CHP Design Considerations for Municipal Water Treatment Facilities

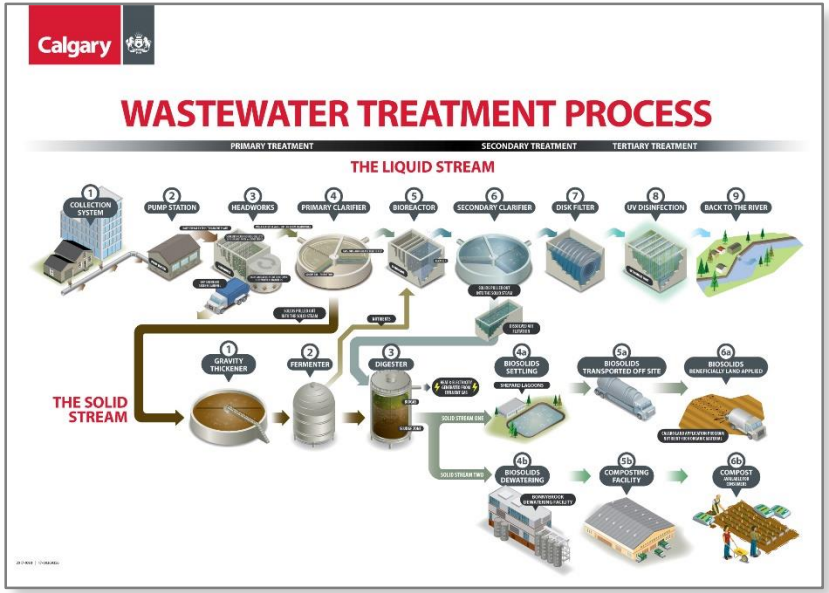
Solar® Turbines
A Caterpillar Company

CleaverBrooks®

Learning Objectives

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

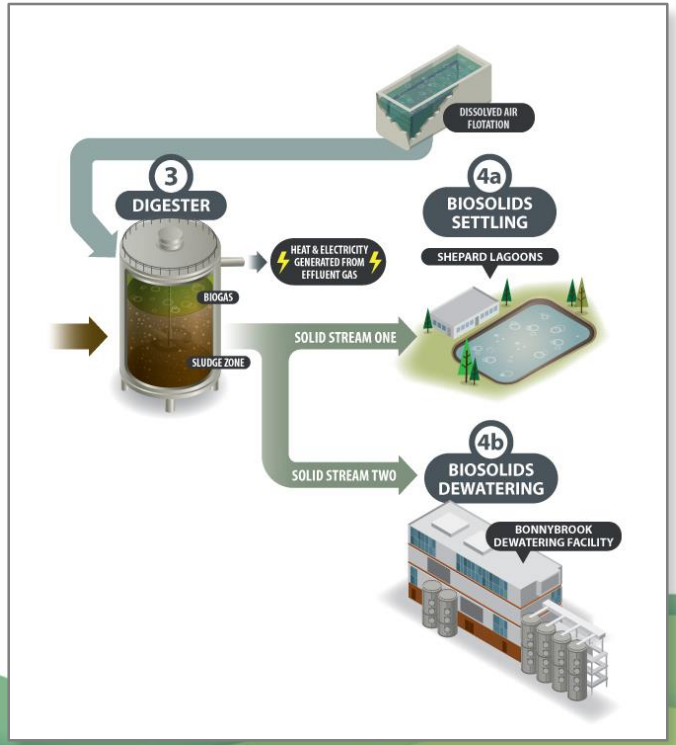
Project Background



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

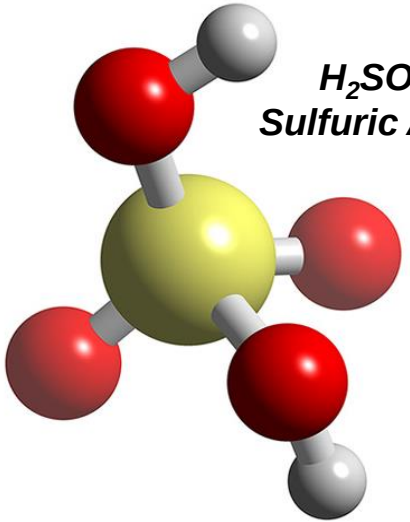


Expanded Cogeneration Facility

- 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 H_2S
- System includes a biological H_2S scrubber but its reliability has proven to be questionable
- Combustion of this fuel in the CTG can result in a 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



