Maintenance challenges in Coke Dry Quenching plant (CDQ)

COKE OVEN#3
Capacity- 1.5MTPA

COKE OVEN#4
Capacity- 1.9MTPA

CDQ1
BATTERY#1 (56 OVENS)
BATTERY#2 (56 OVENS)

CDQ2
BATTERY#3 (56 OVENS)
BATTERY#4 (56 OVENS)

CDQ3
BATTERY#5 (72 OVENS)
BATTERY#6 (72 OVENS)

CDQ4
BATTERY#7 (72 OVENS)
BATTERY#8 (72 OVENS)
COKE DRY QUENCHING

MAIN SPECIFICATIONS OF CDQ PLANT

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>CDQ 1 &amp; 2</th>
<th>CDQ 3 &amp; 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum coke throughput (charging amount to the chamber)</td>
<td>120 T/H</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rated coke throughput (charging amount to chamber)</td>
<td>85 T/H</td>
<td>112 T/H</td>
</tr>
<tr>
<td>3</td>
<td>Coke solution loss</td>
<td>Approx. 1%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Red hot coke temperature</td>
<td>1000±50°C</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cooled coke temperature</td>
<td>200°C or less</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pre-chamber volume</td>
<td>1.5 hours or more</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cycle time of charging crane</td>
<td>10.5 min/cycle</td>
<td>8.2 min/cycle</td>
</tr>
<tr>
<td>8</td>
<td>Boiler max. steam production capacity</td>
<td>Max. 72 T/H</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Steam production at rated coke throughput without BFG</td>
<td>Max. 49.3 T/H (85 T/H / 0.58)</td>
<td>Max. 65 T/H (112 T/H / 0.58)</td>
</tr>
<tr>
<td>10</td>
<td>Steam production ratio without BFG</td>
<td>580 kg/T of coke</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Steam production ratio with BFG</td>
<td>750 kg/T of coke</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Steam pressure</td>
<td>9.5 ± 0.2 MPa</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Steam temperature</td>
<td>540°C</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Circulation gas volume</td>
<td>Max. 180,000 Nm3/H</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Circulation gas temperature at inlet of boiler</td>
<td>980°C</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Circulation gas temperature at inlet of cooling chamber</td>
<td>130°C</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Operation hours per day</td>
<td>24 hours/day</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Operation day per year</td>
<td>345 days/year</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>2 years once</td>
<td>22 days</td>
<td></td>
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</table>
CASE STUDIES COVERED

1. Increase in life of CDQ Bucket liners.
2. Modifications in Discharging facility to reduce maintenance.
INCREASE IN LIFE OF CDQ BUCKET LINER PLATE’S.

SITUATION BEFORE IMPLEMENTATION

- Initially the liners are of cast iron with single fastener.
- Due to which any fluctuations in battery temperatures coke sticking problems leads to damage of liners(CDQ Bucket)
- During breakdowns of charging crane/CDQ loco the hot coke will be in bucket for longer time this leads to damage of liners

- LINER PLATE DESIGN & MOC
- LINER PLATE MISSING IN CDQ BUCKET

- Immediately stop pushings in that particular bucket and cooling starts followed by wet quenching.
- Shutdown for liner plate changing after cooling.
SITUATION BEFORE IMPLEMENTATION

- As the discharge of coke is continuous the missing liner is found at RSV and discharge is stopped.
- As soon as discharge stops the boiler inlet temperature drops results in low steam generation.

