Leachate Recirculation and Biogas Collection Methodologies in Bioreactors

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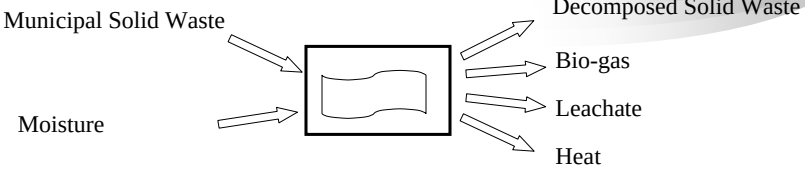
1

INPUT

OUTPUT



2

Leachate Recirculation Attributes

- Leachate quality becomes uniform over time
- Traditional leachate treatment postponed
- Heavy metal concentrations reduced over time
- Settlement rates accelerated
- Settlement enhanced
- LFG production enhanced in both quality and quantity

3

- Leachate Recirculation Concerns:
  - Bioreactor increases the complexity of analysis dictating a need for better information
  - Instrumentation - moisture distribution, moisture control, decomposition indicators
  - Increases slope stability concerns
  - Potential for leachate breakout

4

Leachate Generation

- Begins with the placement of waste and does not cease until well after closure
- About 50% of the moisture infiltrating a landfill is not absorbed by the waste

5

Properties Affecting Hydraulic Conductivity

- Leachate properties
  - kinematic viscosity
  - density
- MSW properties
  - moisture content
  - degree of biodegradation
  - composition
  - compaction
  - depth within the landfill
  - degree of processing
  - landfill age

6

Biogas Collection Issues

- Must reflect from outset, the considerable quantities of biogas which will be developed
- Relying upon the collection system when it is most capable

7

Landfill Gas

- Odors/potential carcinogens
- Explosion, asphyxiation and toxicity hazards
- Release of greenhouse gases
- Adverse effects on local air quality

8

Gas Collection Effectiveness in Bioreactors

- Significantly higher rates of gas production
- Require significantly higher gas collection capabilities
- Not uncommon for gas trenches and wells to accumulate liquid

9

Issues with Gas Collection

- Air intrusion through point of entry into the bioreactor - an ongoing issue
- Care needed regarding bottom/dragdown effect on bioreactor equipment
- Must avoid providing a conduit for transfer of leachate vertically through the refuse

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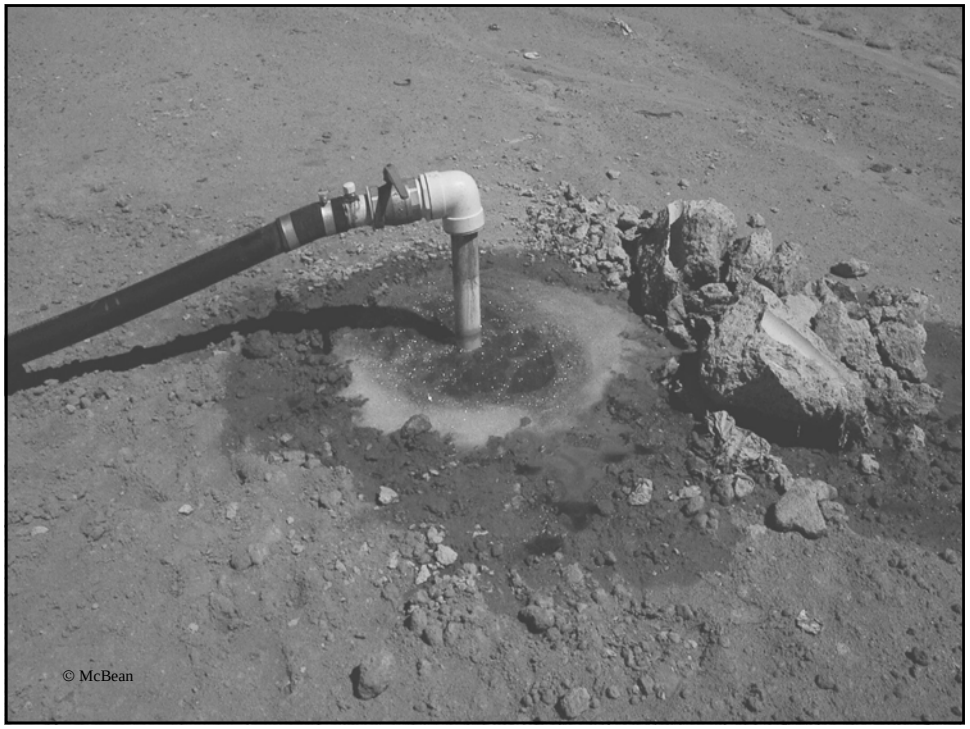


