power generation group

Fireside Corrosion in Oxy-Combustion Demonstration Plant (FutureGen 2.0)

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4th Oxy-Corrosion Workshop

June 19, 2014

FutureGen 2.0 Organizational Structure

U.S. DEPARTMENT OF ENERGY

Project Oversight

FutureGen™ ALLIANCE

Oxy-Combustion Repowering

CO_2 Pipeline & Storage Hub

B&W Power Generation Group

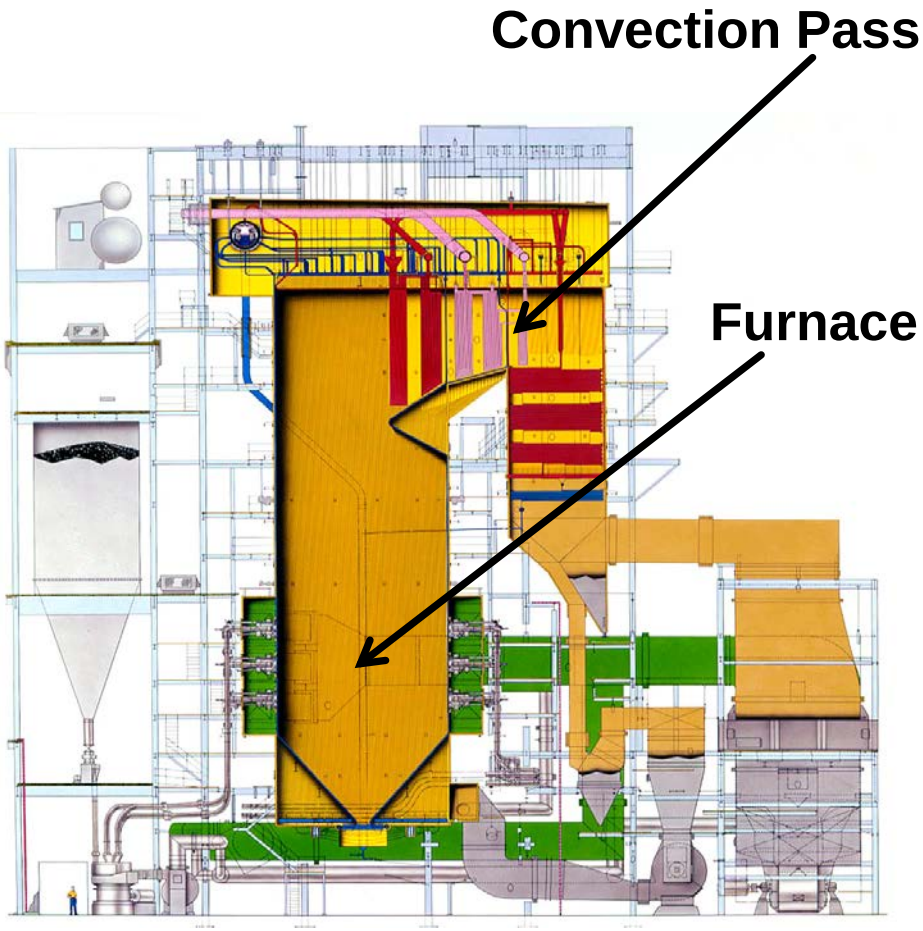
Oxy-Combustion Boiler and GQCS

AIR LIQUIDE™

ASU & CPU

Technology Providers

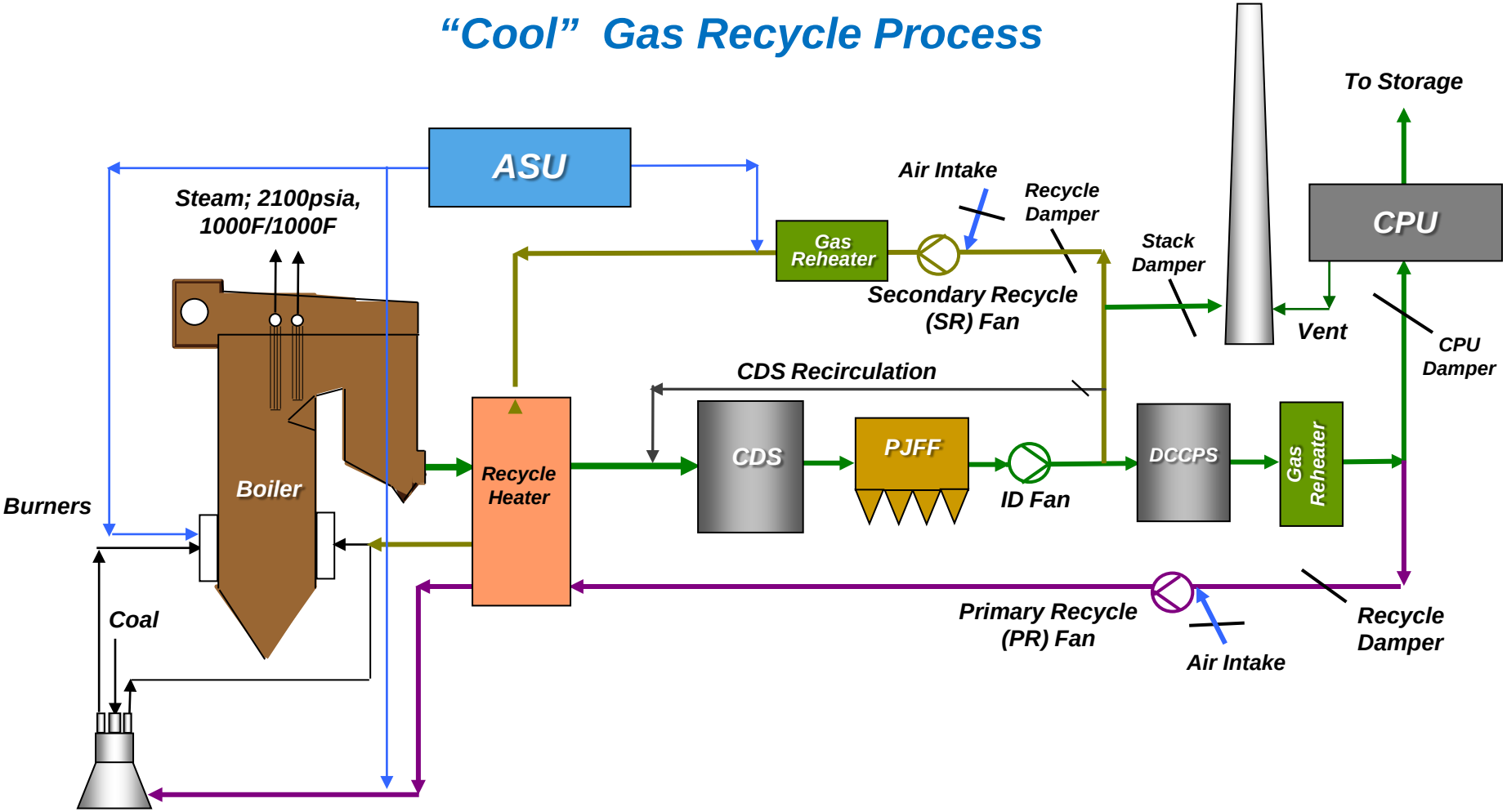
Impact of Oxycombustion on Boiler Design



