SOxNOx2016

Control of Particulate Matter (PMI)

New Delhi, Dec 22, 2016

Imagination at work
Indian Emission limits for TPPs (all plant capacity)

New norms (7th December 2015)

<table>
<thead>
<tr>
<th></th>
<th>PM emission</th>
<th>Mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>All units installed before 31 Dec 2003</td>
<td>100 mg/Nm3</td>
<td>&gt; 500 MW 0.03 mg/Nm3</td>
</tr>
<tr>
<td>All units installed between 31 Dec 2003 and 31 Dec 2016</td>
<td>50 mg/Nm3</td>
<td>0.03 mg/Nm3</td>
</tr>
<tr>
<td>All units installed from 01 Jan 2017</td>
<td>30 mg/Nm3</td>
<td>0.03 mg/Nm3</td>
</tr>
</tbody>
</table>

The new regulation is in line with existing global norms for most countries.

New norm call for:
- Retrofit of old fleets
- New fleet suitable for lower emission
Global scenario

- Attempt to bring down PM 2.5/PM 10
- Consideration of low emission 3-5 mg/Nm3 at stack in order to bring down these ultra fine PMs

Review of Best Available Technology for low emission

- Fabric filters
- Low low temperature ESPs
- Evaluation of dust removal by WFGD
- Wet ESPs after WFGD
Global scenario

• In China new emission requirement for 10 mg/Nm3, which was rolled out in Dec 2015, is not regulatory. Many customer is looking for 5 mg/Nm3 at the stack

• In Korea, requirements from customers coming for 3 mg/Nm3 at stack

• MATS regulation in US requires very low emission from stack

• Industry Emissions Directive (IED) 2010/75 asks to restrict emission following the BAT. In EU, plants are asking for low emission from stack (10 mg/Nm3).
Use of Low low temperature ESP at Japan

Design data for Stack emission 8 mg/Nm3

Table from the top, Particulate, Sulphur Oxides and flue gas temp at each point
System flow: GAH (gas air heater/ Ljungström APH) - GGH (non leak GGH, high temp side) - ESP - ID fan - WFGD - GGH (non leak GGH, low temp side) - BUF (Boost Up Fan) - Stack
Low low temperature ESP-concept

- Utilizes the fact that resistivity drops at lower temperature

- Number of references for GE LLTs (in Japan, Australia)

- Tosoh Nanyo#6 : 220 MW PC fired plant in Japan, Operating temp 85-95 deg C. Operating on Chinese coal, Indonesian coal & Australian coal blends, the ESP is successfully operating with low emission
Wet ESPs in Power Stations

- Emissions of 1 mg/Nm3 or less has been measured at the outlet of HFWESPs
- Effectively removes SO$_3$ mist
- Large installation bases in Japan & North America
  - Nakoso Power Station
  - Himeji Power Station
  - Shin-Nagoya Power Station
  - Spurlock Power Station-U1,U2
  - Dakota Power Station
  - Elm Road Power Station-U1,U2
  - Dallman Power Station Unit 4
  - More...........

© GE POWER. All rights reserved. Information contained in this document is indicative only. No representation or warranty is given or should be relied on that it is complete or correct or will apply to any particular project. This will depend on the technical and commercial circumstances. It is provided without liability and is subject to change without notice. Reproduction, use or disclosure to third parties, without express written authority, is strictly prohibited.
Indian Scenario

- ESP already installed in all plants
- ESP remains as proven solution for PM removal
- Available at competitive prices
- Poor acceptability of Fabric Filter

Technical challenges:

- High to very high resistive Indian fly ash
- Space availability for retrofits
Features for an ESP to overcome back corona generated by high resistive dust

- Uniform current distribution in the fields
- Effective rapping to keep the electrodes clean
- Semi-pulse mode operation (intermittent charging)
- Power Control Rapping
Mega Fabric Filter (bag lengths 10 m or more)

Features:
- Compact design
- More filter bags per valve
- Available up to 12 m bags
- Modulated pulsing
  - Efficient pulse
  - Flushing
  - Modulated return to filtering mode
- Walk in plenum or Top door design (bag maintenance area)

Special nozzle design for cleaning of 12 m bags

OPTIPULSE ®
ESP and FF are still the chosen technology

**Electrostatic Precipitators (ESP)**

- **Strengths**
  - Matured Product - Rugged construction -- accepts back-end temperature up to 350 °C
  - Operation can be adjusted for Oil firing during start

- **Weaknesses**
  - High Capex for difficult coal
  - Low Sulfur, High Ash requires very large ESPs
  - Affected by change in Coal, limitation < 15 mg/Nm3 under Indian scenario

**Fabric Filters (FF)**

- **Strengths**
  - Lower Capex
  - Not affected by Coal variation - accepts back-end temperature up to 250 °C
  - Can achieve < 10 mg/Nm3 consistently
  - Higher efficiency on PM 2.5

- **Weaknesses**
  - Pre coating of Bags and/or sacrificial chamber
  - Requires an appropriate maintenance regime
# Mega Fabric Filters (10 m bags) in TPP