Gas Collection Methodologies

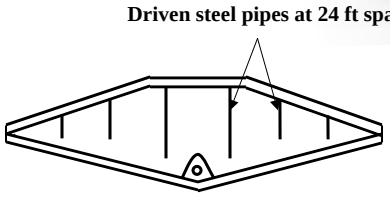
- Collection methodologies include:
  - Drive point wells
  - Drilled extraction wells
  - Horizontal gas collection wells

12

Drive Point Extraction Wells

- 50 mm iron pipe, no granular
- Modest radius of influence of collection (e.g. 4 m)
- Examples of installation Hagby, Sweden; Grudziadz, Poland; Getlini, Latvia

13



Mechanism of Gas Collection

14

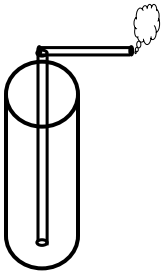
Concerns with Drive Point Methodology

- Tightening required around surface to prevent air intrusion
- Vertical migration opportunity for leachate
- Subsidence and proximity of perforations to surface
- Dragdown and possible puncture of bottom liner
- Plastics “wrapping” around well column during installation, thereby intefering with biogas collection

15

Drilled Extraction Wells

- Similar to traditional landfill gas extraction wells - drilled, surrounded by granular
- Implementation possible after placement of wastes is completed
- Shortcircuiting of leachate being recirculated



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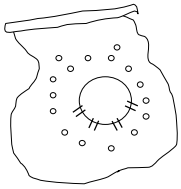
Horizontal Gas Collection Wells

- Concern with ingress of fines
- Can be added during development of biocell and/or after cell virtually completed
- Concern with filling with condensate and/or recirculated leachate



17

Horizontal Gas Collection Wells

- Pipe strength and materials and maintaining of integrity
- Transmissivity of bedding system
- Perforation pattern and spacing

18

Condensate Management in Biogas Collection System

- An absolutely major issue - surging, blockage, “gumming up”

19

- Uncertainty in gas - very moist waste (approaching field capacity) may produce gas at rates that are more than double the rate of production from dry wastes, all other factors being equal

20

Part II: Leachate Recirculation Issues

21

Leachate Recirculation

- Objectives
  - Elevate moisture levels in refuse to maximize degradation rate
  - Introduce moisture, microorganisms and nutrients
  - Considerations must include leachate collection methodology to be employed

22

Recirculation provides

- Opportunities for pH buffering, nutrient addition, moisture additions

  (optimum pH 6.8-7.2)

  young leachates pH<6.5
- To accelerate decomposition (little if <20%, maximum at > 40%)

23

Purposes of Moisture Introduction

- Leachate recirculation has long been known to enhance biodegradation because
  - increases in situ moisture content accelerate decomposition,
  - maintains moisture flow through the waste,
  - improves the distribution of microbes and nutrients in the waste stream
  - organics introduction
  - bacterial seeding
  - pH buffering
  - nutrient content

24

Moisture Addition Can be Accomplished by:

- Recirculation of leachate
- The addition of water
- The addition of other, bulk liquids

25

Major consideration:

- Difference between bioreactors and leachate recirculation landfills
- Bioreactors increase the complexity, dictating need for better information (moisture distribution, moisture control and decomposition indicators)

26

Concerns During Recirculation, for Bioreactor Performance

- Must ensure the recirculation elements are not entry points for air intrusion
- Evenness of injection essential for success
- Odor prevention
- Freezing in winter
- Cost
- Accessibility of the controls
- Hydraulic blocking problems

27

Alternatives for Leachate Recirculation

- A number exist – surface and subsurface; retrofit as opposed to as-builts
- Most appropriate is dependent on size of bioreactor
- Pre-cap versus post-cap

28

Surface Application Methods

- Constrains waste disposal operations
- Nuisance odors
- Health and safety concerns
- Limited amount of liquid that can be introduced
- Unevenness of introduced moisture

29

Infiltration Ponds

- Many of the problems of surface application methods
  - Odors
  - Spatially limited/Unevenness of moisture introduction
  - Reasonable experience at this approach

30

31

Vertical Injection Wells

- Examples include:
  - 2 inch diameter steel rods, perforated over bottom 2 ft
  - 12 ft wells used by DSWA, filled with baseball-sized granular
- Individual delivery points for recirculated leachate
- Injection under pressure