Subcritical Boiler

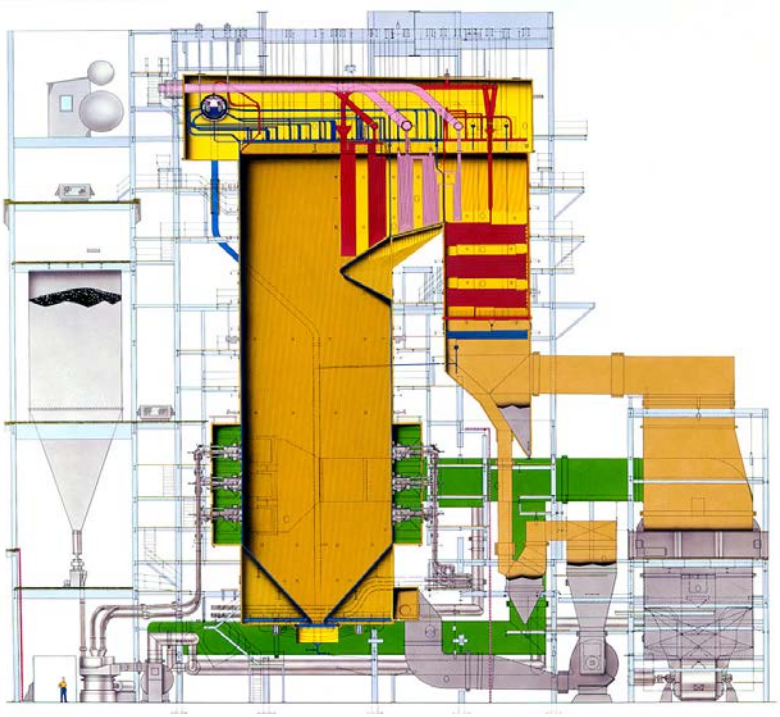
FutureGen 2.0 Process Configuration

"Cool" Gas Recycle Process



FutureGen 2.0 Fireside Corrosion Considerations

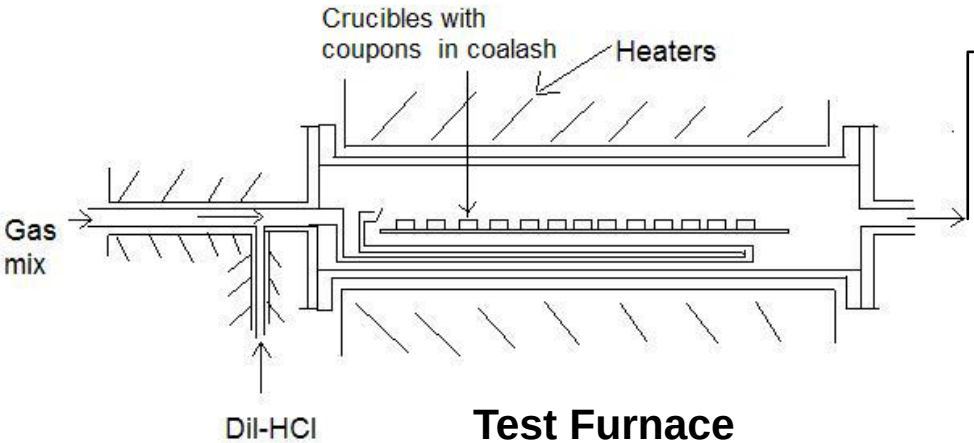
- Blend of 60% Illinois #6 + 40% PRB
- S = 2.1 wt.%
  Cl = 0.1 wt.%
- Un-staged combustion
- "Cool" gas recycling
- SO_2 = 2300 ppmv
  HCl = 100 ppmv
- Main steam T = 538°C (1000°F)
- Maximum SSH outlet bank metal T = 616°C (1141°F)



Coal Ash Corrosion on SH/RH

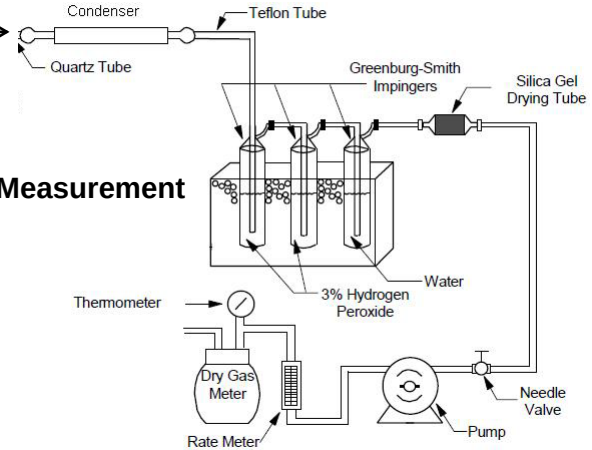
Perform laboratory corrosion tests (based on IL#6 coal)

- Temperature: 593-649ºC (1100-1200ºF)
- SO_2: 2200 ppmv
- HCl: 300 ppmv
- Balance: O_2-N_2-Ar-CO_2-H_2O
- Deposit Al_2O_3-SiO_2-CaO-Fe_2O_3-$Fe_2(SO_4)_3$-Na_2SO_4-K_2SO_4-$CaCO_3$-K_2CO_3-$MgCO_3$-Na_2CO_3
- 1000 hours, isothermal

