Managing Landfill Liquids to Maximize Landfill Gas Collection Efficiency

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Today’s Webinar Topics

• Benefits of a landfill gas collection & control system
• Typical landfill gas collection system & well components
• Landfill liquids characteristics (leachate & condensate)
• How liquids affect LFG collection system efficiency
• Economics of LFG well dewatering systems
• Monitoring liquid levels in LFG wells
• Air-powered Pumps for gas well dewatering
• Case history examples
• Question and answer session
**LFG Collection & Control System Benefits**

- Comply with federal, state & local air quality regulations
- Control odors from gas, minimize neighbor complaints
- Use LFG as a fuel to offset a fossil fuel source
- Generate electricity to sell to utility or end user (LFGTE)
- Collect carbon credits for destruction of gas (flare)
- Collect Investment Tax Credits or Production Tax Credits for renewable energy or fuel made from LFG
- Generate tradable credits for renewable energy generation or biofuel made from LFG
  - Renewable Energy Credits (RECs) for LFGTE plants
  - Renewable Identification Numbers (RINs) for alternative fuels

**Direct Use of LFG**

**Medium Btu Projects**

- LFG is used with **minimal treatment** to run boilers and kilns or heat buildings, replacing fossil fuels
  - Key is to find a potential user close enough to make pipeline cost pay off
- Gas can be used on site to evaporate leachate or liquid wastes
- Gas can be flared for carbon credits
  - Market for carbon credits has dropped sharply since 2009
  - In USA, future credits are lost if LFG collection is required by regulation
LFGTE Projects

- Revenue from sale of electricity to power grid or to an end user
- In USA, Renewable Portfolio Standards (RPS) are a major economic driver
  - Renewable Energy Certificates (RECs) can be worth more than electric power
  - Can still generate RECs even if LFG collection system becomes mandatory
- Gas pretreatment is often limited to removing moisture and particulate
- High siloxanes or hydrogen sulfide (H2S) level may require greater pretreatment
- **Air leaks into gas system**, typically not removed, can result in engine damage

High Grade LFG Uses

High Btu Projects

- High quality and high-Btu gas can be sold to utility pipeline or to an end user
- High Btu gas can also be used to make fuel – CNG, LNG, methanol feedstock
- Often requires **significant gas treatment** to remove O₂, N₂, H₂S, and siloxanes that can be very expensive ($1M or more), increasing gas production cost as much as 50% where O₂ or N₂ exceed requirements
- **Better field practices and well field maintenance can pay off** – it costs much less to prevent air leaks into collection system than to remove O₂ and N₂ later through gas treatment
Typical Landfill Gas Collection System

Typical Landfill Gas Well Components

- LFG Wellhead Flow Control Valve
- Gas Collection Header Pipe
- Annular Seal
- Perforated Pipe/Screen
- Rock or Gravel Backfill
**Landfill Liquids - Leachate**

*Liquids from precipitation, waste breakdown, and discarded liquids*

- Volume varies seasonally and regionally, often widely
- Elevated temperatures
- High levels of suspended and dissolved solids
- Foaming potential
- Viscosity greater than water
- Corrosives and aggressive organics
- Extreme pH at some sites

**Landfill Liquids - Condensate**

*Liquid that condenses from landfill gas in the collection system*

- Volume varies with gas flow and precipitation
- Moderate temperatures
- Lower solids than leachate
- Viscosity typically close to water
- Mostly water and organics, but can be more aggressive (H₂S, low pH)
- Potentially explosive environment (landfill gas)
Why Manage Landfill Liquids?

Leachate Collection & Recirculation
- Regulatory compliance (maximum head against liner)
- Minimize leakage, side slope seeps and odors
- Gradient control in unlined landfills to prevent leakage
- Leachate recirculation to accelerate gas production and treat leachate (reduce BOD/COD)

Condensate & Leachate in Gas Wells/Piping
- Maximize gas flow from wells
- Increase profits, reduce fugitive emissions and odors
- Reduce liquid accumulation in piping (low spots, sumps)
- Maintain steady operation of power generation systems
- Prevent damage to blowers, generators and flares

Leachate Flow in Typical MSW Landfill
**Benefits of Increased Moisture Content and Leachate Recirculation**

**Landfill Methane Generation Model**
(250,000 Tons Per Year Disposal; Closure Year 30)

PROBLEM:

