EXPERIENCE ON OPERATION AND MAINTENANCE OF CFBC BOILER AT KLTPS- KUTCH GUJARAT
TOPICS COVERED

- DESIGN AND CONSTRUCTION FEATURES OF CFBC BOILER.
- MAJOR PROBLEM FACED DURING O&M OF CFBC BOILER.
Type - Natural Circulation, Balance Draught, CFB Combustion, Water Wall Tube Boiler

Total No. of Boilers – 01

Designer - BHEL

Design Fuel - Lignite

Start Up Fuel - LDO and up to 30% of BMCR

Sorbent - Limestone

Inert Material – Bed Material
### DETAILS OF BOILER WATER VOLUME

<table>
<thead>
<tr>
<th>Description</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Economizer</td>
<td>37.8</td>
</tr>
<tr>
<td>2. Super heater</td>
<td>38.9</td>
</tr>
<tr>
<td>3. Combustor water walls</td>
<td>27.0</td>
</tr>
<tr>
<td>4. Back pass water walls</td>
<td>9.5</td>
</tr>
<tr>
<td>5. Drum</td>
<td>10.4</td>
</tr>
<tr>
<td>6. Headers</td>
<td>14.0</td>
</tr>
<tr>
<td>7. Piping</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>187.6</td>
</tr>
<tr>
<td>Water volume with 5% reserve</td>
<td>200.0</td>
</tr>
</tbody>
</table>
**MAIN DESIGNED PARAMETERS**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>BMCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temp.</td>
<td>°C</td>
<td>36</td>
</tr>
<tr>
<td>Main stem at Boiler MSSV outlet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>TPH</td>
<td>315</td>
</tr>
<tr>
<td>Pressure</td>
<td>Kg/Cm2</td>
<td>94</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>540</td>
</tr>
<tr>
<td>Feed Water Temp.</td>
<td>°C</td>
<td>237.3</td>
</tr>
<tr>
<td>Predicted Coal factor @ 100% BMCR</td>
<td></td>
<td>&lt;1</td>
</tr>
<tr>
<td>Predicted Limestone Consumption @ 100% BMCR</td>
<td>TPH</td>
<td>&lt;18*</td>
</tr>
</tbody>
</table>

* Actual consumption of limestone varies based on limestone reactivity and boiler operating condition.
CFBC BOILER AT KLTPS- KUTCHH GUJARAT
OVERALL DIMENSIONS

- **Combustor**
  - Width (m) - 6.88
  - Depth (m) - 11.52
  - Height (Nozzle to drum)(m) – 39

- **Cyclone**
  - Diameter(ID) (m) - 7.3
  - Height (m) - 16.8

- **Convective Pass**
  - Width (m) – 9.7
  - Depth (m) – 5.6
  - Height (m) – 32
The circulation loop consists of
- Combustor
- Cyclone
- Standpipe
- Loop Seal
COMBUSTION CONTROL UTILIZING FBHE WITH SPIESS VALVE.
**Seal Pot**
- Number of seal pots: 2
- Cross sectional area: D1.1 m
- Type: Refractory lined walls

**Fluidized Bed Heat Exchanger**
- Number of FBHEs: 2
- empty chamber: 2
- evaporator bundle chamber: 1
- Super heater bundle chamber: 1
- Type: Refractory lined walls
- Control device: Spiess valve
- Dimensions: 6.52x4.89mx6.747m
BOILER COMMISSIONING STEPS FOLLOWED

- Mechanical Completion
- Check Listing
- Pre-Commissioning
- Commissioning
  - Refractory Dry Out
  - Lit-up with Liquid Fuel
  - Alkali Boil Out
  - Steam Blowing
  - Safety Valve Floating
  - Solid Fuel Firing (Lignite)

MAJOR PROBLEMS FACED IN CFBC BOILERS

- Water Walls Tube Failures (near lignite & SUB entry and penthouse area)
- NMEJ Damages.
- Clinker Formation.
- Refractory Damages.
- APH tubes Chock-up.
WATER WALLS TUBE FAILURES
(NEAR LIGNITE & SUB ENTRY AREA)
Tube Failure Due to Accumulation of high temp. Bed material. Because leakage at roof sealing.
Main causes for tube failures were:

- Maximum tube failures occur at Lignite and SUB entry area due to refractory damages at the entry of the lignite and SUB.
- Tube failures occur at pent house due to accumulation of bed material in pent house of combustor.
- Accumulation of bed material in pent house due to damages in sealing of combustor at roof.