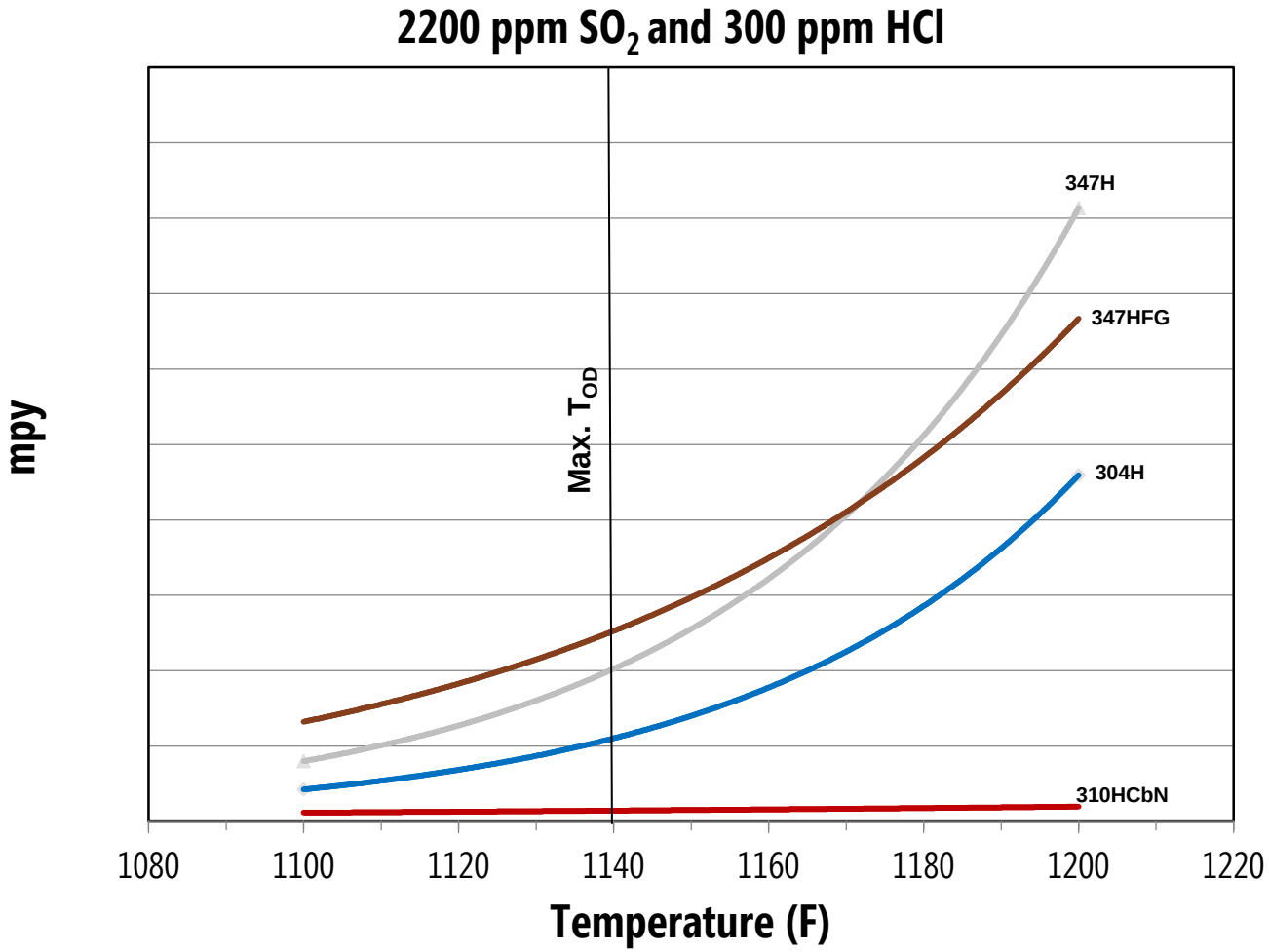


Test Furnace

SO_3 Measurement



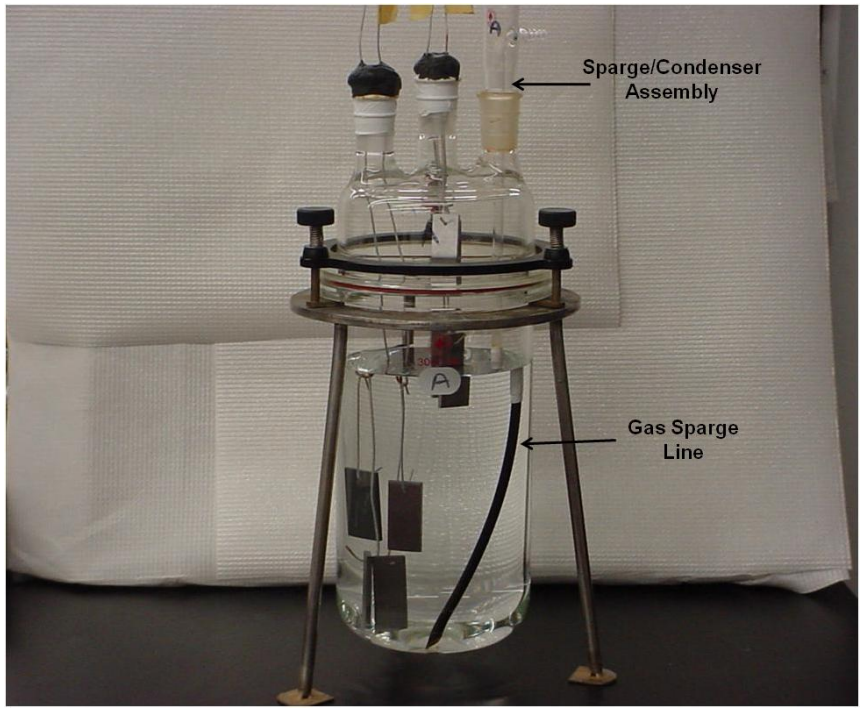
Corrosion Rate of "Conventional" SH/RH Alloys

