Managing Landfill Liquids to Maximize Landfill Gas Collection Efficiency

David Kaminski
QED Environmental Systems Inc.
Ann Arbor, Michigan - San Leandro, California

Today’s Webinar topics:

• Why install a LFG collection system?
  – Regulatory drivers
  – Beneficial uses
• Landfill gas collection system basics
• Landfill liquids characteristics (leachate and condensate)
• How liquids affect LFG collection system efficiency
• Economics of LFG well dewatering systems
• Pumps used to dewater LFG wells
• Case history examples
• Question and answer session
Reasons to collect LFG - Regulations

• US state/federal regulations require LFG collection based on landfill gas emissions measured for both methane and non-methane organic compounds (NMOCs)
  – USEPA New Source Performance Standards (NSPS) or Emissions Guidelines (EG), based on age of site
  – USEPA regs for Explosive Gas Migration (40 CFR 258.23)
  – Various state and local regs for air pollution and odor control

Reasons to collect LFG - Regulations

• New USEPA Greenhouse Gas Tailoring Rule (May 2010)
  – Regulates GHGs under US Clean Air Act
  – Will apply to hundreds of smaller GHG sources, such as small landfills.
  – Beginning in 2011, the new rule will apply to sites that increase emissions by 100,000 tons CO\textsubscript{2}e annually
  – As little as 500 cubic meters/hour of additional LFG generated (estimate)
Reasons to collect LFG - Regulations

• Outside USA – Kyoto Protocol (United Nations Framework Convention on Climate Change)
  – 187 countries/states as of October 2009, including AU & NZ
  – Established a “cap and trade” system for members
  – Allows for Clean Development Mechanism (CDM) projects for carbon credits in developing countries (lower cost to develop)
  – Sites can also sell gas as fuel and earn renewable energy credits

Future Regulatory Drivers

• Various Australian State EPAs are looking at increased regulation of landfill gas emissions
  – Victoria EPA completed an assessment of 260 landfills in 2009
  – Driven by methane emission from the Cranbourne site, where over 60 homeowners were relocated due to LFG in structures
  – Future AU regulations are expected to move LFG collection from voluntary to compulsory
Reasons to collect LFG – Revenues!

• Carbon Credits
  – Credits created by reducing or avoiding the release of GHGs
  – Methane is a potent GHG – 1 ton CH₄ = 21 tons CO₂
  – Value of credits is dependent on stringency of “verification protocol” used
  – International carbon market values are as much as 2-3x US market values
  – Worldwide, carbon market values have dropped as much as 50% in past year, though long-term outlook is stronger

Reasons to collect LFG – Revenues!

• LFG is a renewable energy source
  – LFG can be used to generate electric power on-site and sold to power grid
  – LFG can be used to run boilers, kilns or to heat buildings near the landfill, replacing fossil fuels
  – Can also be used on-site to operate leachate evaporators
  – Gas can be converted to “high BTU” feedstock and sold to utilities through pipelines
  – Recent projects are converting LFG to liquid natural gas (LNG) for use as vehicle fuel for refuse truck and other fleet vehicles
  – LFG being converted to methanol as feedstock for biodiesel fuel production
Diversity of Project Types
Direct Use of LFG

- Direct thermal (dryers, kilns)
- Boiler applications – replace fossil fuels
- Combined heat & power (CHP)
- Natural gas pipeline injection
- Greenhouse heating
- Leachate evaporation
- Vehicle fuel (LNG, CNG)
- Artist studio
- Hydroponics
- Aquaculture (fish farming)
Landfill Gas Well Installation

36" (1m) bucket auger rig drilling LFG wells
Hollow stem auger rig for gas probes

Typical Landfill Gas Well Components

Gas Collection Header Pipe
Annular Seal
Perforated Pipe/Screen
Rock or Gravel Backfill
Cross-Section of Typical Sanitary Landfill

Gas Header Pipe
Flare/LFGTE Plant
Leachate Plant
Leachate Flow
Gas Extraction Wells
Waste Cells
Monitoring Probes

What is Leachate?

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

- 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

What is Condensate?

