Overview of Factors Affecting Fouling in Recovery Boilers

Honghi Tran
University of Toronto

Colloquium on Black Liquor combustion and Gasification,
Park City, May 12-16, 2003
Three Principal Parameters Determining the Rate of Fouling

- Particle Concentration
- Particle Stickiness
- Sootblowing Efficiency
Particle Concentration

Particle Stickiness

Deposition

Low Conc.

Less Sticky
Deposition

Particle Concentration

Particle Stickiness

Fouling/Plugging

Sootblowing Efficiency

High Efficiency

Low Conc.

Less Sticky
Types of Particles

- **Fume**: 0.5 µm (0.1 - 1 µm)
- **ISP**: 20 µm (1 - 100 µm)
- **Carryover**: 500 µm (100 µm - 3 mm)
ISP Covered with Fume
Three Principal Parameters Determining the Rate of Fouling

- Particle Concentration
- Particle Stickiness
- Sootblowing Efficiency
Factors Affecting Carryover Concentration

- Firing load
- Air flow rate and distribution
- Black liquor properties
- Black liquor sprays
  - Nozzle design
  - Liquor temperature and pressure
  - Liquor properties
Liquor Spray Study at Domtar Espanola

May 2, 2003
Three Principal Parameters Determining the Rate of Fouling

- Particle Concentration
- Particle Stickiness
- Sootblowing Efficiency
Factors Affecting Carryover Stickiness (Liquid Content)

- Particle composition
  - Black liquor composition (Cl, K)
  - Black liquor droplet size
- Particle temperature
  - Flue gas temperature
  - Retention time
  - All burning particles are sticky!
U of T Entrained Flow Reactor

- Sample
- Gas burner
- Particles
- Furnace
- Probe
- Camera

9 m
0 mole% Cl/(Na+K)

1

5

10

20
Effect of Particle Size on Deposition

Mill “A” Black Liquor
EFR Temp. = 800°C
Prediction of Sticky Temperature

Black Liquor Composition

Particle Composition

Sticky Temperature
Composition (Wt%)

Oxidized Smelt:
- Na$_2$SO$_4$ (30)
- Na$_2$CO$_3$ (65)
- K-salts (2.5)
- NaCl (2)
- Carbon/impurities (1)

Carryover:
- Na$_2$CO$_3$ (50)
- K-salts (2.5)
- NaCl (2)
- Carbon/impurities (1)
Carryover Particle Composition Continuously Changes

- Cl, K and carbonate contents are lower than previous thought
- S (sulphate and sulphide) content is higher
- Changes depend strongly on particle size, temperature and excess O₂
Factors Affecting Sootblowing Efficiency

- Sootblower nozzle design
- Blowing sequence and frequency
- Deposit adhesion strength
  - Composition
  - Tube temperature
- Tube arrangement
Three Principal Parameters Determining the Rate of Fouling

- Particle Concentration
- Particle Stickiness
- Sootblowing Efficiency
Deposit Removal Studies

- Laboratory studies
  - Composition
  - Tube surface temperature
  - Particle size
- Numerical simulation
  - Free jet
  - Jet-deposit interaction
- Field studies
  - Sootblowing efficiency
Effect of Chloride on Removal

Probe temp. = 400°C
0% K
% CO₃

mole% Cl/(Na+K) vs. PIP (MPa)
Effect of Potassium on Removal

Probe temp. = 400°C
0% CO₃

Minimum PIP (MPa)

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<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
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<th>1.2</th>
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- 5 mole% Cl/(Na+K)
- 2 mole% Cl/(Na+K)
Air Jet Impingement Apparatus
Conclusions
Acknowledgements

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