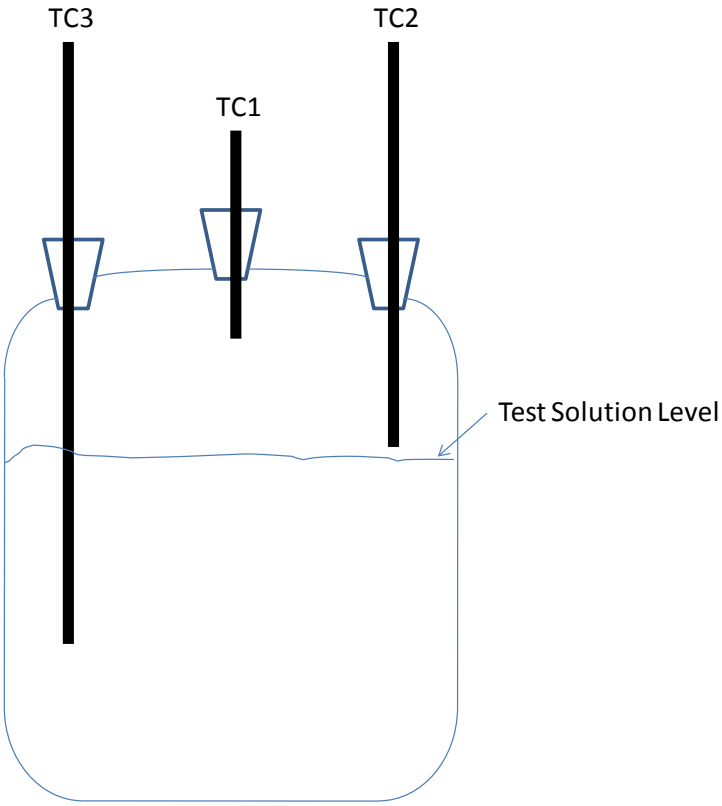


Acid Dew Point Corrosion

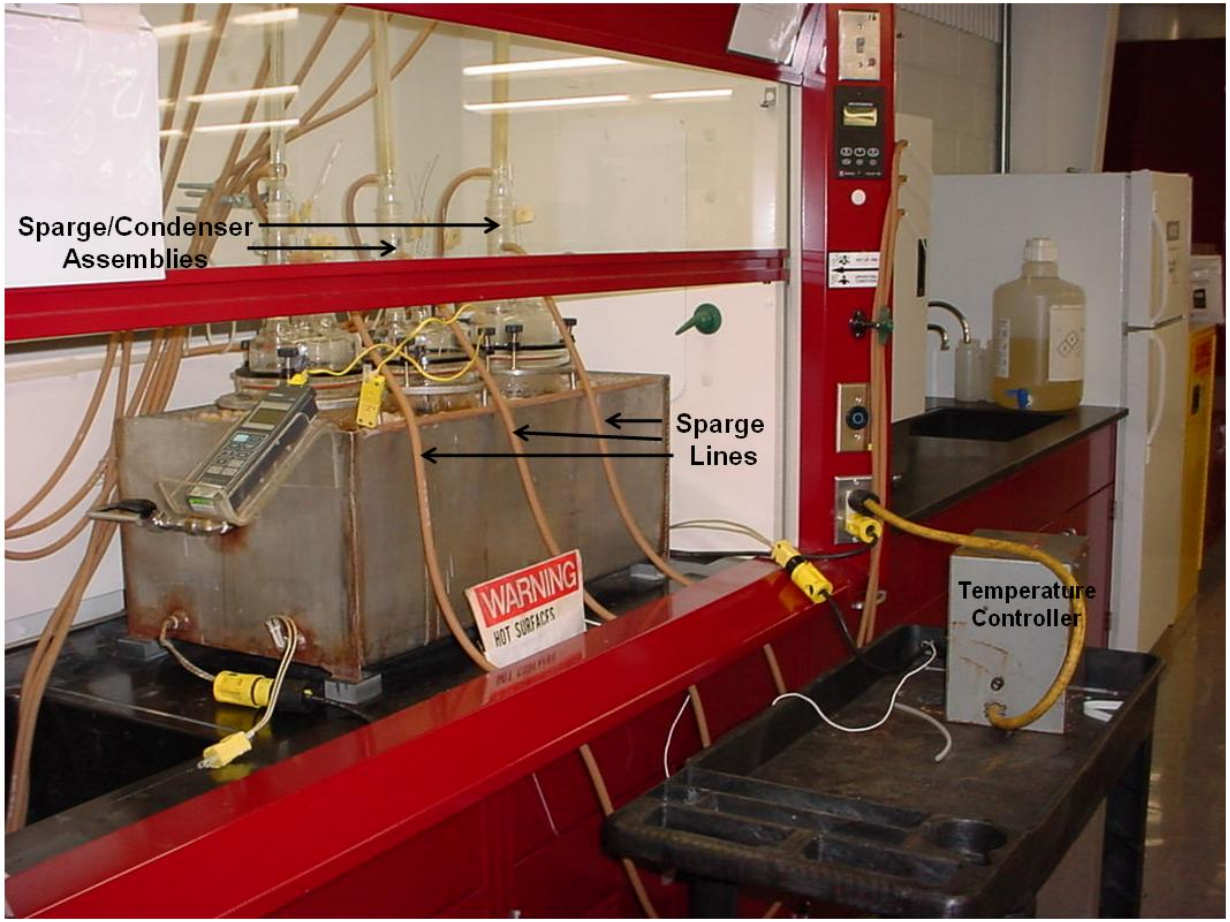
- 30 MW_{th} Pilot-scale combustion facility (CEDF) burning PRB and lignite coals
- Primary and secondary condensates collected
  - Condensate pH = 2.2-2.8 from very low-sulfur coals
- Carbon steel and Corten exposed to condensate solutions at 110-190°F under $CO_2/N_2/O_2$ cover gas for up to 175 hours
- These alloys also exposed to sulfuric acid solutions of different concentrations up to 25 wt.%

