a controlled manner with purpose of accelerating the degradation of MSW inside a landfill containment system.”

Leachate Treatment and Management

- Leachate from active or closed cell reintroduction into bioreactor landfill cells offers an economical disposal method

Increase in 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.

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



Potential Long-Term Risk Reduction

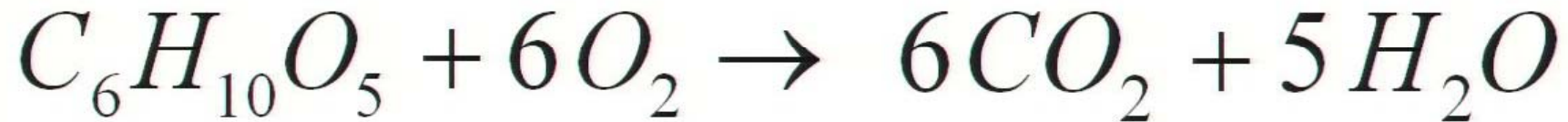
- Controlled short term decomposition rather than persistent long term emission

Microbial Processes

- Aerobic
- Anaerobic

Waste Stabilization

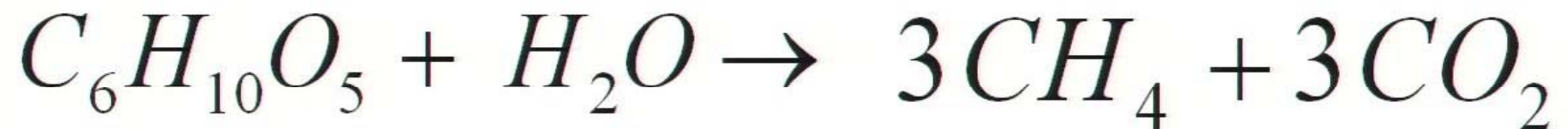
- Aerobic waste biodegradation
 - Consider 1 molecule of cellulose



- The end-products are carbon dioxide (CO₂) and water (H₂O)

Waste Stabilization

- Anaerobic waste biodegradation
 - Consider 1 molecule of cellulose



- The end-products are methane (CH₄) and carbon dioxide (CO₂)

Enhancing Waste Stabilization

- Several enhancement techniques may be used to accelerate the waste stabilization process.
 - The addition of moisture is the most common
 - The addition of air promotes rapid stabilization and has been practiced at some landfills
 - Other enhancements techniques may also play a role – nutrients, etc.

Enhancing Waste Stabilization

Possible Sources of Liquids

- Leachate
- Wet wastes
 - Biosolids
 - Sludges
- Wastewater
 - Domestic
 - Industrial

Recirculation Amounts

- How much to recirculate:
 - Initial moisture content: 15-25% (wet wt)
 - Field capacity: 35-45% (wet wt)
- An increase from 20% to 35% in moisture content requires:
 - 55 gallons per ton

Liquids Addition Methods

- How do you get the liquids in?
- Leachate recirculation systems
 - Surface System *vs.* Subsurface Systems
 - Retrofit *vs.* As-built

Focus on Two Subsurface Methods

- Horizontal Trenches
 - Shallow systems
 - Deep systems
- Vertical Injection Walls
 - Large diameter systems
 - Small diameter systems

Materials of Constructions

- Preferred piping material is HDPE
- Typical pipe size is 3 to 4 inches (perhaps larger if gas collection is desired)
- Typical trench width is 3 to 5 feet.
- Typical hole diameter ($3/8 - 3/4$ inch)
- Bedding materials:
 - Chipped tires
 - Stone
 - Other? (crushed brick, crushed glass)
 - None?

Vertical Injection Wells

- Two major types
 - Large diameter wells
 - Small diameter wells
- Many of the early leachate recirculation attempts used large diameter wells.
- Most new designs use small diameter wells

Options for Collecting Gas in Bioreactors

1. Use leachate collection system
2. Let the cap serve as a primary gas collector
3. Smart use of leachate recirculation devices

Design Considerations

- The landfill should be designed from the beginning with the idea of collecting gas from the leachate collection system

Review of Bioreactor Landfill Design Elements

- Foundations
- Liner systems
- Leachate collection systems
- Stormwater control systems
- Slope stability considerations
- Leachate management systems
- Gas extraction systems
- Capping and closure
- Leachate recirculation system

Monitoring Parameters

- Physical parameters
 - Geotechnical considerations
 - Head on liner
 - Mass balance
 - Moisture balance
- Analytical monitoring parameters
 - Leachate
 - Solids
 - Gas
- Industrial liquid addition criteria

Conclusion

- Bioreactor Landfills may offer a sustainable solution for long-term solid waste management

Questions?