



Biogas: The hidden costs of going green

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Risk Engineering – Machinery Breakdown

Zurich Services Corporation

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Biogas: The hidden costs of going green

- On the job!



Photo by David Parsons – NREL 06894

Biogas: The hidden costs of going green



- “Green energy “ – sign of the times?
- 2012 – Zurich discusses energy produced by solar boilers
- 2013 – Issues with boilers using biogas
- 2014 - ????

Biogas: The hidden costs of going green



- Where biogas originates
- Why companies are using biogas
- Components of biogas
- Challenges of using biogas in boilers
- Methods to reduce the number of problems inherent with use of biogas

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- What is biogas?
- Biogas = sewage sludge gas = digester gas = landfill gas
- Product of microbial metabolism – What?
 - Anaerobic microorganisms (methanogens) consume organic solids (volatile solids or VS) in a digester , holding tank or landfill
 - Microorganisms produce
 - CH₄ (~60%)
 - CO₂ (~40%)
 - Sulfides, H₂O and Nitrogen
 - Production rate: approximately 10 to 16 cu.ft. biogas/lb. of VS broken down (2)

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- Sources of biogas
 - Obviously landfills
 - Sewage sludge
 - Energy crops
 - Agricultural waste
 - Food waste

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- Created from many sources, used in many applications
- Our interest – boilers



Photo by Zurich RE Todd Maldonado
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- Components of biogas (5)

Biogas Vs. Natural Gas

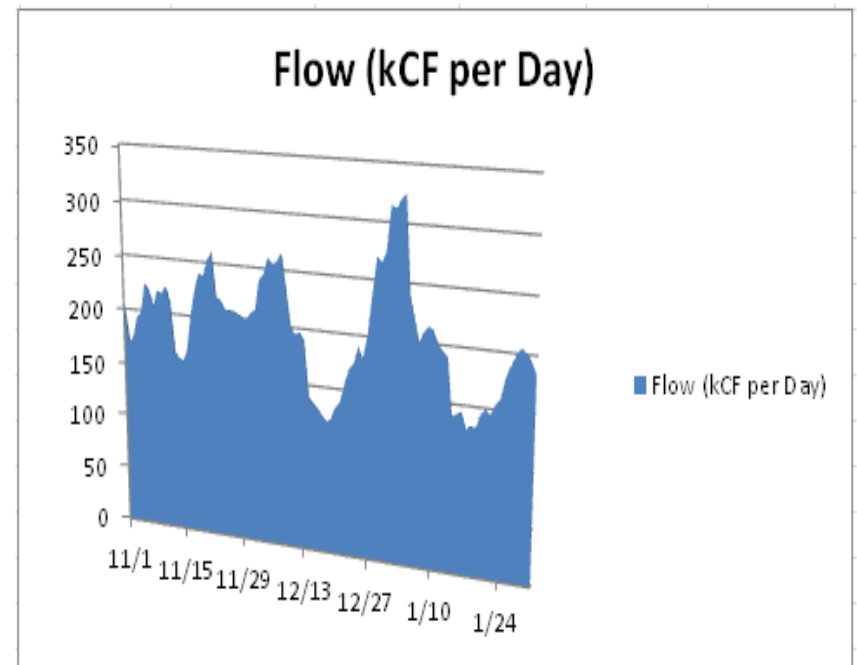
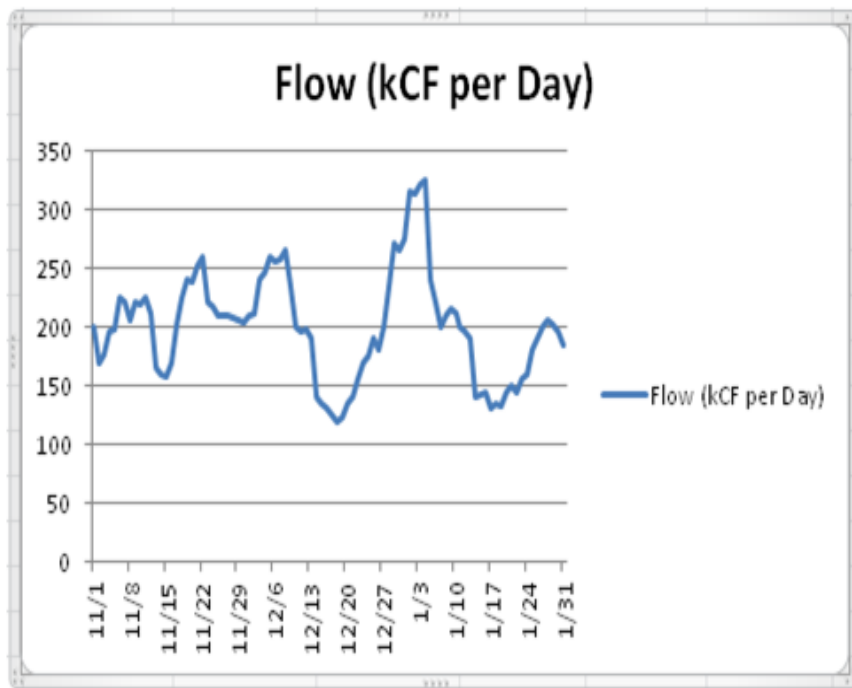
Component	Biogas	Natural Gas
Methane	60%	80 to 95%
Carbon Dioxide	39%	1%
Nitrogen	1%	1 to 5%
Heavy Hydrocarbons	0 (Zero)	2 to 12%
Sulfides	Up to 2500 ppm	Up to 7 ppm
Energy Content, BTU/cu. ft.	600	1000
Origin	Sludge production	Biomass 100 million per year