<table>
<thead>
<tr>
<th>Plant</th>
<th>Details</th>
<th>Emission measured at stack (after FGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manjung 4, Malaysia</td>
<td>Plant capacity: 1x1000 Mw</td>
<td>Less than 2 mg/Nm3</td>
</tr>
<tr>
<td></td>
<td>Fuel: Coal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow: 1535 m3/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start up yr: 2014</td>
<td></td>
</tr>
<tr>
<td>Tanjung Bin 4, Malaysia</td>
<td>Plant capacity: 1000 Mw</td>
<td>Less than 1 mg/Nm3</td>
</tr>
<tr>
<td></td>
<td>Fuel: Coal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow: 1540 m3/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start up yr: 2014</td>
<td></td>
</tr>
<tr>
<td>Lin kou, Taiwan</td>
<td>Plant capacity: 3x800 Mw</td>
<td>Less than 2 mg/Nm3</td>
</tr>
<tr>
<td></td>
<td>Fuel: Coal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow: 1207 m3/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start up yr: 2015</td>
<td></td>
</tr>
</tbody>
</table>

© GE POWER. All rights reserved. Information contained in this document is indicative only. No representation or warranty is given or should be relied on that it is complete or correct or will apply to any particular project. This will depend on the technical and commercial circumstances. It is provided without liability and is subject to change without notice. Reproduction, use or disclosure to third parties, without express written authority, is strictly prohibited.
Manjung-4 Mega FF
• Options of retrofit
Retrofit / Upgrade options – Mechanical, Electrical & combination

Mechanical retrofit – to increase collecting area

- Internal replacement
- Field addition
- Height increase and Field addition
- Parallel Pass

Electrical retrofit

- EPIC-III controller
- SIR (Switched Integrated Rectifier)
- ESP to FF conversion

© GE POWER. All rights reserved. Information contained in this document is indicative only. No representation or warranty is given or should be relied on that it is complete or correct or will apply to any particular project. This will depend on the technical and commercial circumstances. It is provided without liability and is subject to change without notice. Reproduction, use or disclosure to third parties, without express written authority, is strictly prohibited.
• ESP upgrade
New parallel ESP and electrical upgrade with High Frequency HV units (SIR)

- Torrent Power, Ahmedabad India
- BHEL ESP upgrade for Station D 120 MW by installation of parallel ESP with SIR4 & EPIC-III and new electricals & service of existing ESP’s
  - Commissioning Dec 2010
  - Service of existing ESP’s
  - New parallel ESP installation
  - SIR4 (1 no.) and EPIC-III (4 nos.)
  - New electricals and control room.

Value for customer
- Emission < 50 mg/Nm3, wet
NALCO Angul 5 x 120 MW Boiler ESP upgrade

- BHEL ESP upgrade for Unit no 1,2,3,4,& 6 for 100 mg/Nm3 emission
- Upgrade of existing 2 nos ESP’s with increase in height + Addition of a new parallel ESP
NALCO Angul 5 x 120 MW Boiler ESP upgrade
SAIL Rourkella Steel, India – HP Boiler 5&6, 150 TPH

- Orient ESP upgrade by Internal s of new design, height increase and addition of one field for 100 mg/Nm3 emission
Plant Name- Bao Steel China

- Mitsubishi Lurgi ESP for 2 x 300 MW power plant upgrade by field addition and SIR for emission < 100 mg/Nm3 in 1st phase

- Scope of Engineering, supply and services
- Retrofit of all existing fields by increase in height.
- Addition of one field addition at outlet of ESP.
- SIR 4 12 nos. 70/1700 each unit in all fields.

- Value for customer
  - Emission < 100 mg/Nm3, wet
• ESP to FF conversion
ESP to FF conversion

- ESP to FF conversion is required in case of drastic change in coal type which ESP cannot handle like switching to a lower sulphur coal and other changes in process condition
- compliance with upcoming particulate control regulation etc.
- addition of a wet/dry FGD or mercury system,

The conversion of an existing ESP casing to a pulse jet Fabric Filter (FF) for utility is becoming increasingly common as more power plants seek air quality control system retrofitting to minimize emission and improve air quality.
COHPAC® Concept (partial conversion)

COHPAC – Compact Hybrid Particulate Collector

- Combination of an existing or a new ESP with a High air-to-cloth ratio baghouse to "overcome the problem of the sensitivity of ESP particulate collection and flue gas properties and the alternative of having to substitute the ESP with large bag filters in which its use would be prohibited by cost and space considerations"*

- It is believed that high filtration speed is made possible by the pre-collector and associated pre-charger effects (agglomeration of dust particles)
Full conversion of ESP to FF

ESP casing is retained and the ESP is converted into FF Pulse Jet FF (HRFF)

Liddell 4X500 MWe Coal, Australia, PER UNIT 14664 BAGS, LENGTH 8 M

© GE POWER. All rights reserved. Information contained in this document is indicative only. No representation or warranty is given or should be relied on that it is complete or correct or will apply to any particular project. This will depend on the technical and commercial circumstances. It is provided without liability and is subject to change without notice. Reproduction, use or disclosure to third parties, without express written authority, is strictly prohibited.
ESP to FF conversion in TPP-examples

Koradi Unit 6, 210 MWe CPP, India

Liddell 4x500 MWe CPP, Australia

Vales point, 2x660 MW, U 5&6

Munmorah Unit 4, NSY

© GE POWER. All rights reserved. Information contained in this document is indicative only. No representation or warranty is given or should be relied on that it is complete or correct or will apply to any particular project. This will depend on the technical and commercial circumstances. It is provided without liability and is subject to change without notice. Reproduction, use or disclosure to third parties, without express written authority, is strictly prohibited.