

H2S Treatment of Landfill Gas at the Roosevelt Landfill



GC ENVIRONMENTAL, INC.

Kevin Ricks
Klickitat Public Utility District

Phone: (509) 773-7430

E-mail: kricks@klickpud.com

Daniel Waineo, Principal
GC Environmental

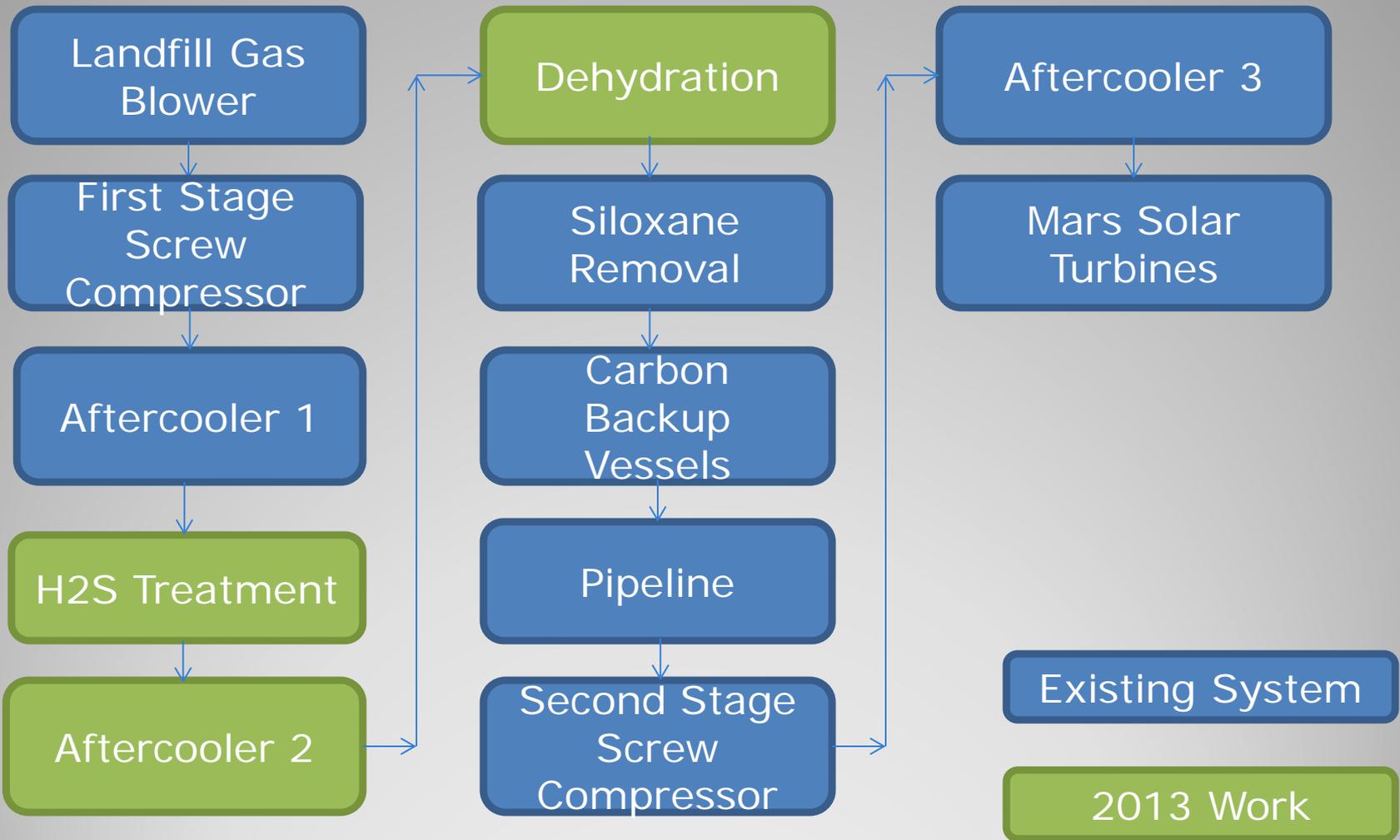
107 SE Washington Street

Suite 243

Portland, OR 97214

Phone: 503-234-7984

E-mail: dwaineo@gc-environmental.com



LFG Gas Treatment at Roosevelt



Landfill Gas Blowers/Flares



First Stage Compressors



Aftercooler 1



H₂S Treatment



Aftercooler 2

- Glycol Pumps/Double Wall Tank



Dehydration System

- New Chiller/Pipebridge



Dehydration System

- Heat Exchangers/ Coalescing Filter



Dehydration System



Siloxane Removal