Dew Point Corrosion Test Apparatus



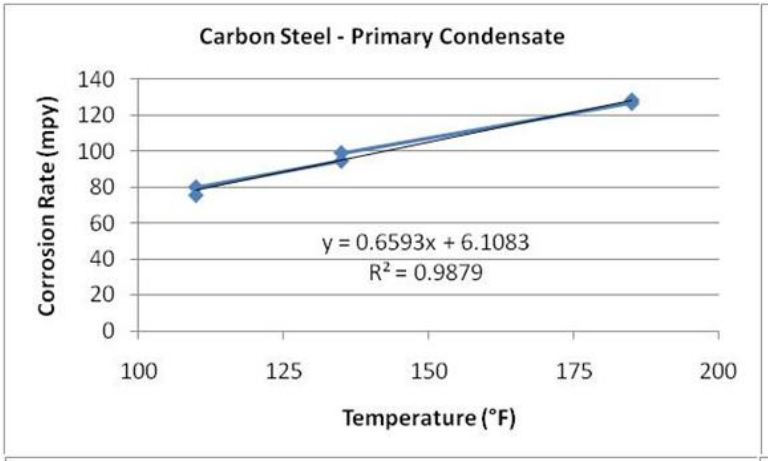


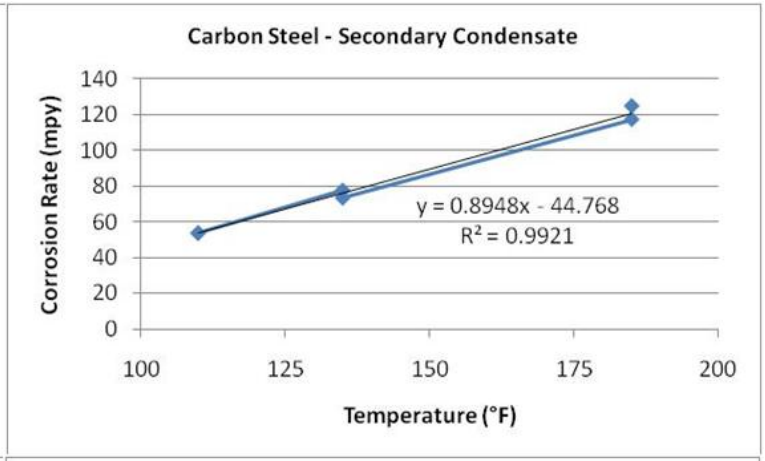
Laboratory Dew Point Corrosion Test

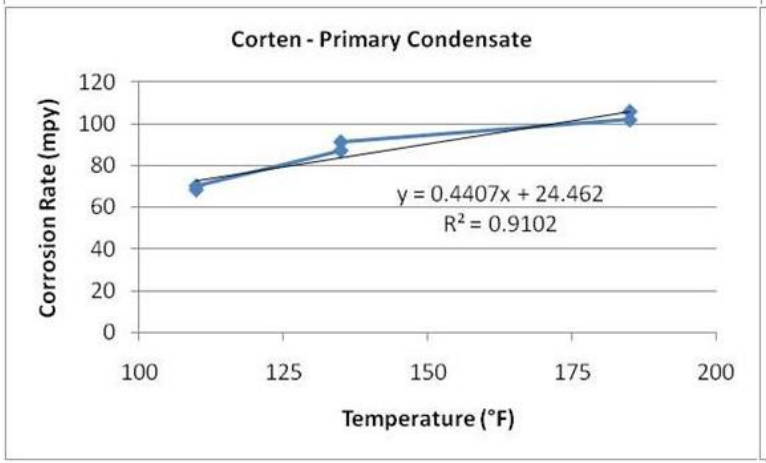


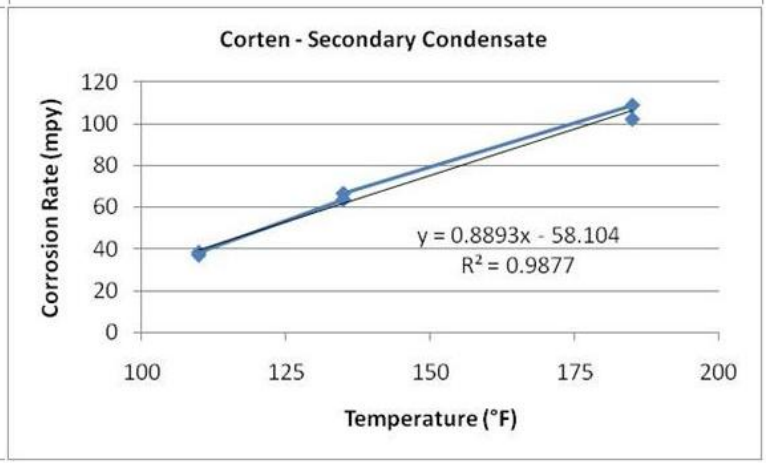
Corrosion Rates vs. Temperature

PRB Condensate





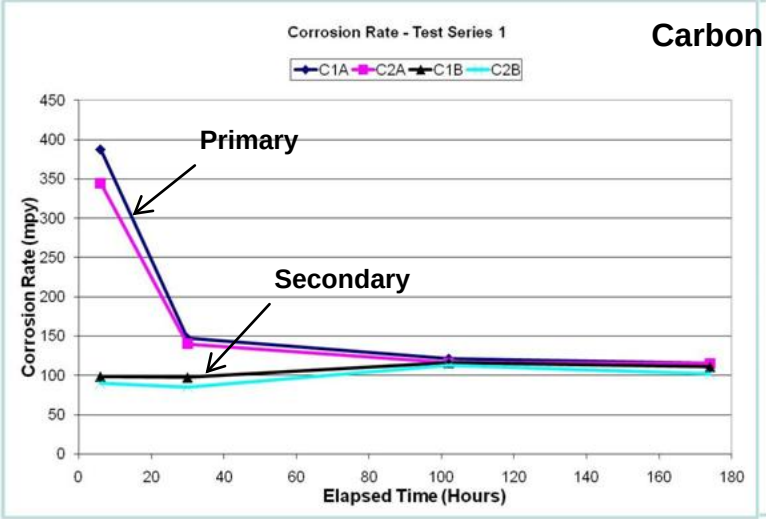


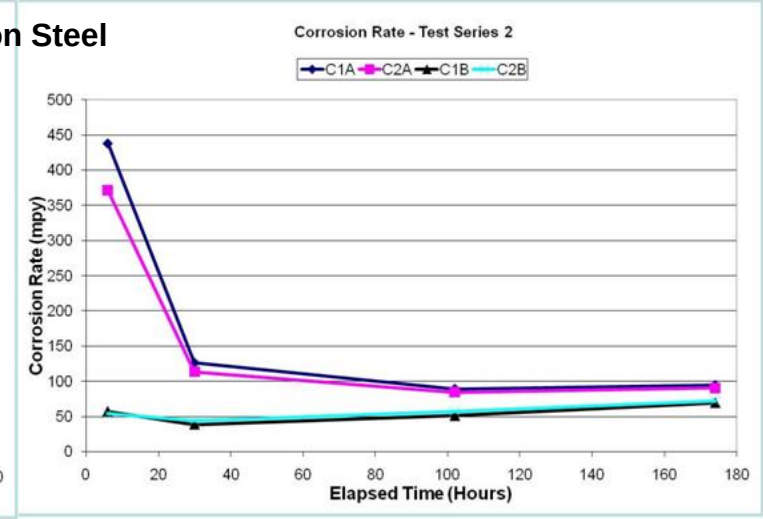