Remedial actions:

- Thickness of refractory and numbers of anchors welded are increased at Entry of Lignite and SUB.
- Material of sealing at combustor roof changed from MS to SS and refractory poured at empty area on sealing plate.
Frequently damages of NMEJ
NMEJs at flue gas path are critical in nature and failure of which leads to Boiler shutdown

Problem:
+ Failure of Seal Pot to Combustor NMEJ frequently

Root Causes:
+ High sealing gap between male & female duct

Remedial Action Taken:
+ Changes in design of NMEJ(Harmonic layer)
+ Sealing gap was reduced
+ Dust Trap provided
SEAL POT TO COMBUSTOR NMEJ
DETAILED DRAWING OF NMEJ

- Dust Seal Trap
- Harmonic bolster
FITTING OF DUST SEAL TRAP

Fitment work of Dust seal trap is under progress (Dt.27-02-11)

Dust Seal Trap

Fitment work of Dust seal trap is under progress from pipe sleeve end. (Dt.28-02-11)
FITTING OF HARMONIC BOLSTER

Fitment of Harmonic Bolster is commenced after filling gaps in Duct Seal Trap. (Dt:04-03-11)

Fitment work of Harmonic Bolster is under Progress (Dt:04-03-11)
Main cause of Clinker

- Clinker Formation at low combustor temperature < 700 deg C during mixed fuel (solid + oil) operations.
- Oversize of the lignite.
CLINKER NEAR PA FAN NOZZLES
REMEDIAL ACTIONS TAKEN:

- Restricted Operations on mixed fuel.
- Maintaining Combustor temp. during very high fluctuation on load.
- Resized the lignite as per designed value.

Type Of Fuel
- Solid Fuel: Coal
- Liquid Fuel: LDO
Areas of major refractory damages:

- **Combustor Area**
  - SUB Area
  - Lignite entry area
- **FBHE Area**
  - Partition Wall
  - Side Wall
- **Cyclone Areas**
  - target area
  - bull nose area
  - seal pot
Problem:
- Frequent failures of refractory at Target area, Bull Nose Area

Causes:
- Use of low abrasion resistance refractory material

Actions taken:
- Refractory (Alumina Content – 80%) was introduced in cyclone bull nose area, Target Wall Area in place of existing dense refractory (Alumina Content – 45%)
CYCLONE DUCT IN RED HOT CONDITION
REFRACTORY DAMAGES IN COMBUSTOR TO CYCLONE DUCT
REFRACTORY DAMAGES IN COMBUSTOR TO CYCLONE DUCT
REFRACTORY DAMAGES IN CYCLONE.
REFRACTORY DAMAGES IN CYCLONE.
REFRACTORY DAMAGES AT FBHE AREA
Problem:
- Failures of refractory at partition wall & Empty Chamber side walls

Causes:
- Use of low abrasion resistance refractory material

Actions taken:
- Castable refractory of high alumina content
- (high abrasion resistance) introduced in place of existing castable Refractory
- Numbers of Anchors are increased
Problem:
- Failure of refractory at Start-Up Burners (SUB) & lignite entry area

Causes:
- Soft insulating material below the dense castable refractory at SUB area
- Poor refractory Application & heat curing procedure

Action Taken:
- Modification of burner profile to increase the thickness of refractory
- More numbers of anchors provided.
- Refractory Dry Out with external burners
Currently we are facing problem of chock-up of APH. Which leads the suction pressure of ID fan very-very low i.e., Upto -35mbar. Hence machine is compelled to run at reduced load. Hence there is still question that how to overcome this problem.
CHOCK-UP IN APH
THANK YOU
BACK UP SLIDE
Auxiliary consumption is higher ie. 17% at full load and 19% at reduced load 19% as compared to PF boilers.

Boiler Down time is higher as compared to PF boilers.
**Fuel Sieve Analysis & Limestone Specification**