Discharging facility Rotary Seal Valve (RSV) Jam

CHANGES MADE IN SYSTEM

| Received from | Material Details | C % | Si % | Mn % | P % | S % | Al % | Cr % | Mo % | Ni % | Co % | Cu % | Nb % | Ti % | V % | Remarks |
|---------------|-----------------|-----|------|------|-----|-----|------|------|------|------|------|------|------|-----|---------|
| CDQ           | SS 304          | 3   | 1.3  | 0.8  | 0   | 0   | 24   | 0.13 | 7    | 0.3  | 0    | 0.1  | 0    | 0    |          |
| CDQ           | SS 310 HN       | 0.3 | 1.4  | 0.79 | 0   | 0.1 | 19-23| 0.25 | 23-27| 0.1  | 0.2  | 1    | 0    | 0    |          |
| CDQ           | SS310HN         | 0.3 | 1.4  | 0.79 | 0   | 0.1 | 19-23| 0.25 | 23-27| 0.1  | 0.2  | 1    | 0    | 0.1  |          |
| CDQ           | SS310HK         | 0.6 | 0.9  | 0.01 | 0   | 1.1 | 24-28| 0.18 | 18-22| 0.1  | 0.1  | 0.3  | 0.1  |      |          |
Liner plate MOC was changed from (cast iron to HN grade). Further Up gradation of liner MOC (HN grade to HK grade). At some Critical locations liner plate rib design improved and modifications in fastening methods further added to the life of bucket liners.
ADVANTAGES

- Increased the Availability of Loco car.
- Reduced production delay by conveying hot coke to the chamber
- Reduced bucket cooling time for liner plate changing during shutdown
- Enhanced steam generation in Boiler

Modifications in Discharging facility to reduce Maintenance.
MODIFICATIONS IN DISCHARGING FACILITY TO REDUCE MAINTENANCE

- Vibrofeeder drain line
  - Design modification in suction line
- Slide gate hopper

Problem’s faced

- In vibrofeeder, dust collected & drained in to de-dusting mains as pic shown.
- It’s a continuous process. Over a period of time, drain line get choked due to angle of repose for dust flow.
- Choked lines hamper the performance of vibrofeeder. Indirectly restrict the coke discharge with heating up of coils.
- CO gas beyond safe limit due to this improper inspection of conveyors.
- Stoppage of coke discharge leads to production loss.
**Modification**

- Increase in the Angle of connecting pipe.
- Smooth flow of dust in Pipe reduce the damages.
- The line has been connected directly to de-dusting header.

**Result**

- It has enhanced the performance of vibrofeeder. Low maintenance required.
- Coil temp maintained normal.
- Increase of suction pressure as it is directly connected to de-dusting header.
- Conveyor stoppage frequency reduced & there is no pipe damage here after.
Slide Gate Hopper

Problems -
- Accumulation of coke fines in hopper.
- Due to which slide gate getting jam frequently.
- During stoppage of discharge slide gate cannot be closed for maintenance, so CO gas leakage at discharging area.

Modification -
- Angle of drain line and pipe size has been changed.
- Provision of man hole for periodic cleaning of hopper.
Slide Gate Hopper

Result:
- Reduced the frequency of slide gate malfunctioning (full open/close).
- No CO gas was found at discharge area, hence easy maintenance of discharging equipment's can be done.

Refractory Maintenance Challenges

LIFE ENHANCEMENT OF CDQ SLOPING FLUE PILLAR BRICKS
View of CDQ Pillar, Flat Arch & Ring Duct

JSW CDQ Chamber General Arrangement Drawing

- Cone
- Ring Duct
- Pre-chamber
- Dust catcher
- Flue hole
- Passage channel
- Cooling chamber
- Flue post

Sloping flue side view
Sloping flue front view
Details of CDQ Refractory

- In CDQ refractory lining is there in Chamber, PDC and Boiler.
- Chamber is divided into three zones first zone, second zone and third zone.
- Total there are 36 nos of pillars in the second zone.
- In one CDQ 1300 Tons of Refractory is there and 500 shapes is used.

Refractory Problems faced during Operation

- The pillar bricks are getting cracked and falling down after doing the refractory maintenance job.
- The cooling chamber refractory bricks are getting eroded.
- The Jack Arch portion of the bricks are getting eroded.
- The life of the refractory pillar is less than one year.
- Erosion in the top layer of the third zone bricks.
CDQ sloping flue pillar Refractory life improvement.

Failure Analysis Chart.
Possible ideas Generated:

1. Repair of Complete pillar during yearly maintenance.
2. Filling of Cracks by Refractory mortar.
3. Upgrading the Quality of Refractory bricks.
4. Reducing CDQ process temperature fluctuation.
5. Strengthening of Pillar lining by repairing the first layer completely.
6. Strengthening of pillar lining by repairing 2 layers namely 9,3 series bricks.
7. Coating the erosion area to avoid unwanted gaps.
8. Increase the width of pillar bricks.
9. Providing a sliding expansion joint between 9,3 series bricks.

