Permeable Layers to Improve Landfill Gas Recovery from Indian Landfills

March 3, 2010

Don Augenstien\textsuperscript{1}
Ramin Yazdani\textsuperscript{2}
Chetan Zaveri\textsuperscript{3}
John Benemann\textsuperscript{1}

\textsuperscript{1} Institute for Environmental Management Inc., 4277 Pomona Avenue, Palo Alto, California, U.S.A.
\textsuperscript{2} Yolo County Planning and Public Works Department, Division of Integrated Waste Management, Yolo County, California, U.S.A.
\textsuperscript{3} IL&FS Ecosmart Ltd, Mumbai, India
Presentation

- Introduction
- Description of permeable layer approach and benefits
- Current Project objectives
- The site selection
- Future plans
Typical Landfill and Gas Collection

- Current landfill gas collection technology
  - Fill waste and cover with soil
  - Drill vertical well
  - Install gas wells and collect gas
  - Adjust gas wells weekly to maximize methane content
Typical Landfill Gas Collection

- Limitation with current methods
  - No soil cover and waste placement is haphazard
  - Poor gas quality due to air entrainment
  - Staff needed for constant well adjustment
  - Vertical well could be waterlogged
Simplified schematic of conventional LFG well and gas flow: Illustration of typical problem – irregular surface flux

Arrows and lengths denote gas flows or fluxes. Note variable surface fluxes and emissions distant from well, entrainment near well, inefficient collection. Fissures, irregularities in waste/cover exacerbate problems.
PERMEABLE LAYER TO IMPROVE LFG COLLECTION

Simplified illustration: Subsurface probes to track and control LFG recovery.

- SAMPLING TUBES to conducting layer and cover
- Extraction line—LFG to use
- SURFACE SOIL COVER
- Low permeability layers—membrane and/or WASTE (thickness ca. 1-2 meters)
- More landfill---extends on
- WASTE
- Permeable layer LFG — shredded tires, chips etc
- LFG entrainment area here
- WASTE
- Deep well ca, 10-20M feet deep
- 100 ft (30M) from surface to base layers
Barometric pressure – blue, right hand axis
Permeable layer methane dark blue -- left hand axis
Cover layer methane (2) brown and yellow -- left axis
Permeable Layer Gas Well Benefit

Without permeable layer

With permeable layer

Oxygen intrusion

Pumping well

Tire layer
Results of finite element analysis

- Pumping rate

![Graph showing CH₄ emission through top biocover (%) vs. Pumping rate based on the total LFG generation rate (%). The graph includes lines for different scenarios: With tire layer-CH₄ emission at $K_{st}$, Without tire layer-CH₄ emission at $K_{st}$, With tire layer-CH₄ emission at $K=K_{st}/10$, and Without tire layer-CH₄ emission at $K=K_{st}/10$. The graph highlights the comparison between with and without tire layers.]
Summary of Benefits

- Recover methane gas for power
- Reduce current fugitive methane emissions
- Revenue generated from power generation
- Revenue generated from carbon credits
- Reduce typical number of gas wells per acre
- Reduce labor cost for gas well monitoring
Application in USA: Placement of Permeable Layer Over Waste
VIEW OF ONE ACRE SHRED TIRE LAYER
SHRED TIRE PERMEABLE LAYER BEING PLACED

WASTE LAYERS
USA: Waste Placement Over Permeable Layer
Soil Cover and Gas Collection
Piping Installation
Gas Well Installation and Data Collection and Evaluation
Project Objectives in India

- Visit sites
- Select best site for a demonstration project
- Develop a preliminary design
- Perform feasibility study
- Report to EPA Methane to Markets
Site Visit and Selection Criteria

- Selection criteria for sites
  - Adequate organic waste flow (>1,000 tons per day)
  - Waste height (>15 meters)
  - Available permeable material for use
  - Available soil cover on site
  - Available equipment and personnel
  - Agency cooperation, assistant, and technical knowledge
  - Site security for future demonstration project
  - Power generation potential on-site
IL&FS Ecosmart, located in East Mumbai, India. Technical expertise and numerous contacts in India’s municipal waste industry were of inestimable value in conducting the project

3 India Trips

November 2008 – Chennai
January 2009 – Multiple sites
January 2010 – Mumbai – 3 sites
SUMMARY OF SITES EVALUATED

Trip 1 November 2008 (Benemann)
Chennai -- Kodungaiyur

Trip 2 January 2009 (Yazdani, Zaveri)
New Delhi -- Okhla
New Delhi -- Balsawa
New Delhi -- Gazipur
Agra -- Shahdara
Perungudi -- Chennai
Vellakal -- Madurai TN
Betahalli Bangalore
Vidyaranyapuram Mysore
(City) Hubli Dharwad Karnataka
Hyderabad

Trip 3 January 2010 Mumbai (Augenstei, Yazdani, Zaveri, Augenstein)

Mulund
Kalyan Dombivali
Ulhasnagar
OFFICIALS MET: 3 MUMBAI SITES:

1. Mulund, Mumbai

Mr. R. A. Rajeev, IAS, Additional Municipal Commissioner
Mr. B.P. Patil, Chief engineer (SWM), In-charge (and Dy. Ch. Engineer (SWM) Projects) [He holds 2 positions]
Mr. P.S. Awate, Executive Engineer, SWM Project
Mr. Phalari, Executive Engineer, SWM Project
Mr. Machewad, Sub-Engineer, SWM Project
Mr. Desai, Asst. Engineer, SWM Project

2. Kalyan Dombivali, Mumbai

Mr. Pramod Narkhade, Sanitary Inspector
Mr. Sulakhe, APHO
Mr. Shiju Jacob, Antony Waste Handling Cell (P) Ltd.