H_2SO_4
Sulfuric Acid

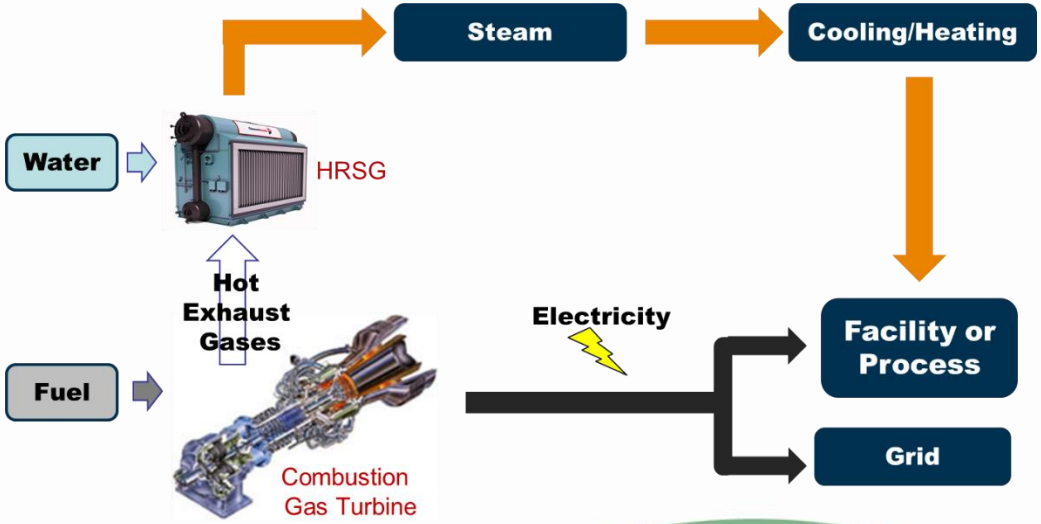
CHP System

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

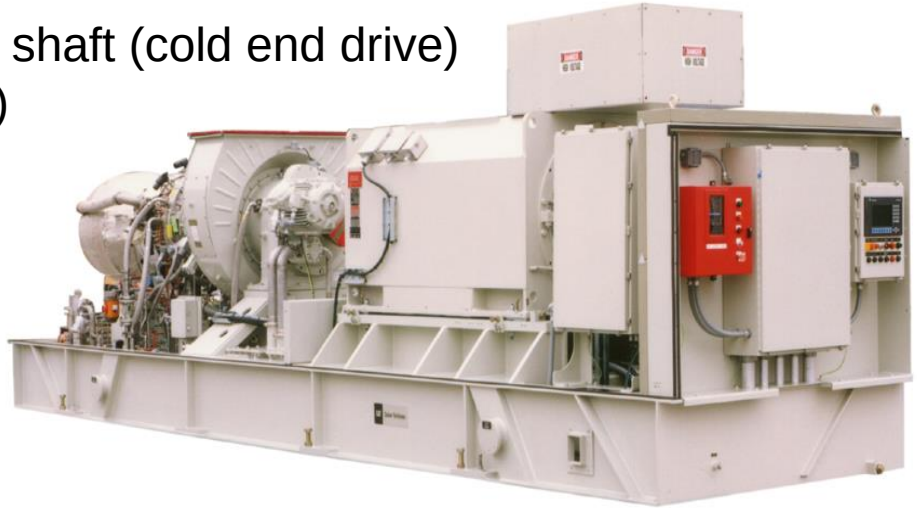
Key Design Considerations

- 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

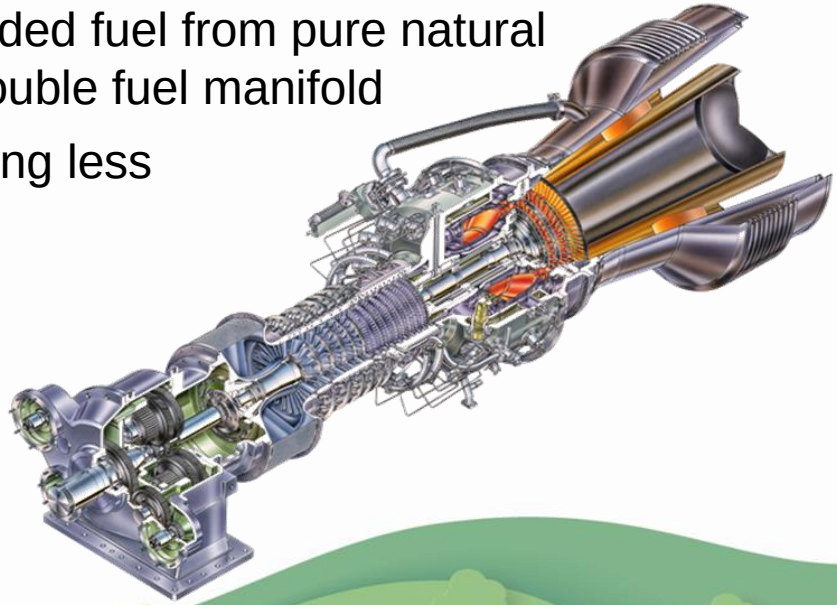


CTG Concerns

- 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 (H_2S) up to 5,000 ppm
- Fuel carbon (CO_2) 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