- Leachate/condensate accumulate in gas wells, blocking screen openings and reducing gas flow
- Long-term accumulation can clog the well screen and backfill, leading to permanent reduction in gas flow from the well
- Leachate recirculation can accelerate leachate buildup in gas wells
Liquid in LFG wells and surrounding waste cause gas and liquid to compete for pore spaces in waste and results in high shut-in gas pressure, causing leachate seeps or blow-outs and silt in wells while reducing gas collection rates.
**SOLUTION:**

- Install a dedicated pumping system to dewater the well to increase gas flow and maintain long-term viability of the well
- Increases the zone of influence around well, reducing LFG emissions and odors and air leaks into system, improving gas quality and NSPS regulatory compliance

Zone of Influence

Leachate accumulation effectively shortens the length of the well intake and reduces the “zone of influence” in the waste.

Dewatering the well and surrounding waste can increase the zone of influence *with no increase* in vacuum, reducing the risk of air infiltration and maintaining gas quality.
**LFG Collection Improvement**  
Gramacho Landfill, Brazil

<table>
<thead>
<tr>
<th>Well</th>
<th>LFG Flow (SCFM) Before Pumping*</th>
<th>Change in LFG Flow SCFM</th>
<th>%</th>
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<tr>
<td>10</td>
<td>39</td>
<td>20</td>
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<td>25</td>
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<td>10</td>
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<tr>
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<td>66%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>554</strong></td>
<td><strong>344</strong></td>
<td><strong>62%</strong></td>
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</table>

* Average of 6-8 flow measurements taken over 30 days (August 2009)  
† Single flow measurement taken after dewatering (October 2009)

**Benefits of LFG Well Dewatering**

- Maximize gas collection rates and zone of influence
  - Increase revenues where gas is utilized
  - Reduce fugitive emissions, odors
  - Maintain regulatory compliance in gas wells
- Reduce liquid accumulation in collection piping & sumps
- Maintain steady operation of generators and flares
- Prevent damage to blowers, engines and flares
- Increased useful life of LFG wells by reducing clogging and encrustation of well screens and backfill
As little as 5 CFM additional gas flow per well at $2.50/mmBtu can pay for a $3,300 dewatering pump system in just one year, with additional annual revenue generated thereafter.

Gas Well Dewatering - Economics

<table>
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<tr>
<th>Gas Value ($/mmBtu)</th>
<th>1 CFM</th>
<th>5 CFM</th>
<th>10 CFM</th>
<th>25 CFM</th>
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Additional Annual Gas Value @ 50% Methane

Economics of LFG Well Dewatering

Try the latest QED LFG Calculator at www.qedenv.com/landfillgas
Common gas well dewatering pumps

- Electric submersible (centrifugal)
- Air-powered automatic
- Piston

*Each is affected differently by site factors*

### Air-Powered Automatic Pump Advantages

- High clearance design for solids handling
- Handles higher temperature and viscosity than electric pumps – no cooling required
- Gentle pumping action reduces leachate foaming
- Built-in level control – no sensors required
- Short models can pump down to 15” (38 cm)
- Wide range of materials to handle low pH, high chlorides, aggressive chemicals
- Explosion-proof, no shock hazard
- Soft failure mode – simply clean pump to remove solids and restore operation
- Light weight aids installation and service
- Longer warranty than electric or piston pumps
AutoPump™ AP4+ Design Features

**Easier disassembly:** removing four bolts on bottom inlet allows complete pump disassembly in minutes – no turning of the inlet assembly required and no O-ring sticking

**Easier service:** quick-release clip on actuator rod allows quick float removal for easier cleaning. Pump body has a high-polish ID finish to reduce solids build-up and precision bore sizing to improve O-ring fit

**Increased durability:** All metal parts are 304SS or higher for improved corrosion resistance; plastic parts are high-strength & high-temperature engineering plastics (PVDF, PEEK)

**Increased warranty:** 5-year full warranty with no pro-rating in later years

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Monitoring Liquid Levels in LFG wells

- Tracking liquid levels over time can identify wells that would benefit from a dedicated dewatering pump system
- More than half of all landfill sites don’t routinely measure liquid levels due to problems with well access or level measurement devices detecting foam
- Wells without access ports require shutting down gas flow, removing the cap, and then rebalancing the well after the cap is replaced. Techs are exposed to LFG and leachate.
- Installing a dedicated liquid level probe or indicator can save valuable field labor and improve data collection

