CHP Design Considerations for Municipal Water Treatment Facilities
Learning Objectives

- Project Background
- Unique Concerns
- Gas Turbine Impact
- HRSG System Impact
  - HRSG Design
  - Economizer Design
Project Background

Facility: Bonnybrook WWT Plant

- Calgary, Alberta, Canada
- Worlds largest cold-weather biological nutrient removal plant
- Expanding to meet a growing population now and in the future
Project Background

Expanded Cogeneration Facility
- New Combustion Gas Turbine Generator (CTG)
- New HRSG
- New Steam Turbine Generator
Unique Concerns

- Raw Digester Gas can contain as much as 5000 PPM of $\text{H}_2\text{S}$
- System includes a biological $\text{H}_2\text{S}$ scrubber but its reliability has proven to be questionable
- Combustion of this fuel in the CTG can result in a $\text{SO}_2$ content in the HRSG flue gas as high as 266 ppm
- The sulfur acid dew point of this flue gas will be approximately 285°F
CHP System

Key Components
- Solar Centaur 50 CTG firing natural gas & digester gas blend to produce 4.5 MW of electricity
- HRSG to generate 23,000 lbs/hr of steam at 350 psig

Key Design Considerations
- Combined heat & power generation and efficiency
- Fuel flexibility
- Steam production including process and cogeneration
- Life expectancy
CTG Package

- Solar Centaur 50 (4.5 MW ISO) single shaft (cold end drive) combustion turbine generator (4.16kV)
- Industrial turbine
- Sound attenuating (85 dB) weather proof package in CSA certified single lift module
- On skid controls, fuel system, and ancillary equipment
- Integral fire suppression system
CTG Concerns

- Wide & varying fuel gas composition
- Blending fuel from 100% natural gas (1000 BTU/scfm) to 100% digester gas (550 BTU/scfm)
- Startup on 100% digester gas (no other torch fuel)
- Fuel bound sulfur (H₂S) up to 5,000 ppm
- Fuel carbon (CO₂) composition up to 40%
- Potential for high levels of siloxanes in fuel
- High ambient air particulate matter (dust) levels
- Very cold ambient air temperatures (less than -30° C)
CTG Combustion

- Wide fuel suitability for combustion of blended fuel from pure natural gas to pure digester gas (low BTU) with double fuel manifold
- Conventional dry emission system producing less than 46 ppm on pure (100%) digester gas
- Able to startup on pure (100%) digester gas without pilot torch boost fuel
- Capable of handling fuel bound sulfur concentrations between 3,000 and 5,000 ppm without impact on lifespan
CTG Accessories

- Siloxane removal system (provided by owner)
- Self cleaning updraft combustion air filter system for extreme cold weather application
- Package ventilation barrier filers for dusty environment
- Package heaters for extreme cold weather startup
- Oil/air lube oil cooler & VFD for extreme cold weather operation
HRSG System

Key Components
• Ductwork
• Boiler
• Economizer
• Stack

Key Design Concerns
• Cold End Corrosion
• Flue Gas Migration
HRSG System

Boiler System
• Simple Design
• Saturated Steam
• Maximize Heat Transfer

Key Design Concerns
• Cold End Corrosion (NOT A CONCERN)
• Flue Gas Migration (A CONCERN)
HRSG System

Internal Casing / Floating Liner:

Risk is migration of sulfur laden flue gas into gaps in the internal liner and eventually cooling and forming acid in the walls of the boiler.
HRSG System

Design Solution:
Membrane wall construction in the boiler. No longer possible for flue gas migration through the walls of the unit.

Adjacent fins of all furnace, and outside convection tubes are continuously seal welded to form a pressure tight, water cooled panel.

Fins are dual-welded to tubes.

Mineral Wood Insulation

Corrugated pebble grain aluminum lagging
HRSG System

Key Components
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Key Design Concerns
• Cold End Corrosion
• Flue Gas Migration
HRSG System

Traditional Design

FW INLET 228°F

Acid Dew Point = 285°F

BOILER 413°F

STACK 335°F

ECONOMIZER

FLUE GAS 451°F
HRSG System

Possible Solutions

• Disposable economizer?
• Disposable portion of economizer?
• Materials?
• Feedwater recirculation?
• Must increase the feedwater temperature
  • Increase the DA pressure?
HRSG System

Engineered Solution

Acid Dew Point = 285°F

FW INLET 228°F

STACK 335°F

BOILER 410°F

FLUE GAS 451°F
Summary

Meet unique needs with a unique engineered system.

Nitrogen – Oxygen – Iron - Argon
Any Questions

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