Liquid that condenses from landfill gas in the collection system
Condensate Characteristics

- Volume varies with gas flow and precipitation
- Moderate temperatures
- Relatively low solids concentrations
- 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

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

Condensate

- 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
Landfill Liquids and LFG Generation

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

- Dry Site (k=0.02)
- Wet Site (k=0.06)
- Bioreactor LF (k=0.5)

PROBLEM:
Leachate and condensate accumulate in LFG wells, blocking screen openings and reducing gas flow. Long-term accumulation can clog intake with solids and biomass, leading to permanent reduction in gas flow from the well.
Gas Flow vs. Liquid Levels in Wells (Clarke, 2007)

White Areas = Gas flow

Blue Areas = Low/no gas flow

Blue Areas = High Liquid Levels

The combination of liquid accumulation in the LFG wells and within the waste results in high shut-in gas pressures, leading to leachate seeps or blow-outs while reducing LFG flows.
SOLUTION:
Installing a dedicated pumping system prevents liquid accumulation for maximum gas flow and long-term viability of the LFG well.

The pump should only operate when liquid accumulates from precipitation, leachate recirculation, and wet waste.

Economics of LFG Well Dewatering

US Example:
- 70-foot well
- 50 feet of screen
- 30 feet of liquid in well reduces open screen area to 20 feet
- Dewatering pump system installed to increase gas flow
- Pumping system at a cost of $3,500 would have ROI of 4 months

Download the QED LFG Calculator at www.qedenv.com/landfillgas
Typical landfill pump types

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

Each is affected differently by site factors

Electric Submersible Pumps

Advantages
- High flow – up to 800 LPM or higher
- Work in vertical, sloped or horizontal wells
- Pumps from depths of up to 175+ meters
- Widely available from variety of vendors

Disadvantages
- Made for pumping clear, cool water
- Solids, organics can attack bearings/seals
- Metallic components subject to corrosion
- Explosion and fire potential, shock hazard
- High flow can accelerate siting of wells
- Failures tend to be expensive (e.g., motor failure)
- Close tolerance impellers prone to clogging
Air Powered Automatic Pumps

Advantages
- High clearance design for solids handling
- Built-in level control, no sensors required
- Explosion-proof, no shock hazard
- Corrosion-resistant materials available
- Soft failure mode - simply flush solids out
- Light weight aids installation and service

Disadvantages
- Flow rates limited to about 55 LPM
- Less energy efficient than electric pumps
- Automatic versions only work in vertical wells; side slope and horizontal wells require surface-mounted controls

Piston Pumps

Advantages
- No air/liquid contact
- Handles extremely viscous liquids
- Pumps from depths of up to 175+ meters
- Liquid drawdown to very low levels (< 15 cm)
- Explosion proof (air-driven systems only)

Disadvantages
- Higher cost than automatic air-powered pumps
- Flow rates limited to about 20-30 LPM
- Less solids handling capability than air-powered pumps
- Mechanical components subject to wear, service
Submersible Pump Selection Guide

QED’s latest Web tool lets you determine the best type of submersible pump for your application based on flow rate, lift, temperature, solids handling, and nine other parameters. We’ll tell you if an air-powered pump will work best for you, or if a traditional electric pump is a better choice.

www.submersiblepumpguide.com

Winnebago County Landfill
Winnebago County Landfill Background

- Closed 110 acre municipal/industrial waste landfill in Wisconsin
- Gas collection system installed in 1990
- 34 electric submersible pumps installed in vertical “dual-extraction” leachate/LFG wells
- 100% pump failure in less than one year due to corrosion, clogging, overheating and level control malfunction due to leachate foaming
- In 1995, the County replaced electric pumps with air-powered automatic pumps.

Winnebago County Methane Collection Improvements with Air-Power Dewatering Pumps

- Air-powered pumps reduced liquid levels in LFG wells by 60% 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 increased due to prevention of flooding in dropout tanks
- Improved flow and drier gas has reduced downtime of electric generation facility
Springhill Regional Landfill
Florida

Springhill Regional Landfill Background

• $7 million LFGTE plant running 6 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 2 of the 6 engines, reducing output to 1.6 MW

• Consultants determined that LFG wells were “watered in”, reducing gas flow from wells

• Leachate temperature exceeded 60° C and was corrosive due high dissolved sulfur dioxide, making dewatering a greater challenge for common pumps
Springhill Landfill Methane Collection Improvements with Air-Power 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

Questions?

For QED Product Information:
EnviroEquip - Toll-Free Numbers
Australia: 1300-735-295
New Zealand: 0800-623-493

E-mail
InfoEnviroAU@thermofisher.com
InfoEnviroNZ@thermofisher.com

Websites
www.enviroequip.com
www.qedenv.com