Recovery Boiler Research Needs – An Industry Perspective

Andrew Jones
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International Paper Recovery
Operation Goals

• Key Concerns of International Paper regarding recovery boiler operations
  – Minimize downtime on recovery boiler, with the goal of eliminating water washes and dry cleaning between annual outages
  – Operating strategies that generate the most net energy from black liquor
  – Positive impact of the recovery boiler on recovery cycle energy efficiency
  – Minimize penalty of operating older technology versus new boiler performance
Minimizing Downtime

• Recovery Boiler downtime costs from $100,000 to $300,000 per day at our facilities
• Water washes is a boiler is severely fouled take from 24-40 hours
• We also have to do frequent dry cleanings on our boilers where we stop liquor firing and operate sootblowers continuously in the superheater and generating bank areas of the boilers – this can damage the recovery boiler due to cyclic fatigue
• Our goal is to eliminate both of these causes of downtime on our recovery boilers
Minimizing Downtime

• What we require are:
  – Recovery boiler operating strategies that minimize fouling
  – Tools for assessing the impact of changes in chemistry on boiler fouling
  – Guidelines on how to most effectively use sootblowers or other cleaning methods to minimize boiler fouling
  – Identification of upgrades to boiler operating equipment that are most effective in reducing fouling
Strategies to increase recovery boiler net thermal efficiency

• Maximize percent solids
• Maximize steam temperature
• Maximize steam flow
• Minimize excess air at stack
• Minimize fouling
• Minimize sootblowing
• Minimize auxiliary power use
Maximize Percent Solids

• Stabilize at as a high a percent solids as possible from concentrator
  – Controls, Better Understanding of Fouling Process
• Minimize the use of direct heating with steam
  – Higher percent solids in liquor
• With direct contact evaporators minimize the use of dilution water
  – Control solids at evaporator outlet to normally not require dilution in cascade or cyclone
Maximize Steam Temperature

- Steam temperature can be reduced if Chloride levels in black liquor are high
  - Can be a significant justification for cost of chloride control
- Corrosion may require more attemporation in order to limit exit steam temperature
- Higher steam temperatures results in additional power generation
  - This can be of considerable value
Maximize Steam Flow

• This goal applies on steam limited recovery boilers
• Apply controls so that the boiler operates as close as possible to the steam limit (Consumed air controls)
• Allows you to generate as much low cost steam as possible
  – Also helps production!
Minimize Excess Air At Stack

- Excess air can be coming in through fans or as leakage (tramp) air in the areas of the boiler with high draft.
- From an efficiency standpoint the goal is to minimize excess air at the stack.
- Combustion air can be minimized by good air system operation and control.
- Leakage air minimization requires good maintenance practices.
Minimize Fouling

• This is beneficial for a number of reasons
  – Increases the thermal efficiency of the boiler
  – Reduces sootblowing steam usage
  – Reduces ID fan horsepower as these are typically variable speed drives

• Knowing all about how we can do this from an operational, chemistry and cleaning strategy is vital
Minimize Sootblowing

• The steam used for sootblowing can often be very expensive
• Many methods exist for reducing consumption of sootblowing steam while not negatively impacting recovery boiler fouling
• What are the most effective methods and where should they be applied?
Minimize Auxiliary Power/Steam Use

- Fans consume a lot of power
  - Examine if they are oversized, if so they can be replaced

- Excessive air temperature may be consuming high cost steam
  - It generates steam on the recovery boiler but there is some efficiency loss

- Condensate systems on steam coil air heaters can be inefficient
Impact of the Recovery Boiler on Cycle Efficiency

- High dregs
- Low reduction
- Variable baume from dissolving tank
High Dregs

• The main negative impact of high recovery boiler dregs is on the mud solids on the lime kiln
  – Mud solids decrease
  – Increases fuel usage on the kiln
• High recovery boiler dregs can be due to poor operation and control of the recovery boiler
Low Reduction Efficiency

• The main negative impact of low reduction efficiency is increased evaporation of the water associated with the sodium sulfate

• Cost of low reduction efficiency is not fully understood
Poor Control of Green Liquor Strength

• High variability in green liquor strength (baume) will result in variability in the causticizing efficiency

• This increases the evaporative load due to the water associated with the sodium carbonate
Minimize the Penalty of Operating Older Technology

• We will continue to operate direct contact boilers for many years

• These boilers have lower thermal efficiency as they use direct heating of liquor with flue has as a means to evaporate water
  – Typically 20% less steam generation for same amount of black liquor burned

• How to minimize the negative impact of these boilers
  – Avoid over-oxidizing the liquor
  – Maximize percent solids
  – Minimize downtime due to more complex operating systems
  – Upgrade air systems to reduce excess air used
Critical Research Needs

• Research need 1 – Maximizing and stabilizing concentrator product solids at maximum levels, how to do this and what is the energy impact

• Research need 2 – Maximum exit steam temperatures as a function of materials and deposit properties and the energy, how to do this and what is the energy impact
Research Needs

• Research need 3 – Minimizing fouling and the impact on boiler efficiency
• Research need 4 – Methods for reducing sootblowing steam consumption and the energy impact
• Research need 5 – Minimizing recovery boiler dregs formation
• Research need 6 – Energy impact of low reduction and causticizing efficiency
International Paper

- We have sales of about $25B/yr
- We employ 83,000 people
- We operate 19 pulp and paper mills around the world including the USA, Russia, Poland, France, Brazil. With many more smaller facilities (paper mills, converting plants) in over 120 countries
- We currently operate 42 recovery boilers
- The largest is 7.4MM lbs DS/day (3350 Metric tons/day)
- The smallest is 0.8MMlbs DS/day (363 Metric tons/day)
- We have many older boilers currently 36 of our boilers are more than 20 years old
About me

- I’ve worked for International Paper for 9 years and I’m responsible for making sure our recovery boilers operate with the highest energy efficiency, with minimum downtime due to fouling and that improvements are made to our recovery boilers when justified
- Prior to my current job I worked for ABB-Combustion Engineering on recovery boiler operations/design and R&D
- I received my PhD from the Institute of Paper Chemistry in 1989 – topic was CFD modeling of a Kraft recovery boiler