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Improving Boiler Heat Transfer Efficiency with Film-Forming Amines

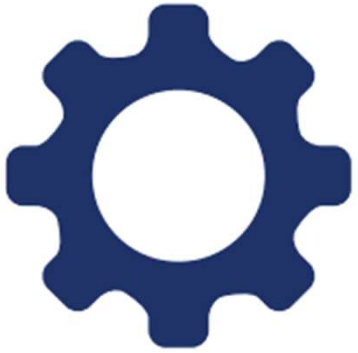
magnus

Overview

Savings with Film Forming Amines

2.4% Improvement in Boiler Efficiency

2.9% Decrease in Natural Gas used (while meeting ASME guidelines)



8 x Reduction in Condensate Corrosion Rate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Problems

Paper Plant Producing Recycled Boxboard

Problems

- Boiler water was above ASME guidelines for water quality
- Poor steam quality due to carryover, causing energy inefficiencies
- Complicated chemical treatment program – feeding 2 amines to 2 different injection points

Program Comparison	ASME Guidelines	Operating Conditions for Previous Program
Conductivity (µmhos)	7000	4612
Silica (ppm SiO_2)	150	222
Alkalinity (ppm $CaCO_3$)	700	650

Well above limit

Solution

Paper Plant Producing Recycled Boxboard

Objectives

- Operate at lower cycles to meet ASME guidelines without a major increase in energy consumption
- Eliminate or reduce carryover
- Maintain or improve condensate corrosion rates
- Reduce product handling by going from 3 products to 1

Solution: Film-Forming Amines (FFA)

Changing boiler water treatment

- A change to the chemistry of film-forming amines allows them to work as a metal treatment
- Formation of a uniform hydrophobic film controls corrosion from dissolved oxygen and carbonic acid
- The film will form on both clean and dirty surfaces
- The contact between water and the metal surface is modified; the metal surface becomes water repellent

Condensate pipe

Condensate piping treated with FFA, a water droplet on the hydrophobic metal surface

Condensate pipe

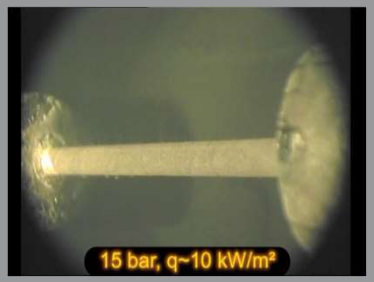
Condensate piping treated with FFA, water wets the surface where the film has been scraped off

Film-Forming Amines: Effect on Heat Transfer

Optimization of Energy Efficiency

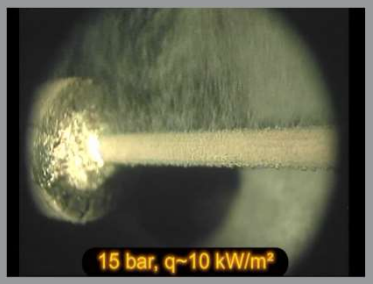
- Promotes nucleate boiling on the heat transfer surface
- Increased bubble count during steam production
- Heat transfer is substantially improved and fuel energy consumption is optimized

Conventional Treatment



218 psig
Constant heat input

FFA Treatment



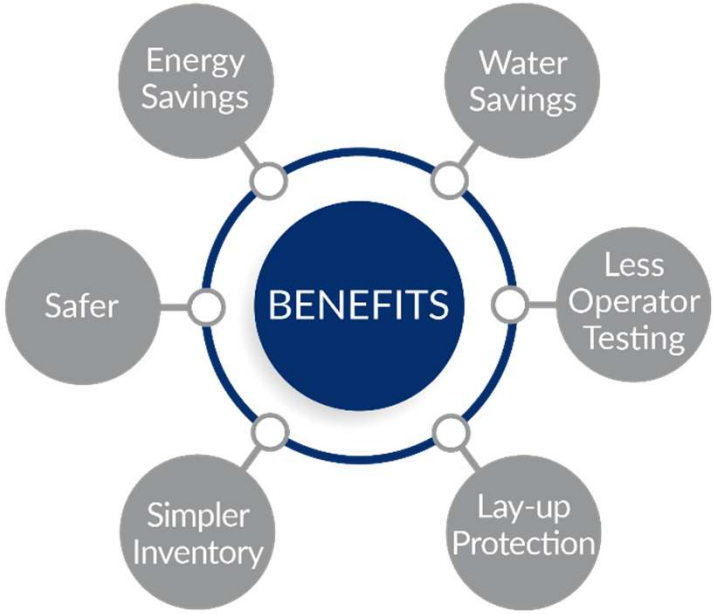
218 psig
Constant heat input

*Reference: University of Rostock GER

Film-Forming Amines: Effect on Chemistry

Organic Chemistry

- Reduction of boiler water carry-over
  - No contribution to conductivity
  - Improved steam quality and purity
  - Increased steam enthalpy
- No reaction with dissolved oxygen
  - Reduced chemical product consumption
- Replaces up to 4 chemical products
  - Less handling and pump maintenance



Results & Lessons Learned

Results

Saving Energy, and meeting ASME guidelines

- Re-established ASME guidelines for silica and alkalinity by reducing cycles in boiler from 248 to 111
  - Normally, this would mean a huge increase in gas consumption
  - Plant observed a DECREASE in natural gas used per unit of steam produced with FFA technology
- Boiler efficiency improvement of 2.4%!

Results & Lessons Learned

Comparing Programs: Reduced Gas Consumption

- Normalizing steam production for the years that different treatment programs were used:
  - Energy Savings: 387,106 m^3/year of natural gas (decrease of 2.9%)
    - at 13¢/m^3, that's $50,324/year saved with FFA Treatment
  - Significant natural gas reduction despite running at lower cycles

Program Comparison	Program Savings Switching to FFA
Boiler Cycles	248.3 down to 110.9
Boiler Heat Transfer Efficiency	2.4% improvement
Natural Gas Reduction (m^3/year)	387,106
Greenhouse Gas Reduction (tonnes CO_2e)	744

Results

Decreased Condensate Corrosion Rate

- Condensate lines were treated with conventional neutralizing amines and DEHA

- Switch to treatment with Film-Forming Amines reduced corrosion rate by a factor of 8

Before Film-Forming Amines: 1.36 mpy

After Film-Forming Amines: 0.17 mpy

Conclusions

Operate at lower cycles to meet ASME guidelines without a major increase in energy consumption

- Increased boiler efficiency by 2.4%; decrease in cycles actually corresponded to a DECREASE in natural gas used

Eliminate or reduce carryover

- Foaming from sample points has been greatly reduced

Maintain or improve condensate corrosion rates

- Corrosion rates have decreased by a factor of 8

Reduce product handling by going from 3 products to 1

- Improved the treatment program with less product handling