Corrosion Rate vs. Time

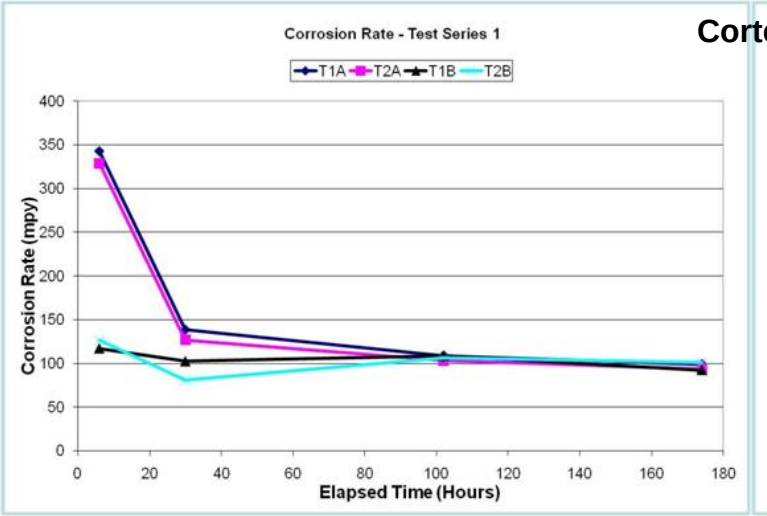
PRB Condensate

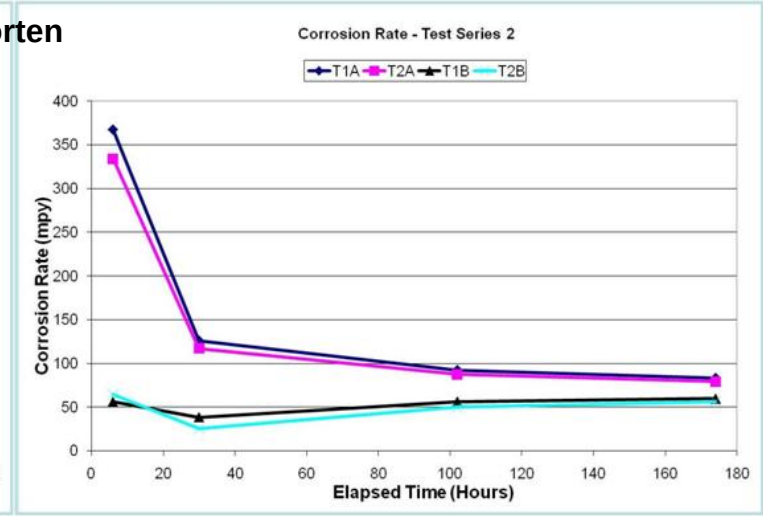
Carbon Steel





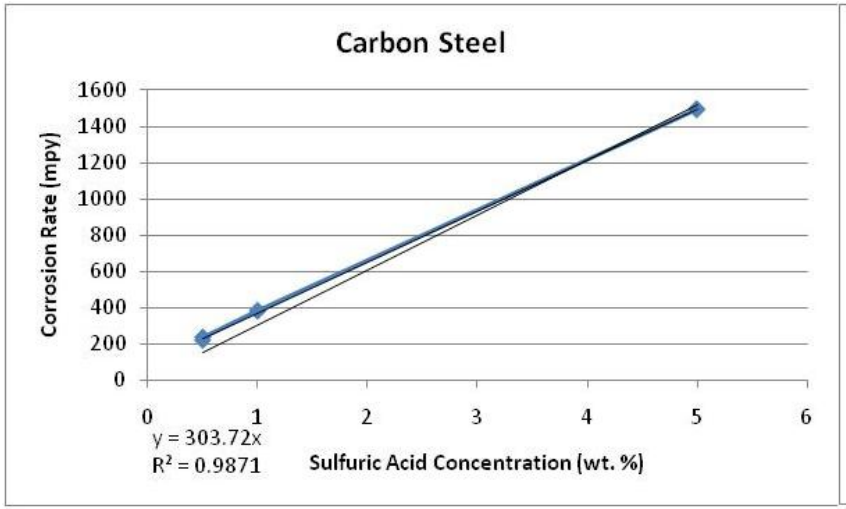
Corten

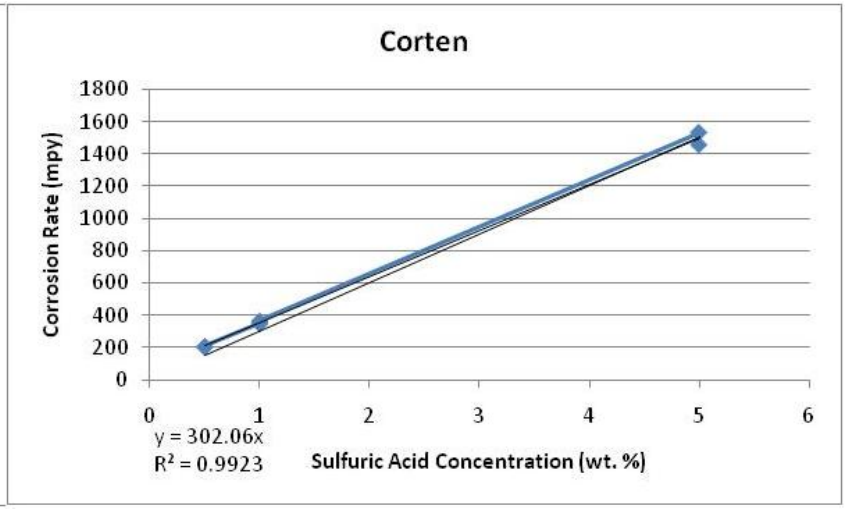




Corrosion Rate vs. Acid Concentration

Samples Fully Immersed in Sulfuric Acid





Ductwork Interior Surface Appearance

← Gas T < Dew Point

Gas T > Dew Point →

Conclusions

- Laboratory tests performed to evaluate fireside corrosion potential of FG2
- Conventional stainless steels may be used for highest temperature sections of SH/RH in subcritical oxy-fired boilers
- Dew point corrosion severe in recycle loop/back end if acid allowed to condense
- Gas temperature designed above dew point or use of coating is essential in recycle loop