Retrofit, Conversion from Solid to Gas Fuel for Circulating Fluidised Bed Utility Boiler

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Overview:

- Circulating Fluidised Bed (CFB) Utility Boiler
- 550 tph steam at 127 barg and 541°C
- Operating on solid fuel for 1.5 years
- Full conversion from Petroleum Coke (Pet Coke)
- Meet NOx requirements and capacity
- Minimal or no impact on waterside
Challenges to Overcome:

- Meet current permit NOx limits - 0.07lbs/mmbtu (118 mg/Nm3)
- No E-FGR (convective impacts).
- Ensure no degradation / derate on steam production.
- Solids return systems - cyclone
- Ancillary equipment
- Fluidization system
- Maintain original design ramp rates
- Maintain 10-1 turndown of steam flow
- No design changes on existing water or steam circuit metallurgy
Options:

1. Remove Fluidised bed bottom and fire vertically.
   - Removes Coal Firing capability

2. Remove Start-Up Burners and Increase Firing Capacity
   - Heat Absorption issues

3. Replace Start-Up Burners and add second level of burners to achieve capacity.
   - Ideal Solution
   - Performance runs are critical for waterwall protection system (circulation ratio) and reliable steam production post-retrofit.
Option 3:

- Replace 4 Start-Up burners with new burners
- Add second elevation of burners
  - (existing tube panel)
- ~80% of equipment remained available for future pet coke firing
- Complete redesign of combustion air system
- Integration of new redundant BMS and controls logic
- New gas fuel skids
- Refractory removal
- Structural support modifications for new equipment
Fluid Bed Bottom - Refractory to be Removed:
Ultra-Low NOx Free Jet Burners:

- Natural Gas firing
- 52 MW HHV (capacity)
- Two Fuel Connections for improved turndown/operation
- Exmo auxiliaries and refractory tile for stability
- Steam lance for NOx reduction
  - never commissioned
- Individual windboxes with dampers
Burner Design Theory:
Combustion Air System Redesign:

- Originally airflow is split between bed lances and start up burners
- All airflow redirected to existing and new burner elevation.
- Physical Air Flow Modeling
Physical Air Flow Modeling:

- Plexiglass Model
- 1/8 Scale

Pressure Coefficient:

\[ C_p = \frac{\text{static Pressure}}{\text{dynamic pressure}} = \frac{1}{[\text{Euler No.}]^2} \]

- Accurate
- Efficient
- Flexible
- Inexpensive
Physical Air Flow Modeling Cont.:

- Airflow Distribution +/-2% to each burner is key.
- Fuel should be “balanced” to each burner
- Flame fit equalized for each burner
- Temperature distribution equalized with firing rate
- System design assistance for balance and pressure drop optimization
Results:

- Unit re-commissioned in less than two weeks.
- <100 mg/Nm3 NOx emissions
  - No FGR or Steam Injection
- 550 tph production achieved
- Sister unit conversion the following year (2014)
Questions?