**Fuel Size:**
- 100% < 15 mm
- 85% < 10 mm
- 50% < 1 mm

**Limestone analysis, % By Weight:**
- CaCO₃: 80.6
- MgCO₃: 3.0
- SiO₂: 6.02
- Moisture: 2.0
- Others: 8.38

**Limestone Size**
- Maximum lump size: 1 mm
- Average size d50: 0.16 mm
- d80: <0.20 mm
- d90: >0.04 mm

Bulk density: 1000 – 1200 kg/m³
Moisture max: 2%
# BED MATERIAL SPECIFICATION

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Material Handled</strong></td>
<td>Crushed Refractory Grog / Bed Ash</td>
</tr>
<tr>
<td><strong>2. Size:</strong></td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td>less than 1 mm</td>
</tr>
<tr>
<td>80%</td>
<td>less than 180 to 200 Micrometer</td>
</tr>
<tr>
<td>50%</td>
<td>less than 150 to 170 Micrometer</td>
</tr>
<tr>
<td>3% (max)</td>
<td>less than 63 Micrometer</td>
</tr>
<tr>
<td><strong>3. Bulk Density</strong></td>
<td>1500 to 1800 kg/m³</td>
</tr>
<tr>
<td><strong>4. Chemical Composition (%) by weight</strong></td>
<td>As Per IS 1355</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>30 to 40 %</td>
</tr>
<tr>
<td>SiO₂</td>
<td>50 to 60 %</td>
</tr>
<tr>
<td>Alkalis (Na₂O+K₂O)</td>
<td>Not more than 3 %</td>
</tr>
<tr>
<td>Iron Oxide</td>
<td>Less than 3.5 %</td>
</tr>
<tr>
<td>Moisture (H₂O)</td>
<td>Less than 1 %</td>
</tr>
<tr>
<td>Initial Deformation Temp</td>
<td>Greater than 1300°C</td>
</tr>
<tr>
<td><strong>5. Quantity required for initial fill</strong></td>
<td>185 tonnes</td>
</tr>
<tr>
<td><strong>6. Qty. recommended for stocking by the Customer</strong></td>
<td>370 tonnes</td>
</tr>
</tbody>
</table>
# Benefits of a CFBC Boiler Over a PC Boiler

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>Description</th>
<th>CFB Boiler</th>
<th>PC-Fired Boiler</th>
<th>Benefits of CFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fuel Size</td>
<td>&lt;15 mm</td>
<td>&gt; 70% &lt; 75 microns</td>
<td>Crushing cost is reduced</td>
</tr>
<tr>
<td>2</td>
<td>Fuel range (ash + Moisture)</td>
<td>Up to 75%</td>
<td>Up to 50%</td>
<td>Accepts wide range</td>
</tr>
<tr>
<td>3</td>
<td>Sulfur Capture</td>
<td>Limestone Injection</td>
<td>FGD Plant required</td>
<td>Less expensive SO2 removal system</td>
</tr>
<tr>
<td>4</td>
<td>Auxiliary Fuel Support (Oil or Gas)</td>
<td>Up to 20 - 30%</td>
<td>Up to 45%</td>
<td>Less Oil / Gas Consumption</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary Power Consumption</td>
<td>Slightly Higher</td>
<td>Lower</td>
<td>If FGD is used in PC, CFB power is lower</td>
</tr>
<tr>
<td>6</td>
<td>Emissions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>SO2, ppm @ 6% O2</td>
<td>&lt; 100</td>
<td>&lt; 200 with FGD</td>
<td>Lower emissions in process, less expensive</td>
</tr>
<tr>
<td>b</td>
<td>NOx, ppm @ 6% O2</td>
<td>&lt; 50</td>
<td>&lt; 100 with SCR</td>
<td>No SCR (or SNCR) system required</td>
</tr>
<tr>
<td>7</td>
<td>Boiler Efficiency, %</td>
<td>Same</td>
<td>Slightly Higher</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>O&amp;M cost</td>
<td>5 - 10% Lower</td>
<td>5 - 10% Higher</td>
<td>Lower because of less rotary equipment</td>
</tr>
<tr>
<td>9</td>
<td>Capital Cost</td>
<td>5 - 10% Higher</td>
<td>5 - 10% Lower w/o FGD &amp; SCR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 - 15% Lower</td>
<td>8 - 15% Higher w / FGD &amp; SCR</td>
<td>......</td>
</tr>
</tbody>
</table>
In India 57% of power generation is from coal, though India has a large coal reserve but most of the Indian Coal is having high ash (15 to 45 %) and low calorific value 2600Kcal/Kg.

Major challenges in coal based thermal power plants are,

- Availability
- Efficiency
- Emission
- Fuel Shift
Boiler availability Depends upon:
- Fuel
- Technology & Design
- Construction Quality
- Maintenance practice
Boiler efficiency Depends upon:
- Fuel Properties
- Combustion technology
- Furnace Design
- Design of Auxiliaries
- Operation Philosophy
EMISSION

- Depends upon;
  - Fuel Properties
  - Combustion technology
  - Operation Philosophy
  - Use of Additives for emission control
Indian IPP owners face recent challenges in terms of Fuel availability in local market and more duties in Imported coals resulting in higher power generation cost and disrupting the profit margins.

- Recently there is major shift seen in dependency in fossil fuels to Refinery waste fuel Petroleum coke (Petcoke) due to higher calorific value, better availability, ease of handling and crushing.
- CFBC technology will be most appropriate considering requirement of high residence time & Better sulfur capture efficiency.