"INOGATE Technical Secretariat & Integrated Programme in support of the Baku Initiative and the Eastern Partnership energy objectives" Project
Training Presentation 2
Introduction to Safety at Landfill Sites

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Hazard of Landfill Gas

- Flammability and Explosivity
- Asphyxiation
- Toxicity
- Corrosion
- Odour
- Ecotoxicity
- Global Warming Potential
Flammability and Explosivity

• Methane is a flammable gas with a calorific value of 35.9MJ/m³.

• Explosive Limits of LFG

  – Lower explosive limit (LEL) = 4.4% CH₄
    • Lower – not explosive in air

  – Upper explosive limit (UEL) = 16.5% CH₄
    • >15 %, too rich to be explosive in air
LANDFILL GAS

Explosion Limits

Methane Concentration
Physiological effects of Asphyxiation

<table>
<thead>
<tr>
<th>Concentration of Oxygen (%)</th>
<th>Physiological Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Blood saturation adequate for resting, walking and heavy work</td>
</tr>
<tr>
<td>17</td>
<td>Faster, deeper breathing, slight impairment of judgement</td>
</tr>
<tr>
<td>16</td>
<td>First signs of anoxia. Dizziness, buzzing in ears</td>
</tr>
<tr>
<td>12-16</td>
<td>Increased breathing and pulse rate. Muscular co-ordination impaired</td>
</tr>
<tr>
<td>10-14</td>
<td>Emotional upset. Abnormal fatigue upon exertion</td>
</tr>
<tr>
<td>6-10</td>
<td>Nausea, vomiting unconsciousness. Collapse may reoccur with person unable to move or cry out</td>
</tr>
<tr>
<td>&lt;6</td>
<td>Convulsions, gasping respiration, death</td>
</tr>
</tbody>
</table>
# LANDFILL GAS

**Physiological effects of respiration of Carbon Dioxide**

<table>
<thead>
<tr>
<th>Concentration of Carbon Dioxide (%)</th>
<th>Physiological Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>None, normal atmospheric concentration</td>
</tr>
<tr>
<td>0.5</td>
<td>Slightly deeper breathing</td>
</tr>
<tr>
<td>2.0</td>
<td>Lung ventilation increased by 50%</td>
</tr>
<tr>
<td>3.0</td>
<td>Lung ventilation doubled</td>
</tr>
<tr>
<td>5-10</td>
<td>Three-fold increase in rate of respiration. Rapid exhaustion and headaches</td>
</tr>
<tr>
<td>10-15</td>
<td>Intolerable panting. Severe headaches, collapse</td>
</tr>
<tr>
<td>25</td>
<td>Death</td>
</tr>
</tbody>
</table>
SAFETY AT LANDFILL SITES

GAS MEASUREMENT AT LANDFILL SITE

\[ \text{O}_2 = 5.5\% \Rightarrow \text{Death} \]

\[ \text{CO}_2 = 29.0\% \Rightarrow \text{Death} \]
SAFETY AT LANDFILL SITES

Corrosion

- Components of LFG and its derivatives have a corrosive potential.
- Corrosion accelerates wear on the plant and equipment, and reduces their effectiveness as control measures.
- Main culprit is carbon dioxide which will dissolve in water and form carbonic acid.
- Effective collection and combustion system is able to reduce the corrosion effects.
SAFETY AT LANDFILL SITES

**Odour**

- Odour from landfill causes local annoyance and is possibly the main reason for the number of complaints received by the operator.
- Presence of odour is often linked to concerns about the impact of LFG emissions on human health.
- Important odorants in LFG include:
  - Hydrogen sulphide $\text{H}_2\text{S}$;
  - Organosulphur compounds, e.g. Dimethyl sulphide;
  - Carboxylic acids, e.g. butanoic acid;
  - Aldehydes, e.g. ethanal;
  - Carbon disulphide.
SAFETY AT LANDFILL SITES

Ecotoxicity

- The lateral sub-surface migration of LFG can cause damage to vegetation on adjacent land and crop die-back. LFG can exert phytotoxic effects to plants.
Global Warming Potential

- Carbon dioxide, methane and a variety of halocarbons found in LFG are all greenhouse gases. They absorb infra-red radiation and produces thermal heat.
- Methane (CH\textsubscript{4}) is the second most important greenhouse gas after carbon dioxide, having an ability to cause damage as much as 22 times of carbon dioxide (CO\textsubscript{2}).
SAFETY AT LANDFILL SITES

TAKE NOTE THAT:

– LANDFILL GAS IS **HIGHLY FLAMMABLE!**
– **NO** LOITERING
– **NO** SMOKING
– **NO** NAKED FLAME
– WEAR PROTECTIVE GEAR
– **ALWAYS BE CAREFUL (ABC)**
SAFETY AT LANDFILL SITES
SAFETY AT LANDFILL SITES

Need for Landfill Gas Management

• Landfill Gas Management is essential and required to eliminate or at least minimise the hazards.
• Prevent the migration of and control of any release of landfill gas.
• Minimise the impact on local air quality.
• Minimise the contribution to climate change.
• Control the release of odorants.
• Minimise the risk of accidents.
• Prevent harm to human health.
During operation a compactor is very sufficient. The use of a compactor can increase the amount of waste capacity with up to 100%

The compactor has a strong steel plate in the bottom, which will protect the operator in case he hits a sharp object. Most compactors have a pressure cabin to avoid the operator to inhale toxic substances.

The first layer of waste must be at least 1.5 m thick and must be crushed and without major objects – to protect the liner system.

Depositing at embankment must always be started from the bottom – to avoid slides.
Personal hygiene is important. In the welfare building the following is preferable:

- Two clothes lockers for each employee. One for clean clothes and one for dirty clothes (working clothes)
- Sink with cleanser, liquid soap, disposable towels and skin care cream
- Shower rooms and toilets
- Work wear and protective equipment
- Canteen
LANDFILL OPERATION AND SAFETY

In modern landfills, wells will be part of the leachate collection system. While working in leachate wells, safety is important:

Risks:

- Toxic or explosive fumes
- Suffocation due to lack oxygen

Precautions:

- No open fire (No smoking)
- Always work in team. One on ground and one in well
- Man in well equipped with: cloves, helmet, breathing apparatus and safety line
- Before entering the well: Empty the well the day before, effective ventilation by blowing air into well, gas measurement to ensure ventilation is sufficient, continuously air blowing while working in well
Any Questions?

Thank you