Carbon Backup Vessels



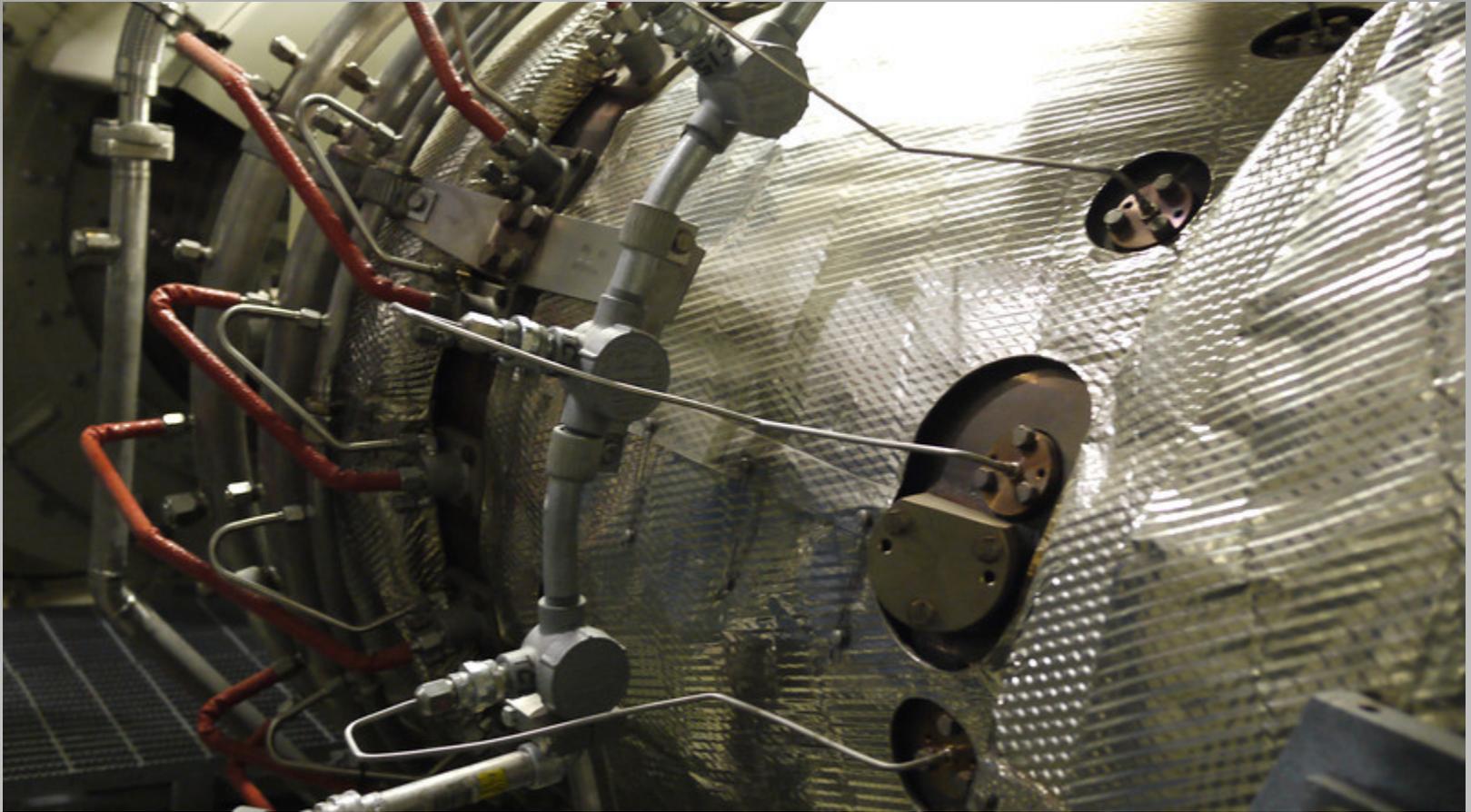
Second Stage Compression



LFG Pipeline



Second Stage Compressor Cooler



Solar Mars 90 Turbines (2 x 10 MW) Combined Cycle



Upper and Lower Sites



Lower Compression Area



Turbine Plant

- Old System (IC Engines 199x)
 - Iron Sponge
- Temporary New System for Turbines (2011)
 - Sulfatreat
- Final System (Summer 2013)
 - Chelated Iron Hydrogen Sulfide Treatment

History of H₂S treatment at Roosevelt

- Iron Sponge

- Dry Media of Iron-Oxide on Wood chips
- Does best using warm wet gas with Oxygen



- 4000 SCFM Treating 300 ppmv H₂S

Solid Scavengers – Iron Sponge

- Advantages
 - Simple system
 - Can be regenerated to some extent with a small Oxygen Stream
 - Fairly low capital costs
- Disadvantages
 - Exothermic during media Regeneration/ Removal
 - Costs for Media Replacement and Disposal of spent material
 - Inconsistent Media Shape

Solid Scavengers – Iron Sponge

- Sulfatreat (iron oxide on ceramic beads)
 - Does best with warm, humid landfill gas with a small amount of Oxygen



- 6000 SCFM at 50 psig with 60 ppmv H₂S

Solid Scavenger – Sulfatreat

- Advantages
 - Very simple system
 - May be exothermic during media replacement
 - Fairly low capital cost
 - Uniform media shape
- Disadvantages
 - Media replacement costs
 - Spent media disposal costs
 - Water may be required to break and flush media from bed