JSW CDQ Design Aspects

Total Load of Ring Duct is distributed on -

Slope Provided in the Flat Arch Skew Brick

On the Pillar Bricks
Validation of Ideas: -

Check

Before

PDCA-1

Plan: - 1. Strengthening of pillar lining for having better Mechanical & thermal stability.
2. Gunning of cooling zone area.

Do: - 1. Dismantling & relining of Sloping flue pillar refractory to first layer
2. Gunning of cooling zone area with 60 % Castable.

After

Results (after 1-year operation): -

1. C type cracks minimized.
2. No improvement in dislodging of Refractory bricks.
3. Relined bricks found at the discharge chute within 3-4 months of installation.
4. Due to gunning in cooling zone area further brick damage is controlled.

Inference of PDCA-1: -

Understood that dislodging of bricks is due to 2 factors namely improper locking & inclination of 76 degree provided in the pillar design, so planned for dismantling & relining of sloping flue pillar up to 2nd layer.
**PDCA#2 :**

**Plan: -** Strengthening of pillar lining by repair up to 2 layers namely (9,3 series bricks) with upgradation in quality of bricks.

**Do: -** 1. Upgradation in quality of Refractory bricks for better thermal & mechanical stability.
2. Irrespective of damages of sloping flue pillars it is being decided to dismantle & Reline of Pillar Refractory brick up to 2 layers.

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**PDCA#2 Conclusion: -**

**Check**

**Before**

**Results (after 2-year operation): -**

1. Dislodging of Bricks was minimized.
2. No cracks develop during the operation.
4. No bricks were found at discharge end .

**Inference: -**

1. Pillar lining service life improved to 2 years .
Electrical Maintenance Challenges

ESTABLISHING WIRELESS COMMUNICATION BETWEEN LOCO BUCKET - LOCO PLC - CDQ PLC

VIJAYANAGAR WORKS

CONVENTIONAL METHOD FOR COMMUNICATION BETWEEN LOCO PLC TO CDQ PLC

- The loco bucket will receive the hot coke from ovens
- This bucket is aligned properly in auto positioning system
- Then the hot coke is charged in CDQ chamber through crane
- There is a sequence of operation to charge the hot coke.
During this sequence of operation several signals get exchanged between locomotive PLC and CDQ PLC.

To achieve this signal exchange we have set of magnetic sensors and switches,

Here sensors will play a major role.

- Two sensors for bucket centring
- One for APS* order
- One for APS* Lock feedback
- One for CDQ order

* APS: Auto positioning system

This sensors and switches were getting damaged due to harsh working condition.

When the locomotive moving along the battery area sensors are getting damaged due to the impact of the coke.

Cables are getting damaged due to hot coke near wharf.
MODIFICATION IN THE SYSTEM

MODIFICATIONS

- During the initial stage we tried to protect the sensors by putting scraper on both side of sensor stand.
- In the next step, in order to further reduce the problem we replaced the sensors with wireless Bluetooth muxset.
- For the wireless muxset power supply, we used heat resistance cable.
DATA SHEET OF MUXSET

- Wireless interface Wireless standard Bluetooth 1.2
- Frequency range 2.402 GHz ... 2.48 GHz (ISM bandwidth)
- Transmission power 16 dBm (40 mW, controlled automatically)
- Antenna connection method MCX (female)
- Power supply for module 24 V DC
- Connection technology 1-wire
- Number of inputs 16 Digital inputs
- Number of outputs 16 Digital outputs
- Analog inputs 2 Voltage input signal 0 V ... 10 V and
- Current input signal 0 mA ... 20 mA
- Analog outputs 2 Voltage input signal 0 V ... 10 V and
- Current input signal 0 mA ... 20 mA
- Operating Range: Up to 100 m With antenna.

ADVANTAGES

- Increased the availability of Loco car.
- Reduced production delay by conveying hot coke to the chamber
- Reduced usage of sensors, hence frequent damage of sensors is reduced.
- Reduced usage of cable, hence Frequent damage of cables is reduced.
- Reduced the damage of loco wagon liner plates.
- Enhanced steam generation in Boiler
Any Questions & Suggestions please