IMPROVING WOOD KILN BOILER RELIABILITY VIA A NEW WATER TREATMENT CONTROL TECHNOLOGY

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Here’s what we’ll be covering this morning

- Purpose of the boiler in a wood products plant
- Challenges associated with operating a boiler in a wood products mill
  - Operational
  - Resources
  - Personnel work load
- Boiler chemical treatment, its application and evolution
- New developments in boiler feedwater scale and corrosion control
- Wood products plant application of the new technologies
- Outcome and benefits of the application
The boiler is crucial for wood products manufacturing

- Controls the drying process
  - Kiln coil heating
  - Steam humidification

- Optimum Moisture Content is Crucial
  - Higher end-use product value
  - Better material usability
  - Increased product strength
  - Lower shipping costs
  - Better insulating and finished material properties

- Drying too fast / too slow - both are bad

As much as 80% of a mill’s energy requirement can be for the drying process
There are two major water related challenges encountered in operating a boiler – scale and corrosion

**Mineral Scale**
- Forms as a result of dissolved minerals in the feedwater exceeding solubility
- Forms insulating material
- Impedes heat transfer
- Can result in equipment damage / boiler shutdown / loss of production
Corrosion is nature’s way of reclaiming refined metals…

- **Corrosion**
  - Two primary types in boilers systems
    - Carbonic acid (condensate)
    - Oxygen
  - Reduce asset life
    - Pitting corrosion
    - General corrosion
  - Cause iron deposits on boiler tubes (energy losses)
  - Shutdown, production loss and safety issues
Over time, chemical treatment of boiler feedwater to prevent or reduce the impact of these challenges has changed.
For scale control, many advancements have taken place in chemistry over the last century.

<table>
<thead>
<tr>
<th>Program</th>
<th>Developed / Used</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>Coagulant / Soda Ash</td>
<td>1900 - 1950</td>
<td>Reduced and easier to remove scale</td>
<td>Still forms scale, program adds solids, increases blowdown requirements. Soda ash can result in increased condensate corrosion</td>
</tr>
<tr>
<td>Phosphate</td>
<td>1930's</td>
<td>Reduced CaCO₃ scale, Reduced solids addition</td>
<td>Still potential for PO₄ scale</td>
</tr>
<tr>
<td>Chelants</td>
<td>Early 1960's</td>
<td>Comparatively lower solids contribution</td>
<td>Corrosion potential if overfed Potential for MgSiO₃ scale</td>
</tr>
<tr>
<td>Phosphonates</td>
<td>Late 1970's</td>
<td></td>
<td>Could result in scale if feedwater hardness not very well controlled</td>
</tr>
<tr>
<td>Polymer overlay for phosphates or chelants</td>
<td>Late 1970's</td>
<td>Conditioned specific types of suspended solids - Fe₃O₄, Fe₂O₃, Ca₃(PO₄)₂, MgSiO₃ to make them less adherent to boiler surfaces</td>
<td>Still potential for PO₄ scale Corrosion potential if overfed Potential for MgSiO₃ scale</td>
</tr>
<tr>
<td>Polymer only (1st gen - polyacrylic acid)</td>
<td>Early 1980's</td>
<td>Maintains hardness in soluble state Reduces solids contribution to boiler water Reduced corrosion potential compared to chelant programs Disperses iron</td>
<td>Could complex with boiler metal if overfed High hardness could cause polymer / hardness complex to deposit</td>
</tr>
<tr>
<td>Polymer only (2nd gen - sulfonated polymer)</td>
<td>2001</td>
<td>Maintains hardness in a soluble state. Less corrosive than chelant. Increased thermal and oxygen stability Keeps suspended solids dispersed Does not precipitate or form precipitates Reduces iron deposition rate.</td>
<td>Could be corrosive if greatly overfed</td>
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</tbody>
</table>
For control of oxygen corrosion in preboiler equipment, we have developed effective chemical oxygen scavengers ...

... but we have still lacked technology that could reliably monitor and control changes in that environment!
...however, the basic approach to controlling boiler water chemistry has always revolved around a “test and adjust” approach...

- Gather sample
- Test
- Adjust chemical feed
- “Repeat as necessary”

Equipment damage / efficiency loss / production loss
...and is still largely centered around testing the water after it is in the boiler

DEAERATOR

An event taking place here....

...could take hours or days to show up here!