33

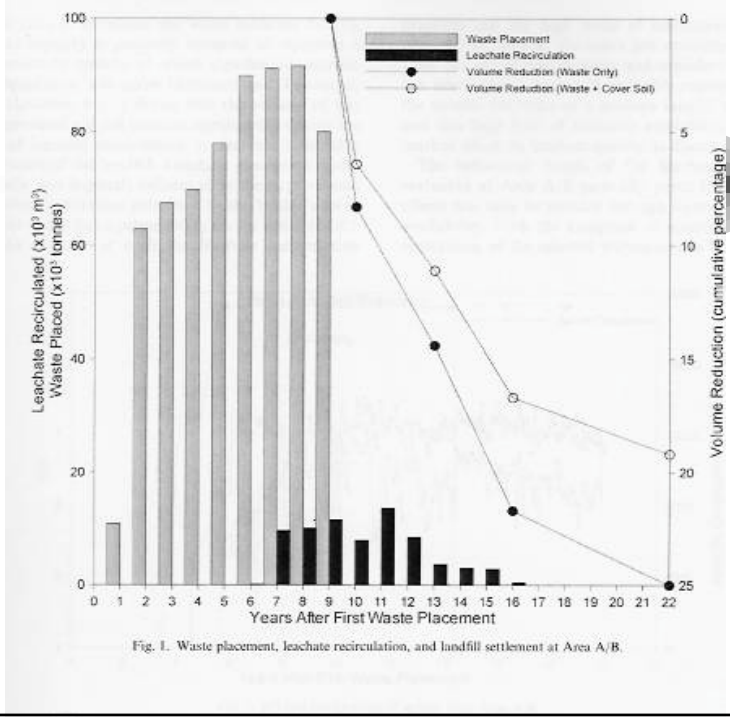


Fig. 1. Waste placement, leachate recirculation, and landfill settlement at Area A/B.

