Power Fluctuation Control through Coal-Fired Power Plant

Japan Coal Energy Center (JCOAL)

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<td>Sub-Critical</td>
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<td>Japanese</td>
<td>Oil or LNG</td>
<td>Imported Coal</td>
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- **IGCC**
- **LNG GTCC**
- **Nucrer Power**
2. Loading rate improvement
2. Loading rate Improvement (1/5)

- Improvement of Burning Characteristics
  - Vertical Pulverizer
- Improvement of Steam Temperature Controllability
  - Three-stage of SH Spray
  - RH Inlet Spray, or Intermediate Spray
  - RH Bypass Steam Spray
- Appropriate Capacity of Accessories
  - Pulverizer, Fan, Pump, Valve, etc.
- Advancement of Control Equipment
  - Control deviation of steam temperature within ± 8 °C
  - Eliminate sudden change of environmental value (NOx)

Load change rate (High Load Range)

1 ~ 2 %/min. ⇒ 3 ~ 5 %/min.
2. Loading rate Improvement (2/5)

Improvement of pulverized coal supply characteristics

- Control of table rotation speed
- Hydraulic control of roller pressurization
- Rotational speed control of classifier

Source: IHI
2. Loading rate Improvement (3/5)

Improving of loading rate: Steam Temp. Control
- 3 Stage of SH Spray
- RH Inlet Spray, or RH Intermediate Spray
- RH Steam Bypass Spray
2. Loading rate Improvement (4/5)

Load change characteristics 1

100% L ⇔ 50% L : 3%/min.

- Reheat Steam Temp.
- Main Steam Temp.
- Feed Water Flow Rate
- Generator Output command
- Fuel flow rate

[Graph showing changes in various parameters such as output, flow rate, steam temperature, and various operational commands during load changes.]

Source: JPOWER, IHI
2. Loading rate Improvement (5/5)

Load change characteristics 2

Main Steam Temp. ±3°C (+8/-12°C)
Reheat Steam Temp. ±6°C (+8/-16°C)

600MW
Power Output
450MW

SCR Outlet NOx

Source: JPOWER, IHI
3. Optimization of minimum load
3. Optimization of minimum load (1/3)

At low load of the mill, pulverized coal at the outlet of the mill is in a lean condition with high Air/Coal Ratio of primary air, and oil support is required.

The minimum load of coal-firing without oil support limited to 30 ~ 40% load.
In order to reduce the minimum load of coal firing (without oil support), it is necessary to increase the pulverized coal concentration of primary air in the burner.

By adding a primary air concentration function to the burner (Wide range burner), stable combustion becomes possible, making it possible to reduce the minimum load of coal firing (without oil support) to 15 ~ 25% load.
3. Optimization of minimum load (3/3)

Wide Range Burner

Normal Burner’s case

Wide Range Burner’s case

Source: IHI
4. Start-up time reduction
4. Start-up time reduction (1/3)

In order to shorten the startup time, it is important to raise the turbine inlet steam temperature quickly. To that end, installing the following startup bypass systems:

- SH Bypass System
- HP / LP Turbine Bypass System (RH Cooling)
- or Turbine Bypass System

Startup Time of Hot Start (DSS)
120 ~ 180 min. (Ignition ~ 100%L)
4. Start-up time reduction (2/3)

Start-up time reduction
- SH Bypass
- HP & LP Bypass (RH Cooling)
  or
- Turbine Bypass
4. Start-up time reduction (3/3)

Start-up Characteristics (Hot Start, DSS)

- **Ignition**
- **Generator Start**
- **100% Load**

**Less than 180 min.**

- **Reheat steam temperature**
- **Main steam temperature**
- **Feed Water Flow Rate**
- **Recirculation flow rate**
- **Fuel flow rate**

Source: JPOWER, IHI
5. Measures to minimize thermal stress

Measures and methods to minimize the influence on equipment regarding thermal stress of high temperature part for intermediate load operation.

- Structure to avoid thick part such as T piece
  ⇒ Adoption of end connection
- Reduce the large diameter pipe that becomes thick
  ⇒ Adopting multiple connection pipes)
- Leveling of each heat transfer surface outlet temperature
  ⇒ Consideration of burner arrangement, heat transfer surface layout / configuration, adoption of three-stage SH spray, implementation of combustion adjustment
- Consideration with control device
  ⇒ Fine-grained control, optimization of control setting values
6. Conclusion

In Japan, upon introduction and capacity increase of nuclear power plants, intermediate load operation came to be required at coal-fired power plants for appropriate load adjustment. Under such situation, relevant technology was developed for improving the load change rate, reducing the minimum load of coal-firing, and shortening the start-up time.

Presently, intermediate load operation is possible even for large-scale coal-fired USC power plants, which has been well proved through operational experience in the same manner for over 20 years.

India will need to manage intermediate load operation with coal-fired power plants as renewable energy is being introduced on massive scale. JCOAL wishes to work together to help utilities to make a smooth shift toward optimal load operation.

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<th>Intermediate Load Operation</th>
<th>Base Load Operation</th>
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<tbody>
<tr>
<td>Load Change Rate</td>
<td>3 ~ 5 %L/Min.</td>
<td>1 ~ 2 %L/Min.</td>
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<tr>
<td>Min. Load</td>
<td>15 ~ 25 %L</td>
<td>30 ~ 40 %L</td>
</tr>
<tr>
<td>( without Oil support )</td>
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<tr>
<td>Hot Start Time</td>
<td>120 ~ 180 Min.</td>
<td>More than 300 Min.</td>
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<td>( Ignition ~ 100%L   )</td>
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We look forward to working with you!

Website: 
http://www.jcoal.or.jp/index-en.html

Contacts:
Mr. M. Ozawa (ozawa@jcoal.or.jp)
Mr. K. Murakami (kzmurakami@jcoal.or.jp)
Ms. Yamada, F. (fyamada@jcoal.or.jp)