By then, its far too late to detect or remedy
We’ll be talking about two new technologies:

- **3D TRASAR Technology for Boilers™**
  - Measures and controls scale inhibitor chemistry
- **Nalco Corrosion Stress Monitor™**
  - Measures and controls pre-boiler corrosion environment

- Real time, on-line control 24/7
- Process visibility for these areas
- Assurance of asset protection
- Optimized chemical usage
- Improved energy savings opportunities
New Boiler Automation Technology

- Directly measures
- Automatically responds
- Maintain optimum treatment levels

**TRASAR Automation**
- Direct control of scale
- Inhibitor chemistry

**NCSM Automation**
- Direct control of preboiler corrosion

Figure 1: LP #3 AT-T ORP Results During Phase 1 and 2 of AEPCO Trial
We implemented and evaluated these technologies at Boise Building Solutions, Manufacturing in Kettle Falls, WA

Results from on-site work
The boilerhouse at Kettle Falls is similar to many others

- 150 psi boilers
- Average 30,000 lbs steam / hour
- Sodium zeolite, dealkalized make-up water
- Steam used primarily for controlling the drying process
- Chemistry is adjusted by daily testing
There were several objectives for the evaluation

- Improved chemistry control
- Optimized operating costs
  - Reduced water costs
  - Reduced energy costs
  - Improved efficiency – avoiding iron deposits in the boiler
Like a lot of other mills and manufacturing plants, this plant has wide swings in steam load.

Figure 4 shows the steam load variations common to wood plants.
We began by establishing current control baseline – for both scale control and boiler feedwater corrosivity, there was extensive variability.

Figure 5 – Steam load and scale inhibitor levels vary greatly during the monitoring phase of the new control technology implementation.

Figure 6 – Boiler feedwater corrosivity also varies widely with steam load swings during the monitoring phase.
Many useful discoveries occurred during the evaluation
A return condensate pump outage showed up as a large increase in feedwater corrosivity.

In a control mode, this change in feedwater corrosivity would have automatically been addressed.

Monitoring mode

...which resulted in an increase in feedwater corrosivity.

A condensate pump failure, resulting in a reduction in returned condensate...
A short term boiler outage showed how this technology could avoid an overfeed.

Monitoring mode

1 - ID fan turned off, boiler shutdown

2 - Chemical feed continues

3 - Boiler feedwater flow re-established, chemical concentration drops

Figure 8 shows how a chemical overfeed can occur in the absence of real-time control capability.
On Mid February, the technology was put into Phase 1 (on/off) control mode...

Control started

...and despite the wide variation in steam loads...
One of the other advantages of this technology is the ability to view the data on the web in real time to ensure control is maintained.
Excellent improvement in control capability resulted

<table>
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<tr>
<th>Feedwater Scale Inhibitor</th>
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<tr>
<td>Desired control range: 8 ppm +/- 0.5 ppm</td>
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<table>
<thead>
<tr>
<th>Feedwater Scale Inhibitor</th>
<th>Pre-boiler Corrosivity</th>
<th></th>
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<tbody>
<tr>
<td>Desired control range: -400mV +/- 10 mV</td>
<td></td>
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<tbody>
<tr>
<td>Average dosage</td>
<td>17.01 ppm</td>
<td>6.7 ppm</td>
<td>Operating above the control range wastes treatment chemicals; operating below the control range increases the risk of scale (wasted fuel), damage to the boiler and production losses</td>
<td>Average reading</td>
<td>-366 mV</td>
<td>-401 mV</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>+/- 23 ppm</td>
<td>+/- 2.4 ppm</td>
<td>An 89.6% reduction in standard deviation</td>
<td>Standard deviation</td>
<td>+/- 71mV</td>
<td>+/- 13 mV</td>
</tr>
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</table>
As expected, wet chemistry control has gotten tighter as well. Standard deviation has decreased by 49.2%
Another achievement was the reduction in water per volume of production.
Some of the improvement highlights included

- Improvement in pre-boiler corrosion stress control
  - Before - 44% in desired range
  - After – 87.1%

- Scale control overfeed reduced from 73% to 15%
  - More improvement anticipated as next control protocol steps are taken

- Summary of improvements and ROI
  - From the initial work since implementing the overall program – cycles have increased from 10 to 30
    - Blowdown reduced by 69%
    - Water saved – 2.4 Million gallons
  - Reduced wet testing
  - Extended equipment life
  - Improved efficiency
  - Greatly increased knowledge of system behavior
  - Enhanced process visibility
  - Reduced total operating cost
Key Take Aways...

- Asset Reliability and Efficiency is the Key in Steam Plant Operations

- Controlling Scale and Corrosion is the Key to Asset Reliability

- New Methods of Measurement and Control have “Changed the Game”
  - Indirect Control to Direct Control
  - Reactive to Proactive
  - Greater Visibility with less Operations Time Requirement
  - Equals Greater Asset Reliability with lower Total Costs of Operations