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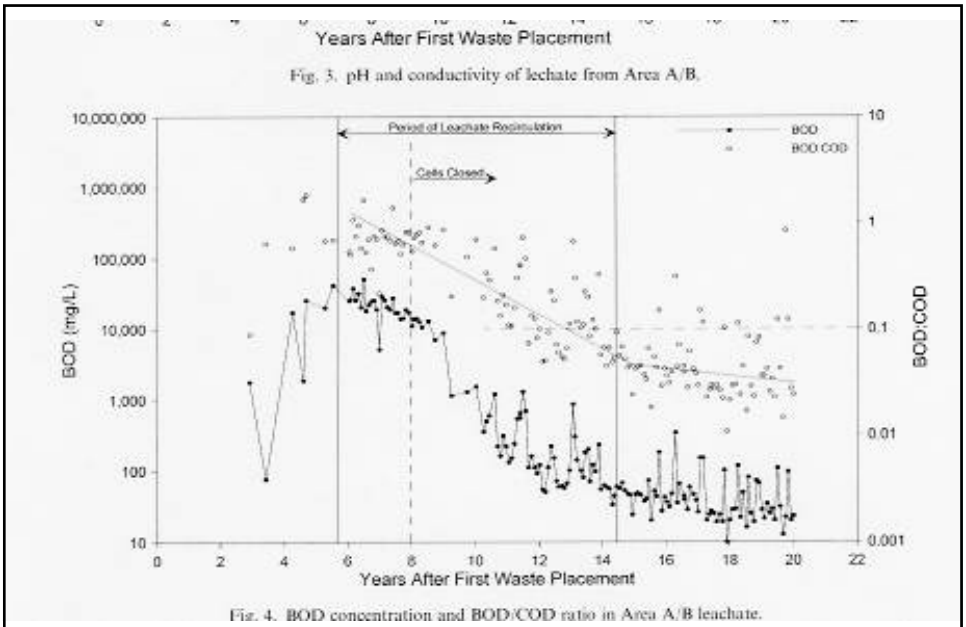
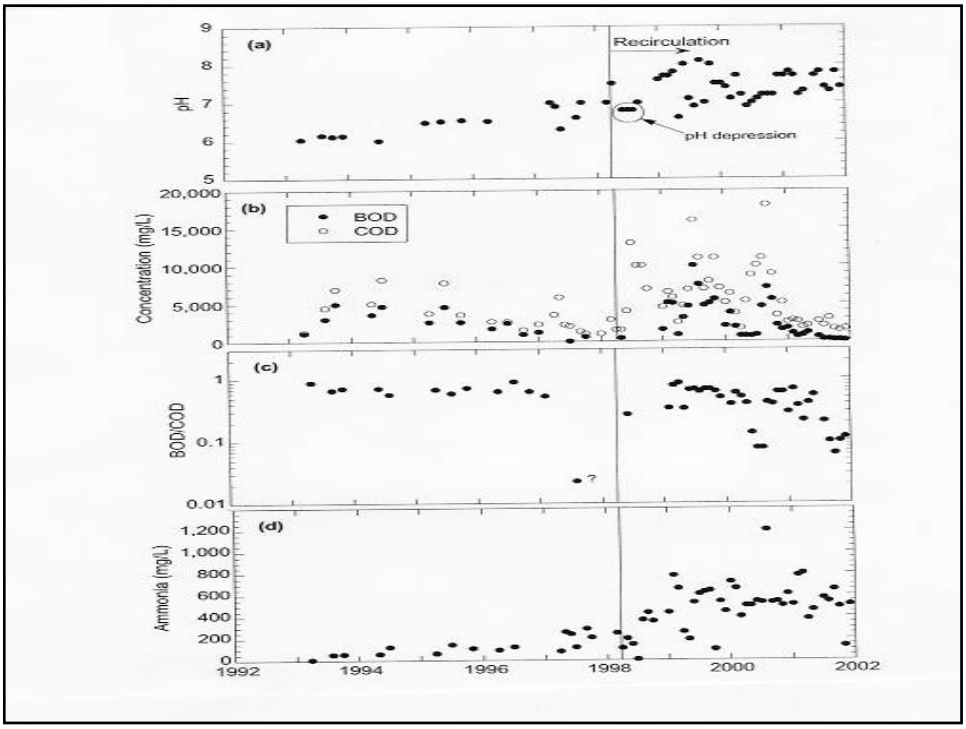
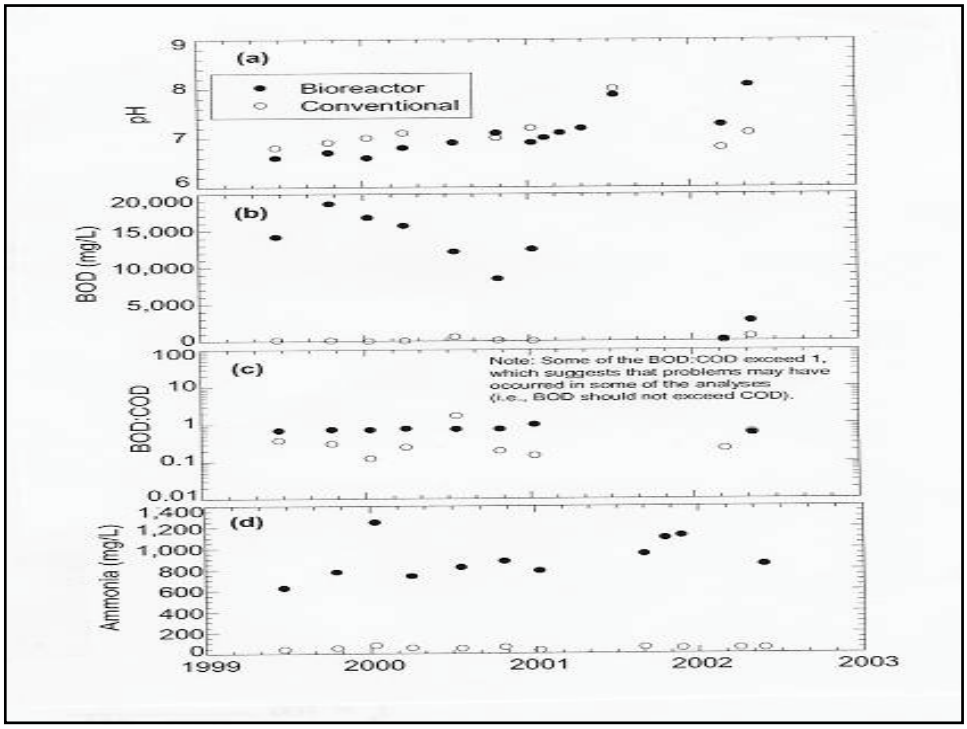


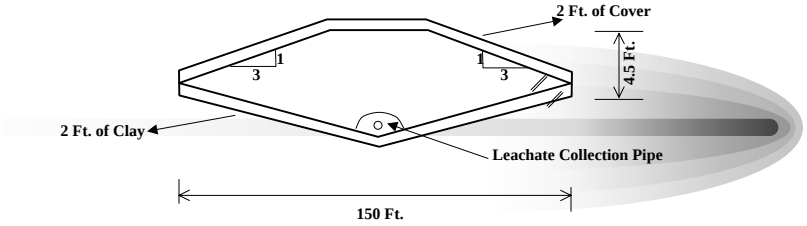
Fig. 3. pH and conductivity of leachate from Area A/B.