Solid Scavenger - Sulfatreat

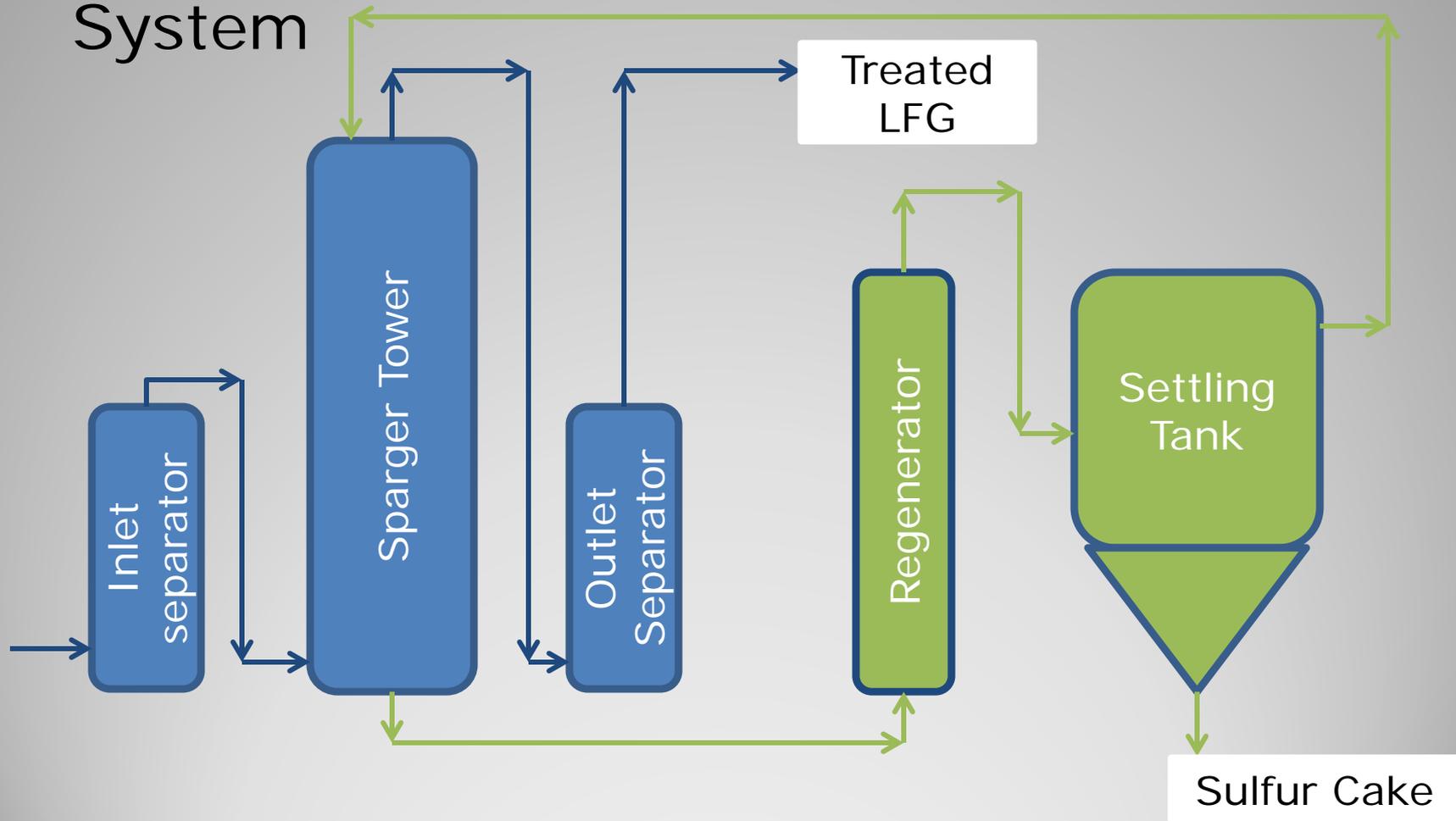
- LO CAT®
- SulFerox®

- Treatment at KPUD:
 - Unlicensed Iron Chelate Process

- Thanks to:
 - Dow Chemical
 - Provides chemicals and technical assistance
 - Westfield Engineering
 - Provided P&IDs
 - Provided spargers vessels and heater skid

Chelated Iron Processes

- Unlicensed Chelated Iron Treatment System



Chelated Iron Treatment

- Chemistry
- Treatment:
 - $\text{H}_2\text{S} + \text{Fe}^{+3}\text{L} \rightarrow 2\text{H}^+ + \text{S}^0 + \text{Fe}^{+2}\text{L}$
- Regeneration:
 - $1/2\text{O}_2 + 2\text{H}^+ + 2\text{Fe}^{+2}\text{L} \rightarrow \text{H}_2\text{O} + 2\text{Fe}^{+3}\text{L}$
- Chelates:
 - Keep the Iron in solution
- Others: Caustic, Surfactants, degradation inhibitors

