Update of Regenerative Reheat Furnace Conversions in North America

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Asian Regenerative Reheat Furnace
Upgrade Objectives

Production Increase
Process Change
Heating Quality Improvement
Fuel Efficiency Improvement
Emissions Abatement
Furnace Upgrade Alternatives

Retrofit Existing
  Inexpensive
  Outage Required

New Furnace
  Expensive
  Minimal Downtime
  Integration Issues
Hybrid Regenerative-Recuperative
Regenerative Media After 1 Yr
Regenerative Retrofit Alternatives

Add Booster Zone
One for One Burner Replacement
Reconfigure Furnace Zones
Reheat Furnace Efficiencies

Typical Combustion Efficiency Comparison

- Avail Heat Cold Air
- Avail Heat Recuperative
- Avail Heat - Recup air and O2 Enrichment
- Avail Heat Regenerative

Furnace exhaust temperature, Deg F
Timken Gambrinus
#4 Rotary Furnace
Regenerative Burner Retrofit
Existing Operational Assumptions

- 92,000 TPY
- 154 MM BTU/hr available heating
- 4.0 MM Btu/Ton
- 4.5 diameter x 10’ long – max 55 TPH
- 2250 deg F discharge temperature

**Furnace Operating Parameters**

- Product 3.25” to 5.5” diameter
- 4.5” diameter pieces without zone 2
- 5.5” diameter pieces with zone 2
- Length 5-10’
- 2250 F discharge temperature
- 2350 F maximum set point temperature
- Cold air firing
Zones 3 & 4 Retrofit

Zone 3
• Existing: 13 bloom 601 burners (52 MM Btu/hr total)
  – Retrofit: 3 triads
  – 3-1150-075 burner (inside)
  – 6 - 1150-035 burners (outside)
    27.0 MM Btu/hr total (nominal)

Zone 4
• Existing: 8 bloom 601 burners (25.3 MM Btu/hr total)
  – Retrofit: 2 triad
  – 2-1150-50 burner (inside)
  – 4-1150-25 burners (outside)
    11.0 MM Btu/hr total (nominal)
#4 Rotary Configuration With Regenerative Burners

5-601 Bloom Burners
22.5 MM BTU

3 Triads
3-1150-075 burner (inside)
6- 1150-035 burners (outside)
27.0 MM Btu/

2-Triads
2-1150-50 burner (inside)
4-1150-25 burners (outside)
11.0 MM Btu/hr

8 Bloom 601 Burners
(25.3 MM Btu/hr total)

4 total - 2 Bloom 401 @ 1.5 MM
2 Bloom 601 at 3.15 MM=9.3MMbtu

Total 95MM BTU/HR
Percentage of savings based on daily tonnages
25% overall
• Maintenance Recap of Regenerative System
  – 1 triad of media changed – hottest zone at 2 years.
  – Replaced 1 cycle valve, 3 pneumatic switching valves, 2 air baffles.
  – Preventative Maintenance needed of cycle valve switching speeds (speed check of each cycle valve adjusted with pneumatic switching valves). Check 2 times a year.
  – Programming to be implemented to add a “bottle” or zone shut off option when needed heating firing rate is below 25%.
Additional Installation-Considerations

• Instrumentation for predictive maintenance of regenerative burner systems
  – Continuous monitoring of differential pressure of media bed
  – Thermocouple- monitoring of preheated air temp per media bed
  – Data system would track increase in differential across beds and decrease in temperature of exhaust air
  – Tracking would provide better scheduling of cleaning of media beds to eliminate unnecessary downtime and costs

• Equipment specification sheets on set up are critical
  – Cycling valve timing setup
Walking Beam Furnace

UNFIRED  CHARGE  HEAT  SOAK

SLABS
Retro-Fit
Benefits

- Faster Heating (Reduced Residence Time).
- Increased Throughput:
  Nameplate Increase: 195 to 225 TPH
- Unchanged Natural Gas Consumption.
- Reduce Stack Emissions.
Reheat Furnace Residence Time

Baseline

REGEN

Avg = 211.4

Minutes

X=179.5
UCL=195.8
LCL=163.3

UCL=195.8
LCL=163.3

Jan-06
May-06
Sep-06
Jan-07
May-07
Sep-07
Jan-08
May-08
Sep-08
Jan-09

Avg = 211.4
Reheat Furnace Throughput

Baseline   Improvement Projects   REGEN

UCL=194.20
\bar{X}=185.6
LCL=176.98

Tons Per Hour

Q1-05  Q2-05  Q4-05  Q2-06  Q3-06  Q1-07  Q3-07  Q4-07  Q2-08  Q4-08  Q1-09

160  165  170  175  180  185  190  195

195  190  185  180  175  170  165  160

163.1  174.2  185.6
Reheat Furnace Natural Gas Consumption

Avg = 1.39

Baseline

REGEN

UCL=1.5505

LCL=1.1872

Avg = 1.39

X=1.37
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Nucor Steel Marion Div.

- Located in Marion, OH.
- 14 stand repeating mill.
- #4 bar through #11 bar produced.
- 1.75# - 5# Sign post produced.
- Mix of rounds and J-bar produced.
Nucor Steel Marion Reheat Furnace Upgrade

- Reduce NOx
- Increase capacity from 90tph to 125tph
- Reduce MMBTU/Ton from 1.47 to 1.2
- PLC Air/Gas ratio control
- Run the furnace with a level 2 system
- Combustion System Reliability Enhancement
GIVEN PROFILE

SOAK ZONE
10 FT

HEAT ZONE
13 FT

PREHEAT ZONE
26 FT

52 FEET EFFECTIVE LENGTH

BLOOM ENGINEERING COMPANY
EXTENDED SOAK PROFILE 125 TPH

- SOAK ZONE: 13 FT
- HEAT2 ZONE: 17 FT
- HEAT1 ZONE: 13 FT
- PREHEAT ZONE: 26 FT

72 FEET EFFECTIVE LENGTH

BLOOM ENGINEERING COMPANY
Soak Zone Extension
Construction During Operation
New Soak Zone Burners
Existing Burners Rebuilt
LOW NOx Burners

- Old burners 0.9 lbs NOx/mmbtu
- Guaranteed 0.115 lbs NOx/mmbtu
- Actual 0.100 lbs NOx/mmbtu
Capacity Has Increased.

- 19 Shift records have been broken since the upgrade.
- Daily record for total tons in a 24 hour period has been broken twice.
- Weekly record has been broken.
- Monthly record for tons has been broken.
- The shipped tons record has been broken since the upgrade.
- Potential dollars gained when charging 460,000 tons = $1,214,676
New vs. Upgrade

• A new furnace would have cost $18 million dollars compared to $6 million spent for the upgrade.
Dual Head Regenerative Burner