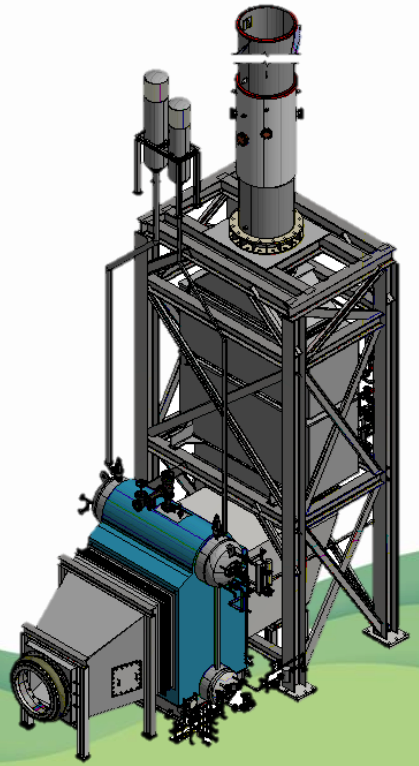
HRSG System

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

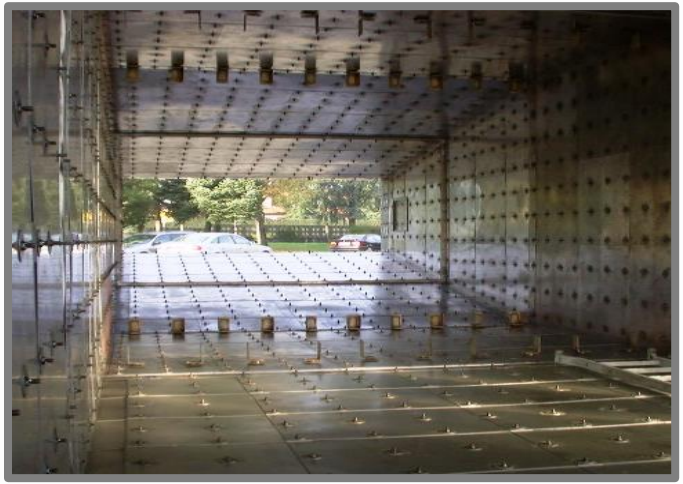
Key Design Concerns

- Cold End Corrosion (NOT A CONCERN)
- Flue Gas Migration (A CONCERN)

HRSG System

Internal Casing / Floating Liner:

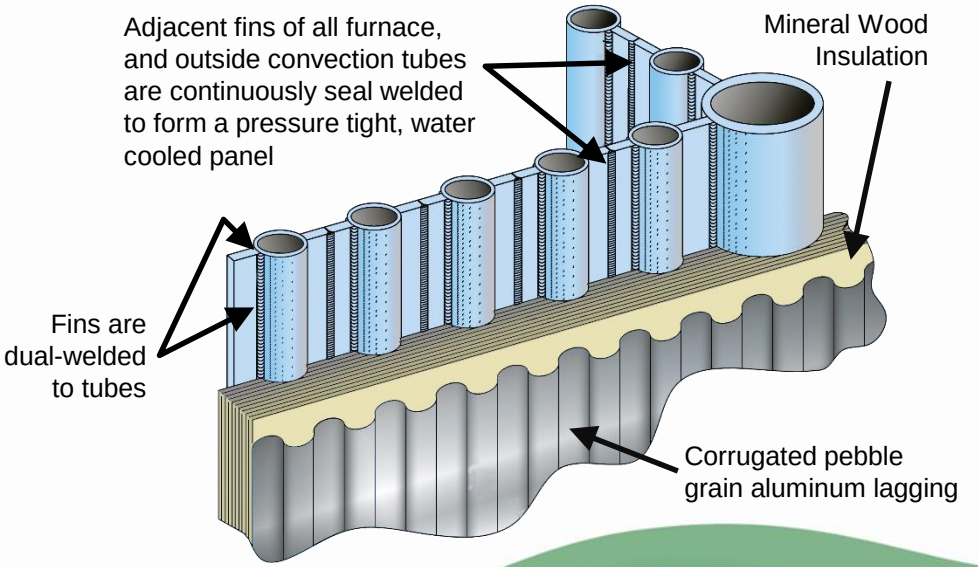
Risk is migration of sulfur laden flue gas into gaps in the internal liner and eventually cooling and forming acid in the walls of the boiler.