Fig. 4. BOD concentration and BOD/COD ratio in Area A/B leachate.

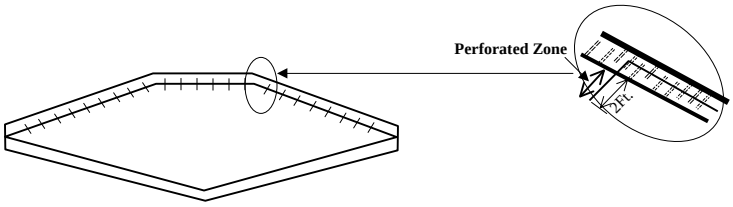
35







Cross-section of Bioreactor, Latvia



Mechanism of Leachate Injection, Latvia

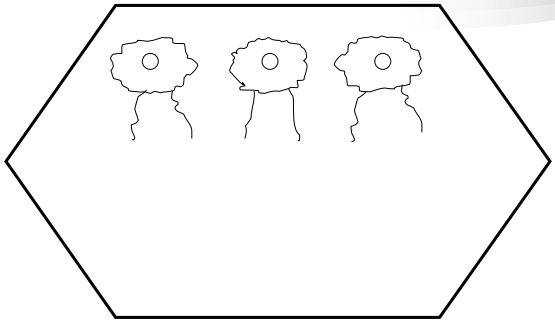
38

Vertical Injection Points

- Concerns
  - Doesn't take much to freeze &/or clog
  - Monitoring to get even injection - individual controls that are accessible
  - Clear PE - if no UV protection, may fail
  - If too long, tendency is for leachate to find some easy route to the bottom of the biocell
  - Adjustments are difficult because of number of locations

39

Infiltration Pipe Galleries



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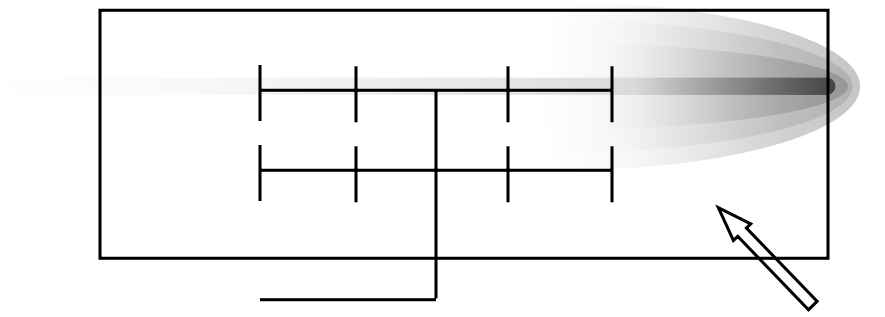
Infiltration Pipe Galleries

- Higher costs but are effective at delivering higher quantities of liquid
- Can be negatively influenced by settlement
- Uncertainty regarding pipe spacing & lengths, pipe perforation patterns and bedding materials
- Can be gravity drainage trenches

41

Horizontal Pipes Per Dendritic Drainage Pattern

42



Dendritic Pattern for Leachate Recirculation

43

Horizontal Injection Pipes in Dendritic Pattern

- Better distributional pattern but harder to control where the recirculated leachate is actually entering the refuse
- Greater tendency for failure post-closure than for horizontal pipe galleries

44

Alternatives for Leachate Recirculation Methods to Energy Cells

- Surface spray application systems
  - spray irrigation at the waste tipping face
  - Tanker truck
- Drip irrigation
- Infiltration ponds
- Individual vertical injection wells
- Horizontal injection galleries
- Horizontal injection pipes in dendritic pattern

45

Capillary Wicking Layers

- Applied as a daily cover (to overcome the potential for channeled flow of leachate through the waste)
- Improves overall moisture dispersal
- Examples e.g. pulp sludges

46

- Some bioreactors are highly stratified
- High lateral hydraulic conductivity as compared to vertical conductivity
- Influenced by degree of waste compaction

47

The Leachate Recirculation Operations Plan should include

- Both application and rest periods
- a monitoring plan which includes recording, precipitation, application rate, total leachate applied

48

Elapsed Time for Generation of LFG -Effect of Bioreactor Acceleration

	Conventional Landfilling (years)	Bioreactor Landfilling (years)
Time to get 50% of LFG generated	28.8	1.3
Time to get 95 % of LFG generated	125	5.8

49

- Questions?

50