Specific example of the use of the tandem mixer

Optimization of gas utilization through additional utilization of lean gas in a gas engine system at the Dreieich Buchschlag landfill

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1. Introduction

The environmental office of the city of Frankfurt am Main has commissioned Rytec GmbH with the operation of the landfill gas venting and gas utilization of the Dreieich-Buchschlag landfill. This landfill covers an area of approx. 40 hectares. About 15 million cubic meters of waste were dumped here between 1969 and 1991, including household waste, household-type industrial waste, construction waste and building site waste. The landfill is being decommissioned by decree of the Darmstadt city council dated February 1999.

2. Initial situation

The landfill has a conventional two-line gas collection system for rich-burn gas and lean gas. The gas engine systems are supplied with fuel gas from the rich-burn gas line. The average methane content in this case is between 48 and 50 percent. The average volume of good gas collected in 2012 was 250 Nm³/h. Gas wells are extracted via the lean gas line. Given the low methane content of these wells (between 30 to 40 percent), they must be treated by a flare plant. The average volume of bad gas collected in 2012 was 85 Nm³/h. Lean gas, characterized by methane levels under 40 Vol%, is drawn in by means of a blower and burned using a high-temperature flare on-site at the Dreieich-Buchschlag landfill. This lean gas combustion is to prevent gas emissions across the landfill surface, but this can be done only in weather conditions where the internal rock pressure is greater than or equal to the ambient air pressure. If the pressure conditions are reversed, the methane content is reduced and falls below the methane level of 30 Vol% required for flaring. Flaring is characterized by regular interruptions since the flare plant requires a minimum volume flow of approx. 700 m³/h because of design limitations. These interruptions go on until the conditions for a restart of the flare plant are in place again. Since the gas operation was converted to full electricity generation in 2002, there has been a desire to make good use of the
lean gas that was previously flared, instead of having to burn it without any economic or ecological benefits. We looked at the following alternatives before eventually opting for a retrofit with a tandem mixer:
- Use of a flox burner with heat extraction
- Use of a pilot ignition engine to generate electricity and heat
- Use of a tandem mixer for an existing gas engine system
It is now possible to convert to electricity low-caloric lean gases by means of ‘standard gas engines’ without any substantial alterations, thanks to the tandem mixer technology.

3. How does the tandem mixer work?

Green Gas Germany GmbH is headquartered in Meerbusch, Germany. The company has developed and patented its own technology that allows gases with methane levels below 40 Vol% to be utilized in gasoline engines. The tandem mixer developed for this purpose consists of two serially arranged gas mixers jointly regulated in a mechanically solid group. This arrangement enables the methane density to be increased while keeping the volume of combustion air constant. The engine controls do not need to be adjusted. Instead of being burned in flare systems, lean gas can now be utilized in gas engines, thanks to this system.
Scheme: Basic principal of tandem mixer (GreenGas Germany GmbH Meerbusch)

4. Concept for the landfill location at Dreieich-Buchschlag

In the future, the gas engine 5 (MWM TBG 616 V12) with an electrical capacity of 375 kW will utilize the lean gas. It is implemented using a DN 100 pipe connected to the lean gas line (delivery side compressor to the flare) to the existing rich-burn gas line via shut-off and/or control valves. The connection to the rich-burn gas line ensures better initial conditions by raising the methane concentration. An adjustment of the original gas control line from DN 65 to DN 100 had become necessary due to higher gas volumes. The authority approved operation of the existing gas engine with the tandem mixer according to our notice of change under Section 15(1) of the German Federal Pollution Control Act without any further conditions.

5. Resulting positive effects for the Dreieich-Buchschlag landfill

Lean gas utilization is ensured during periods of maintenance and repairs since the flare plant was retained. When gas utilization is paused for extended periods of time, the gas components become demixed. Then the lean gas can still be drained via the flare plant and burned until stable starting conditions can be ensured for the engine. In addition, the landfill gas can be extracted in a more gentle manner with smaller lean gas volumes (approx. 150 m³/h, instead of 700 m³/h). This allows the gas engine to be operated with as few interruptions as possible, provided that the rock pressure, as described above, is greater than or equal to the ambient air pressure. The use of the tandem mixer makes it possible over the long term to utilize the landfill gas, which used to be flared, for energy. The investments, essentially consisting of the pipe connection, a new gas control line and the adjustment of controls, will pay off for themselves in less than 1.5 years.

6. Project timeline for the Dreieich-Buchschlag landfill

Operation of plants (since 1992):
- Gas collection from 110 gas collection points
- Remoistening of the landfill Landfill gas utilization Gas treatment (since 1992)
- Gas transport to the Niederrad thermal power plant (1992–2002)
- Conversion of landfill gas to generate electricity (since 2002)
  Power generation: approx. 6,000 MWh/year
- Simultaneous flaring (since 2005)
- Power-up and power-down cascade (since 2007)
- Gas engine operation using a tandem mixer (2013)
- FID emission measurements, gas level monitoring

7. Results of the landfill operations in 2012 (still without lean gas utilization via tandem mixer)

<table>
<thead>
<tr>
<th>Utilization of extracted volume:</th>
<th>2.800.000 Nm³</th>
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</thead>
<tbody>
<tr>
<td>of which flare:</td>
<td>700.000 Nm³</td>
</tr>
<tr>
<td>Gas engines:</td>
<td>2.100.000 Nm³</td>
</tr>
<tr>
<td>Power input:</td>
<td>2.900.000 kWh</td>
</tr>
</tbody>
</table>

Control of rock pressure
Gas quality for gas engines: > 40% CH₄
Gas quality for torch: 30-40% CH₄

The gas engines start from an amount of CH₄ of 40% and increasing rock pressure.
The operation time of the torch is about 15% oft he hours within a year.

The gas decline per year has been between two and ten percent in recent years.