HRSG System

Design Solution:

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



HRSG System

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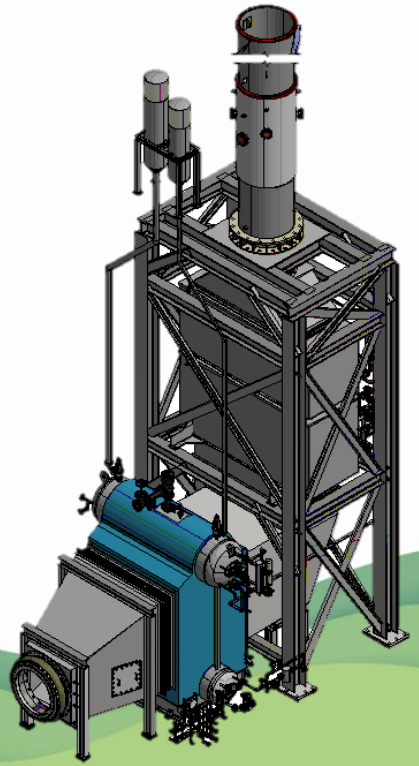
Key Components

- Ductwork
- Boiler
- **Economizer**
- Stack

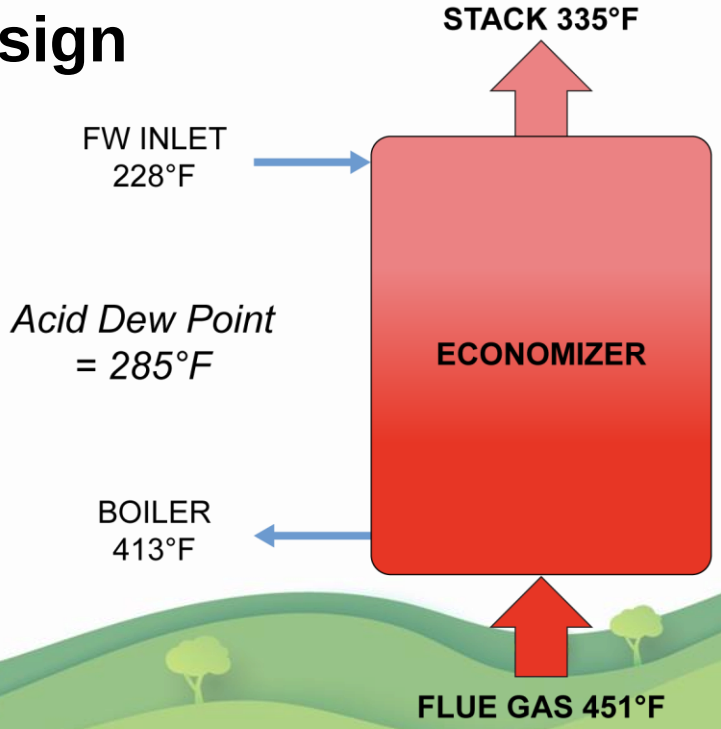
Key Design Concerns

- **Cold End Corrosion**
- Flue Gas Migration



HRSG System

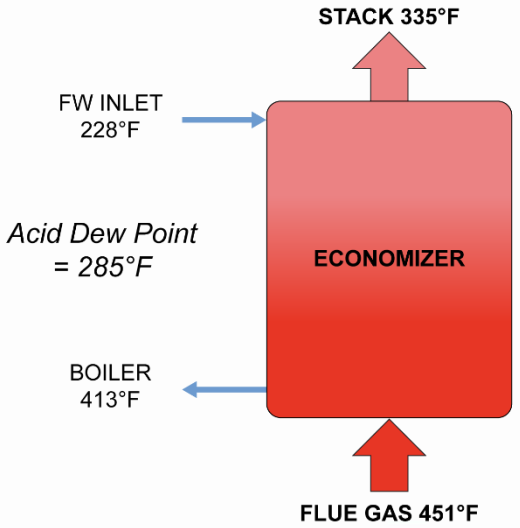