Chart by Zurich RE Buddy Dobbins - 20130325

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- Typical landfill flow rate⁽⁵⁾



Graph by Zurich RE Buddy Dobbins - 20130416

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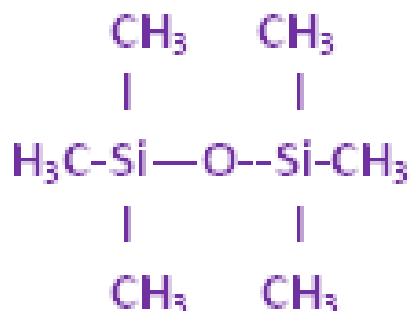
- **Biogas is a RAW MATERIAL**
- Moisture causes
 - Corrosion, together with acid gases
- Hydrogen sulfide causes
 - Corrosion in mechanical moving parts of prime movers
 - Breakdown of lubricants, leading to bearing, piston ring and seal failures
- Siloxane cause
 - Scaling that leads to failure of mechanical components and/or overheating
 - Breakdown of lubricants that leads to failure of mechanical parts



Photo by David Parsons, NREL 01206

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- Hexamethyldisiloxane chemical formula (6)



- Class of organic or inorganic chemical compound
- Organosilicones
- Various siloxane types
 - Halogenated compounds
 - Hydrogen sulphide
 - Corrosive acids
 - Volatile silicon components

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- Issues with siloxanes



Photo by Zurich RE Todd Maldonado – Permission by Covant Energy 20121017

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- Typical siloxane buildup on boiler tubesheet



Photo by Zurich RE Todd Maldonado – Permission by Covant Energy 20121017

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- **Siloxane removal methods⁽⁶⁾**

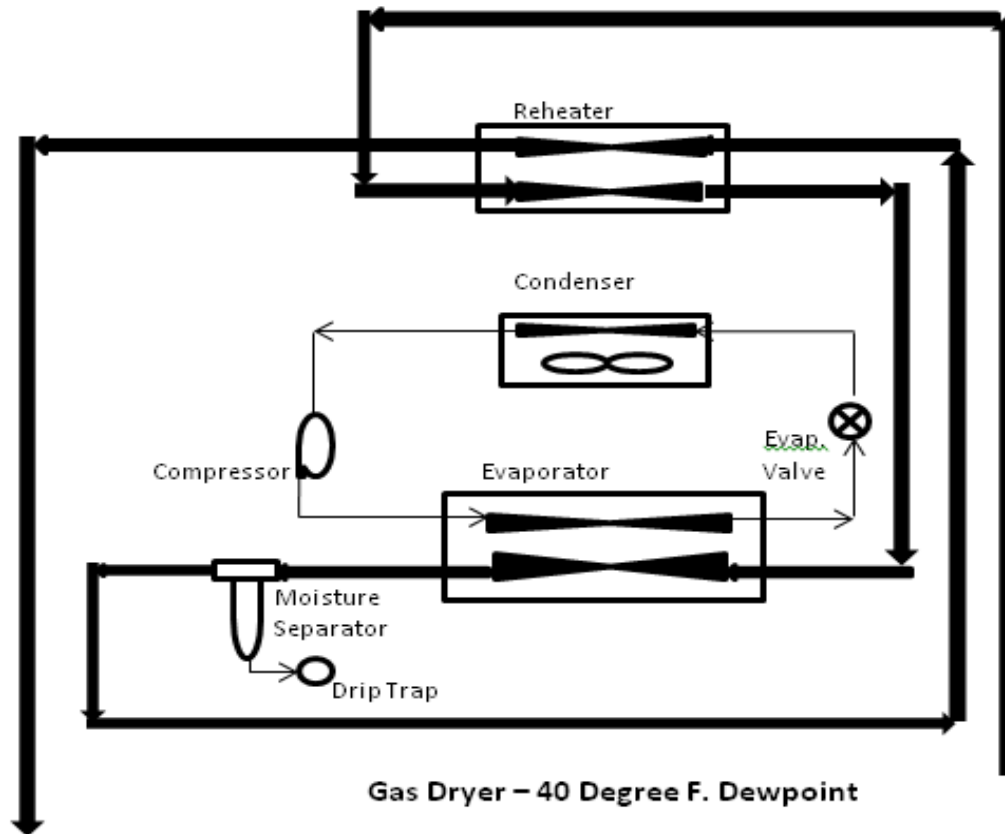
- Dry adsorbent
 - Charcoal
 - Polymers
 - Molecular sieves
- Organic solvents
- Cryogenic, or refrigerant method
- Chemical abatement
 - Sulphuric acid
 - Nitric acid
 - Phosphoric acid



Photo by Calvin Feik – NREL 16029

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Cryogenic condensation (refrigeration method) (7)



Drawing by Zurich RE Buddy Dobbins - 20130330

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- Chemical abatement



Photo by Warren Gretz – NREL 11553

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- Using biogas can be cost efficient but costs of using it must be considered
- Recap the costs to consider using biogas
 - Environmental consideration – odor pollution
 - Treatment of carbon dioxide
 - Presence of moisture
 - Pressure regulation
 - Siloxane – cleanup and prevention

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Have a wonderful conference!

For questions, contact:

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Thank you

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