Recovery Boiler Combustion control system (CCS) & Emergency shutdown (ESD).

Mario López
Jorge Quesada

Rockwell Automation
Process Solutions User Group (PSUG)
November 14-15, 2011
Chicago, IL - McCormick Place West
Company Profile

Carvajal Pulp and Paper is part of Carvajal Group, a privately owned company established in 1904 and headquartered in Cali – Colombia, with over 20,000 employees and annual revenues of over US$ 1.5 billion from seven sectors and operations in 16 countries:

- Technology and Services
- Information
- Pulp and Paper
- Communication Solutions
- Packaging
- Education
- Espacios
Carvajal Pulpa y Papel is a pioneer in manufacturing paper from 100% sugarcane fiber.
The Paper Mill
What is the purpose of the Black Liquor Recovery Boiler (BLRB)…?

- Economic – Reclaims chemicals used during the fiber digestion
- Environmental – Closures the process avoiding waste water impact
Recovery Boiler = Chemical Reactor

Source: Black liquor recovery: How does it work? Magnus Marklund
Recovery Boiler

Operation Risks

- Problems of operation and safety exceed those of conventional power boilers.

- All details of the smelt-water reaction are not thoroughly understood and fundamental information is still lacking.

- Most BLRB explosions have been due to the reactions with molten smelt and water in some form or low solids liquor.

- Uncontrolled ignition of an accumulation of unburned fuel from the auxiliary burners/ gases from pyrolyzed black liquor.

- Dissolving tank explosions due to excessive and uncontrolled smelt runoff or excessive high density in the dissolving tank.
Recovery Boiler

Process Requirements

• High Availability
• Safe Operation
• Reliability

Main Systems

• Feedwater and condensate
• Air and flue gas
• Black liquor firing
• Auxiliary fuel burning (start up and load increase)
• Soot blowing
Recovery Boiler

Process Control

• CCS: Combustion Control System
  – Regulatory control: drum level, furnace pressure, etc
  – Discrete control: water pumps, ID fan, FD fan, etc.

• BMS: Burning Management System
  – Safe operation of auxiliary fuel

• ESP: Emergency Shutdown Procedure System
  – Reliable shutdown if water is known or suspected to be entering the furnace (i.e. leaking pipe)
Recovery Boiler

The need for upgrade...

BLRB data

- Manufacturer: Ahlström-Varkaus
- Design yr: 1972
- Installation yr: 1973

Issues:

- Some failures were hard to fix
- Lack of spare parts for obsolete components
- Reliability could be compromised.

Copyright © 2011 Rockwell Automation, Inc. All rights reserved.
Control Room
Process Audit

An audit to evaluate the BLRB risk was conducted...

Identified critical aspects
• System integrity
• Safe operation requirements.
Process Audit

Set a road map with priority levels:

A) To do now: ESP upgrade, flame scanners and refractometers
B) To plan for soon: BMS upgrade
C) To plan for the future: CCS upgrade.
Recovery Boiler Challenges

System requirements

• NFPA Regulations
  – NFPA 85 Boiler and Combustion Systems Hazard Code
  – NFPA 86 Furnace and Ovens

• Industry Practices
  BLRBAC Black Liquor Recovery Boiler Advisory Committee.
BLRBAC Guidelines for Safety Instrumented Systems\(^{(1)}\):
There are no specific technology requirements: electronic relays and timers, solid state logic types, programmable electronic systems, hard wired logic or combinations of them.

Applications include:

- ESP, Rapid Drain
- Safe Firing of Black Liquor
- Safe Firing of Auxiliary Fuel

Safety Instrumented System Requirements

General Recommendations for ESP and Burner Management:

• Requires several features related to hardware robustness:
  – Fail safe state on failure
  – Non-volatile memory
  – Maximum time to read field inputs/initiate action, etc.

• Requires several features related to program integrity and change control
  – Password
  – On-line modifications not permitted
  – No share of any single fault, etc.
Safety Instrumented System Requirements

• Requirements Applied to ESP:
  – Redundant methods or processor to ensure ESP initiation
  – Bumpless transfer between processors
  – Alternate means of operation or alternate entry points if a digital control system is used (network redundancy accepted)
  – Routine Backup and auto transfer for processor redundancy testing
  – SIS logic state retention should have power from an independent source

• Requirements Applied to Burner Management:
  – Conformance to BLRBAC, FM, NFPA, UL, etc.
  – Master fuel trip relay / hardwired master fuel trip switch accessible to the boiler operator.
  – Trip sequence initiating device indication
CCS - Control System Requirements

BLRBAC Guidelines for Recovery Boiler Control Systems \(^{(1)}\):

- Fail safe mode
- Firm power source
- Backup system
- Critical loops backup
- Communication redundancy
- Man machine interface
- System security

## Technology Selection

<table>
<thead>
<tr>
<th>Application</th>
<th>Logic Complexity</th>
<th>I/O Requirement</th>
<th>I/O Count</th>
<th>HMI Requirement</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESP</td>
<td>Low</td>
<td>Digital</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DI: 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DO: 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td>High</td>
<td>Digital</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DI: 150</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DO: 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCS</td>
<td>Medium</td>
<td>Analog/Digital</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AI: 140 / AO: 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DI: 190 / DO: 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2011 Rockwell Automation, Inc. All rights reserved.
Vendor Selection Criteria

Key Aspects to be Considered

- Proven Technology
- Proven Application Knowledge
- Life Cycle Cost (TCO)
  - Initial Investment
  - Local Support
  - Spare Parts Management.

RA proved to provide the best balance of the aspects above.
Upgrade implementation

CCS: Combustion Control System
  • PlantPAx

ESP: Emergency Shutdown Procedure Syst.
  • Safety relays

BMS: Burning Management Syst. (By COEN)
  • PlantPAx.
CCS and ESP

CCS Redundant Controllers
ESP

Obsolete ESP System

New ESP System
Improved Operation
Benefits

• Provided Employees with a Safe Work Place
• Improved Operation and Maintenance through Process Integration
• Physical Assets and Business Continuity Preservation
• Customers Satisfaction and Market Presence
• Decreased Cost of Risk
• Decreased Life Cycle Cost.
Conclusions

- Technology is not enough, application expertise is crucial for project success
- Go digital is not always the best, see if it fits your application
- Take advantage to reduce Life Cycle Costs:
  - Initial Investment
  - Local Support
  - Spare Parts Management
- Negotiate the full package.
Questions

Mario López
Mario.LopezSoto@carvajal.com
Jorge Quesada
Jorge.Quesada@carvajal.com