3. Ulhasnagar, Mumbai

Mr. Mhatre
Mr. Shiju Jacob, Antony Waste Handling Cell (P) Ltd.
Mulund Site Findings

- Adequate waste and height
- Potential permeable layer and cover soil available!
- Needed equipment available
- Agency cooperation and interest
- Potential future power generation facility from methane
- Site can be secured to prevent damage to pipes and equipment
Mulund Site Findings--cont

- Future capacity and operation assured.
- Footprint for testing can be available
- Onsite technical personnel for vessel methane digester can do gas sampling
- Needed equipment available
- Ability to collaborate with IL&FS Ecosmart
Example of Mulund Data: Waste Analysis (IL&FS Ecosmart, Mumbai, India)

**Table 1: Average Characteristics of MSW Reaching the Mulund Disposal Site**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Parameter</th>
<th>Avg. 7 Days (3 Shifts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Vehicles Sampled</td>
<td>11</td>
</tr>
<tr>
<td>b</td>
<td>Weight of Sample collected for Physical Analysis (Kg)</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td><strong>A. Physical Characteristics (% of total weight)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Wet organic Material (above 1 sq. inch mesh)</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Kitchen waste</td>
<td>39.24</td>
</tr>
<tr>
<td>b</td>
<td>Fruit waste</td>
<td>8.33</td>
</tr>
<tr>
<td>c</td>
<td>Flower waste</td>
<td>0.14</td>
</tr>
<tr>
<td>d</td>
<td>Green grass</td>
<td>0.62</td>
</tr>
<tr>
<td>e</td>
<td>Animal Excreta</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>Wet organic Material (below 1 sq. inch mesh)</td>
<td>3.79</td>
</tr>
<tr>
<td>3</td>
<td>Total Wet Organic Material</td>
<td>52.12</td>
</tr>
<tr>
<td>4</td>
<td>Dry organic material</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Dry grass</td>
<td>9.10</td>
</tr>
<tr>
<td>b</td>
<td>Dry tree remaining</td>
<td>0.48</td>
</tr>
<tr>
<td>c</td>
<td>Cotton waste</td>
<td>2.48</td>
</tr>
<tr>
<td>d</td>
<td>Wood Chips</td>
<td>0.33</td>
</tr>
<tr>
<td>e</td>
<td>Wooden furniture waste</td>
<td>0.62</td>
</tr>
<tr>
<td>5</td>
<td>Total Dry Organic Material</td>
<td>13.01</td>
</tr>
<tr>
<td>6</td>
<td>Recyclable Materials</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Plastic</td>
<td>10.14</td>
</tr>
<tr>
<td>b</td>
<td>Paper</td>
<td>7.52</td>
</tr>
<tr>
<td>c</td>
<td>Cardboard</td>
<td>0.00</td>
</tr>
<tr>
<td>e</td>
<td>Thermocol</td>
<td>0.19</td>
</tr>
<tr>
<td>f</td>
<td>Glass</td>
<td>0.71</td>
</tr>
<tr>
<td>g</td>
<td>Rubber</td>
<td>0.52</td>
</tr>
<tr>
<td>h</td>
<td>Leather</td>
<td>0.67</td>
</tr>
<tr>
<td>i</td>
<td>Metals</td>
<td>0.19</td>
</tr>
<tr>
<td>7</td>
<td>Total Recyclable Material</td>
<td>19.94</td>
</tr>
<tr>
<td>8</td>
<td>Inert</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Sand and Silt</td>
<td>11.64</td>
</tr>
<tr>
<td>b</td>
<td>Stone</td>
<td>0.81</td>
</tr>
<tr>
<td>c</td>
<td>Bricks</td>
<td>2.48</td>
</tr>
</tbody>
</table>
**SIMPLE TEST AREA CONFIGURATION**

**Side view of permeable sub-area**

<table>
<thead>
<tr>
<th>Sample lines/points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth</th>
<th>Low permeability</th>
<th>Surface (waste?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-200 cm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Permeable layer**

- **30-60 cm thickness**

**WELL CONFIGURATION IN SUB-AREA**

- Extraction locus depth
  - Preferably 10-30% of sub-area edge length

- Wellhead depth = 50-90% distance to landfill bottom

**WASTE**

- Gas flow (typ)
Site Challenges

- **Issues:**
  - Waste fires frequent (but usually small)
  - Air intrusion could be an issue
  - Leachate seeps
Addressing Site Challenges

Potential Solutions:

- Add cover soil and compact to stop fire
- Construct test cell away from the side slopes
- Pump leachate from the perimeter ditches and inject near top and side slopes to stop fire and eliminate leachate runoff from site
Future Plans

- Explore support for construction and operation of a demonstration project
- Construct and monitor project
- Expand project to other sites (India and worldwide)
Questions and Answers?

Thank you for your attention