VWEA EDUCATION CONFERENCE

Innovative Digester Gas Treatment at HRSD’s Atlantic Treatment Plant

April 30, 2015
Erv Bonatz – HRSD Atlantic Treatment
Plant Manager 1992 - 2014

Acknowledgements:
Jeffrey Layne – HRSD Atlantic Treatment
Plant Manager
Tom Kochaba – HDR
Drew Zirkle – HDR
Charles Bott – HRSD Special Projects
Arba Williamson – HRSD TSD
Outline

- Background Information
- Digester gas treatment needs and options
- Information about bioscrubber
- Operating cost information
- Lessons learned from operating a bioscrubber
HRSD - Regional wastewater agency in Southeastern Virginia serving 17 counties/cities
The 13 treatment plants at HRSD can treat up to 249 million gallons of wastewater every day.
Atlantic Treatment Plant

- 54 MGD Design Capacity
  - Current flow is 25-30 MGD
- High Rate Activated Sludge – 2.3 day MCRT
- Combined Heat and Power System
  - Two 1.1 Megawatt Engine-Generators
Problems

Problems with Digester Gas as a Fuel

• $\text{H}_2\text{S} + \text{moisture}$
  – Pipe corrosion and plugging
  – Engine corrosion
  – Manufacturers OK with up to 100 to 200 ppmv
    HRSD experience and others need much lower

• Siloxanes
  – “sand” crystallization on heads abrasion in engine
Atlantic H₂S EXTREME & Siloxane Adsorption needed

- 500 to 2000 ppmv sulfides avg = 1500 ppmv
- Siloxanes avg. roughly 25,000 ug/m³

- Decided to reduce loading on Siloxane adsorption and H₂S filters
Gas Treatment Design Needs

- Need to reduce maintenance downtime expensive media changes and get good reliability.

- $\text{H}_2\text{S}$ would quickly fill up iron sponge 3 to 6 months; and would quickly fill siloxane adsorption filter, about 18 months.

- Decided to shoot for close to 0 ppmv $\text{H}_2\text{S}$ to siloxane filter and good partial siloxane removal rate ahead of adsorption filters

- Types of Gas Treatment Systems that were evaluated to remove $\text{H}_2\text{S}$:
  - Bioscrubber – biological aerated filter
  - Iron Sponge
  - Proprietary Media
  - Two-Stage Chemical Scrubber
  - Advanced Refrigeration
  - Pressure Swing Adsorption

- Field work – Europe, & USA – showed value of AFT system coupled with a bioscrubber
Reasons for selecting the Bioscrubber

• Low chemical usage
• Long life for media
  – Less time and money spent replacing the media
• Low Operational cost
• Low cost for $/pound of sulfur removed
• Extend life and performance of siloxane adsorption media
Digester Gas Treatment System Train

1. Bioscrubber
2. Dual Iron Sponges (polishing & back up)
3. Particulate filter
4. Moisture Removal
   1. Compression and Cooling
   2. Reheating – 40 degree F dew point
5. Dual Carbon/Silica Gel Reactors for Siloxane Removal
6. Particulate filter
Digester Gas Treatment System

- Iron Sponges
- Chiller/Compressor
- Carbon/Siloxane
- Bioscrubber
Bioscrubber

• Vessel – insulated FRP tank,
  – diameter = 10’; height = 33’
• Digester gas flow = 250 – 550 cfm
  – Enough gas to run both engines
• Digester Gas – 2,000 H₂S ppmv
  – After bioscrubber – less than 50 ppmv
• Plastic Media
Bioscrubber

- Aerated Biological Scrubber – needs oxygen for aerobic environment (1-2% $O_2$)
- Constant Gas Flow
- Warm Process Water (77-131 degrees F)
  - Hot water heater and heat exchanger
- Nutrients – 10-10-10 fertilizer
- Vegetable oil – defoamer and keeps sulfur compounds from sticking to plastic media
Bioscrubber Performance

• Digester gas – averaged 1,500 ppm of H$_2$S

After bioscrubber,

• Treated gas – averaged 16 ppm of H$_2$S
• Bioscrubber removed almost 99% of H$_2$S
Iron Sponge / Moisture Removal Performance

- Effluent Digester gas
  - Averaged less than 1 ppm of H$_2$S
  - Siloxane influent 25,000 ug/m$^3$ - effluent 10,000 ug/m$^3$
Operational Cost for Bioscrubber

- **Electrical Power**
  - Aeration blower
  - Circulation pump
  - Hot Water heater

- **Nutrients**
  - 10/10/10 Fertilizer
  - Vegetable Oil

- **Potable Water** – 600 GPD (make-up water)
Comparison of Costs

Bioscrubbers
- Low operational cost
- Long life for plastic media

Media Adsorption – Iron Sponge or Proprietary Media
- Minimal operational cost for media adsorption
- Biggest expense is media replacement
Original Goals were met:

- The iron sponge media life estimate 3 to 4 years versus 6 months.
- Maintenance and material costs greatly reduced.
- Siloxane adsorption vessel media life greatly extended, no sulfide loading and siloxane loading cut by almost half. No breakthrough yet after 1.5 years, originally thought could happen in 6 months.
- Overall system reliability – fantastic.
- Good gas – good engine performance and decreased maintenance.
Comparison of Costs

• Comparison of operating costs and media replacement
  – Bioscrubber - $0.40/lb Sulfur removed
  – Iron Sponge - $2.00/lb Sulfur removed
  – Proprietary Media - $4.00/lb Sulfur removed

• Note: experience at other installations demonstrated; above 1,500 ppmv sulfides, bioscrubber economical, less than that sponge alone is more economical.
Lessons Learned from Operating a Bioscrubber

• The iron sponge was a wise investment for a backup to the bioscrubber and for H₂S polishing.

• When the CHP engines were shut down for 6 weeks, the bioscrubber died; the Atlantic plant is considering connecting the digester gas piping to the boilers.

• When the bioscrubber was out of service, all of the H₂S was removed by the iron sponges
  – Influent H₂S was 500-1000+ PPMV instead of 0-50 PPMV
Lessons Learned

• Start up of the bioscrubber during the middle of winter is difficult
• Insulate digester gas piping and condensate piping
• Heat tracing of all sample lines
• When flushing out the bioscrubber for annual inspection, use NPW instead of potable water
Lessons Learned

• Consider using the heat recovery from the CHP system as the hot water source

• Keep up with maintenance of hot water heater and heat exchanger;
  – Scaling on heating elements of hot water heater
  – Sulfur deposits inside of heat exchanger; sump has pH 1-3
Lessons Learned

• Running the CHP engines in a “Base Load” mode of operation allows for a steady flow of gas through the scrubber

• Actuator for water fill valve needs to “Fail” to closed position - spring load
  – If there is a power blip during the fill cycle, valve stays open and floods scrubber
Lessons Learned

• Bioscrubbers make a great home for Ospreys
Questions