 Manual Level Measurement
**Digital Liquid Level Measurement System**

- The Digital Level Meter uses a compact, lightweight compressor powered by rechargeable batteries
- Probe installed below liquid level allows a quick and easy level reading without opening well or interrupting vacuum
- Range to 100 feet (30 meter) of liquid level at any well depth
- Accuracy not affected by foam in wells or vacuum level
- Level probe kits about $100 for 50-foot (15m) well; Digital Level meter $1,285

![Digital Level Meter with Easy Level System](image)

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**QED Easy Level™ High Level Indicator**

- Provides simple visual alert from a distance to excessive liquid level – bright orange indicator pops up when liquid level rises
- Works without opening the well – no air gets in, no gases get out, no vacuum interruption
- Self-powered - no batteries, electric power supply or compressed air source needed
- Not affected by foam – only reacts to liquid
- Use with optional Digital Level Meter for level measurement when probe is submerged
- Under $300 per well – much lower cost than transducer systems and no labor to access the well like manual level tapes

![QED Easy Level System](image)
The Easy Level uses an indicator at the well cap, ¼-inch nylon tubing, and a short, hollow stainless steel probe positioned at the liquid alert level.

**QED Stabilizer™ Well Caps**

- Easy liquid level measurement without removing the well cap or shutting off gas flow – faster, safer, cleaner, easier
- Ports to accommodate dewatering pump fittings and Easy Level indicator or dedicated liquid level bubbler line
- Unique support ring molded directly into the cap aligns & stabilizes gas well head, takes pressure off Fernco® and flex hose
- Molded in high-visibility bright yellow to help prevent well damage by vehicles & heavy equipment
- Available for 6” and 8” wells with 2” or 3” LFG wellheads
Snell Road Landfill – Winnebago County

Snell Road Landfill Background

- Closed 110 acre municipal/industrial waste landfill in Wisconsin – 4.5 M cubic yards waste-in-place
- Gas collection system installed in 1990, powering a 3.0 MW gas turbine generator
- 34 electric submersible pumps installed in the vertical “dual-extraction” leachate/LFG wells
- In less than one year, the electric pumps and controllers required extensive maintenance and the majority of the pumps failed due to corrosion, over-heating, clogging, and controller malfunctions.
- In 1995, the County replaced electric pumps with air-powered automatic pumps
LFG Collection Improvements at Snell Road Landfill using Air-Powered Dewatering Pumps

- Air-powered pumps reduced liquid levels in LFG wells by 62% due to higher reliability & lower downtime
- Methane gas production flow rates increased 20-25%, increasing electricity generation and revenues
- Methane gas system compressor station reliability improved dramatically; flooding in liquid knockout sumps was virtually eliminated
- Improved gas flow and cleaner, drier gas has reduced downtime of electric generation facility
- Reduced pump maintenance and repairs has saved the County 20 – 40 labor hours per month

Springhill Regional Landfill
Florida
Springhill Regional Landfill Background

- $7 million LFGTE plant operating six Caterpillar generators, capable of producing 4.8 MW electricity to supply 4,000 homes
- By 2006, LFG collection system was only producing enough gas to run two of the six engines, reducing output to 1.6 MW
- Consultants determined that LFG wells were “watered in”, reducing gas flow from wells
- Leachate temperature exceeded 140° F and was corrosive due high dissolved sulfur dioxide, making dewatering a greater challenge for common pumps

LFG Collection Improvements at Springhill Landfill using Air-Powered Dewatering Pumps

- Between August-October 2006, 12 air-powered automatic pumps were installed
- By November 2006, the LFG collection system output was returned to original design levels, an increase of nearly 200% over previously reduced levels
- All six generators were back on line within three months, producing 4.8 MW of power
- Liquid levels in all 12 wells continue to be maintained by the air-powered pumps with limited downtime for routine maintenance
Summary

• LFG wells frequently accumulate leachate/condensate that can greatly reduce gas collection rates
• Dewatering systems can reduce liquid levels, increasing gas flow and improving collection system efficiency
• Where gas is utilized, dewatering pumps can pay for themselves in as little as 6 – 12 months with as little as 5 – 10 SCFM increased gas flow
• Results will vary based on liquid level, clogging by solids and bio fouling, type and age of waste and other factors
• Bubbler-type liquid level measurement is faster and easier than manual methods and provides more accurate level readings, even in foaming leachate

Questions?

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