Chelated Iron Treatment

- Sparger Vessels



Chelated Iron Treatment

- Pipe Bridge



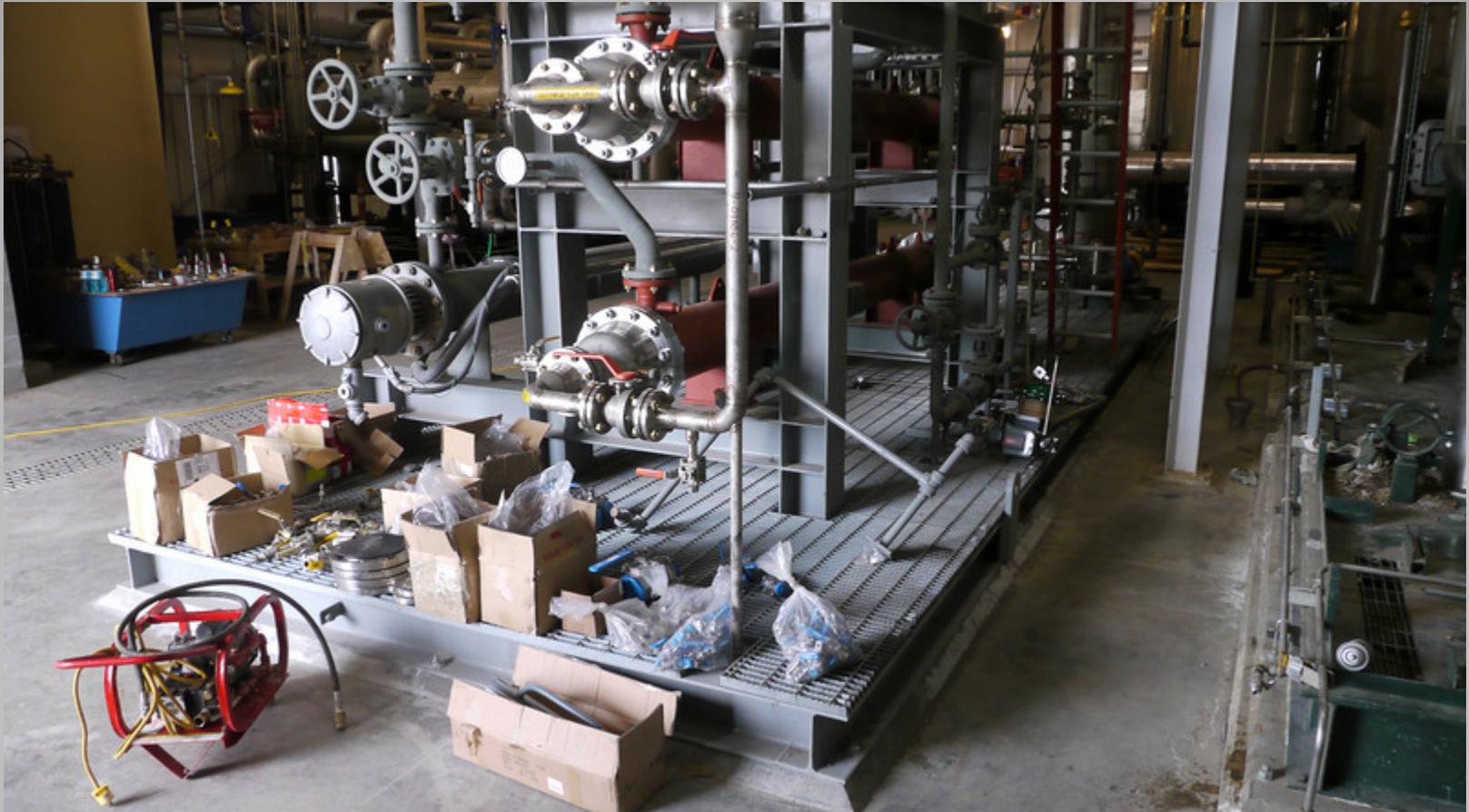
Chelated Iron Treatment

- Regeneration and Settling Tanks



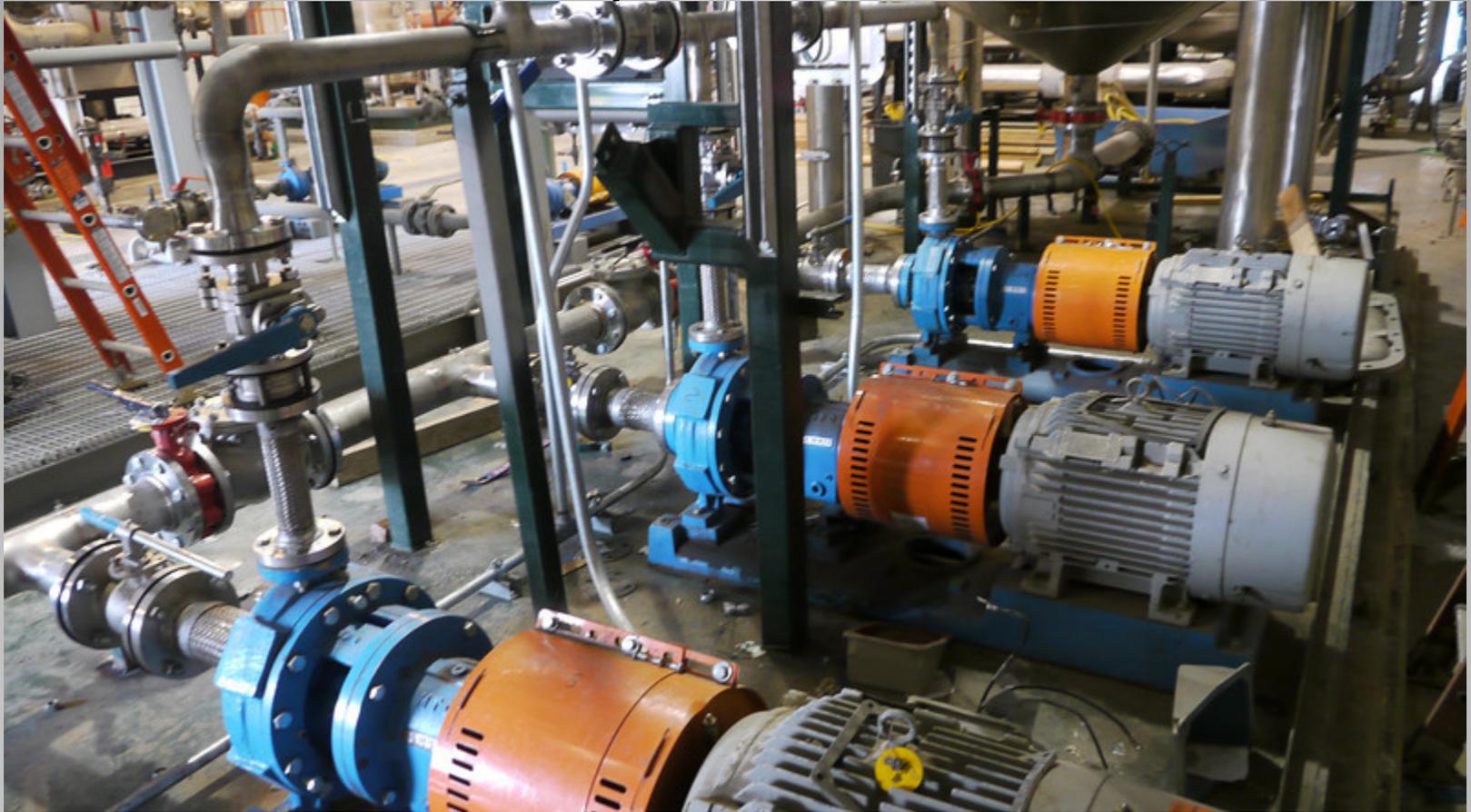
Chelated Iron Treatment

- Heater Skid



Chelated Iron Treatment

- Iron Chelate Pumps



Chelated Iron Treatment

- Chemical Pumps



Chelated Iron Treatment

- Sulfur Filter and Sulfur Cake



Chelated Iron Treatment



Insulated Dehydration System



Insulated Glycol Tank/Pumps



Insulated Settler Tanks



Insulated Heater Skid

- Advantages

- Low Cost of Operation
- No disposal (except sulfur cake)
- Continuous process

Disadvantages

- High Capital Costs
- Process operates warm

- Performance

- Inlet: 250 ppmv H₂S
- Outlet: <10 ppmv H₂S

Chelated Iron Treatment

- Heat exchanger plugging



Sulfur Plugging Issues



Cake Consistency Issues



Sulfur Cake

- Very reliable system that has been treating continuously since startup in July 2013
- 0.25% Oxygen in landfill gas is sufficient for regeneration (regenerator currently is bypassed)
- 100 lbs of Sulfur made per day (no market found yet)
- Chemical use is a little higher than predicted (especially Caustic)

Lessons Learned

- Questions?

Kevin Ricks
Klickitat Public Utility District
(509) 773-7430



Daniel Waineo, P.E.
GC Environmental
(503) 234-7984



LFG H₂S Treatment



Phone: 503-234-7984