Traditional Design



HRSG System

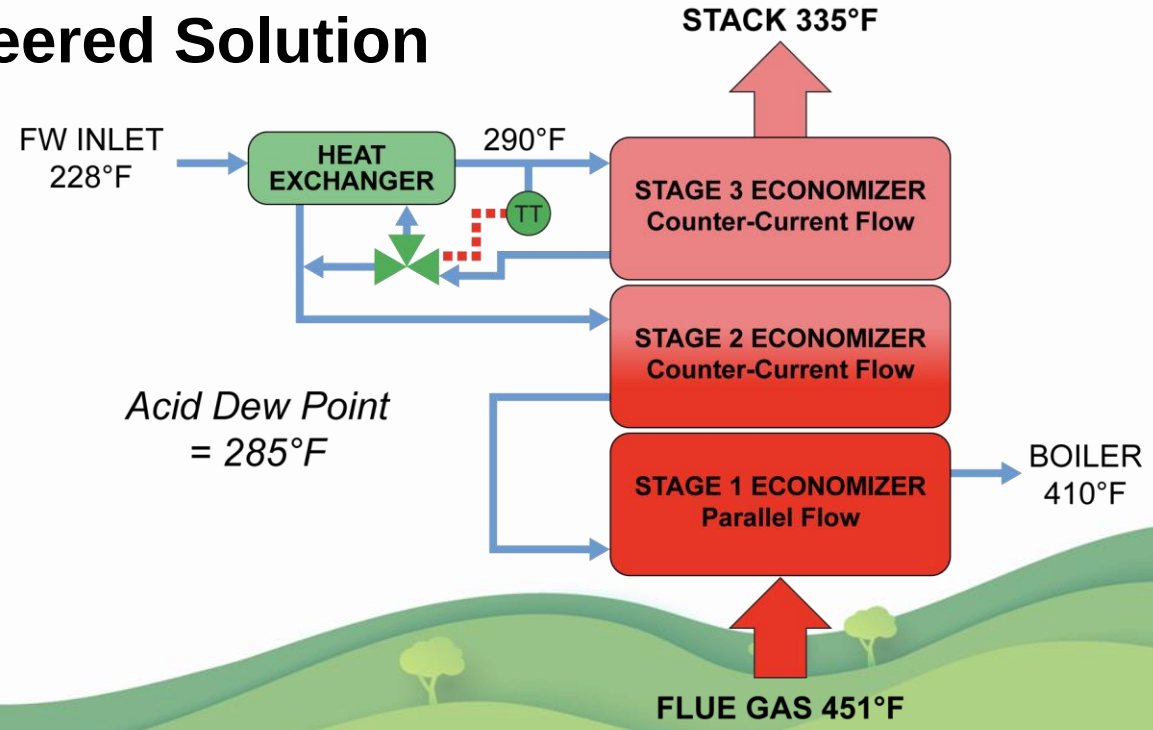
Possible Solutions

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



HRSG System

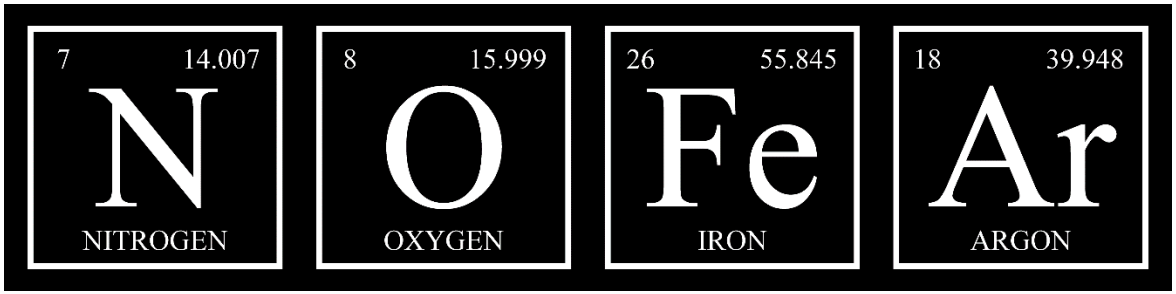
Engineered Solution



Summary

Meet unique needs with a unique engineered system.

Nitrogen – Oxygen – Iron - Argon



Any Questions

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