Japan-China Joint Project for Improving the Environment and the Efficiency of Coal-Fired Power Generation in China

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After JCOAL and the China Electricity Council (hereinafter referred to as “CEC”) signed a “Memorandum on Promoting the Renovation of Existing Power Plants” during the 2007 visit to Japan of Wen Jiabao, Premier of the People’s Republic of China at that time, the Japan-China Joint Committee for Improving the Efficiency and the Environment of Coal-Fired Power Generation in China was formed to promote business-based cooperative activity between Japan and China. In the meantime, China had entered a period of rapid economic growth at the time called the “Golden Decade” and rapidly increased its power facilities capacity and the amount electric power it produces with a primary focus on coal-fired power. However, in 2014, the Chinese government switched its economic policy to a path of stable growth called the “New Normal” and China began hammering out a stricter environmental policy out of a need to deal with air pollution problems, which were attracting global attention, arising from issues such as acid rain and PM.

In this paper, we report on trends in improving the efficiency and the environment related to coal-fired power in China as well as recent activities of the Japan-China Joint Committee.

1. Trends in Coal-fired Power Generation in China

In China, due to geological characteristics that abundant coal resources are present, coal is regarded as a major energy source in the consumption of energy, and coal-fired power generation is regarded as the main source of power in the electric power production and consumption structure. China’s total energy production in 2016 was 3.46 billion tons (standard coal equivalent) and total energy consumption was 4.36 billion tons (standard coal equivalent). Of this, raw coal production accounts for 69.6% of total energy production and coal consumption makes up 62.0% of total primary energy consumed.

Although utilization of renewable energy has increased rapidly over the past decade and the proportion of non-fossil energy has been increasing dramatically, coal and coal-fired power generation remain the main source of energy. At the end of 2016, power generation capacity stood at 1,650 GW. Of this, coal-fired power generation accounted for 57.0% of capacity. Also, coal-fired power generation accounted for 63.9% of the total power generation capacity of 6,100 TWh.
With a rapidly improving level of coal facilities technology, China has achieved an ultra-supercritical pulverized coal power generation technology, which is at an advanced level in the world. Utilizing the greatest number of large air-cooling units and circulating fluidized bed boiler units in the world, China is promoting energy saving technology. Ninety-six 1,000-MW level units were operating by the end of 2016, and the percentage of thermal power generation units with a capacity of 300 MW or higher increased from 27.8% in 1995 to 79.1% in 2016.

Table 1 Design thermal efficiency of condensate turbine coal thermal power generation units with a capacity of 300 MW or higher and coal consumption rate during power generation

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Initial steam parameters</th>
<th>Coal consumption rate during designed power generation (g/KWh)</th>
<th>Coal consumption rate during designed power feeding (g/KWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature (ºC)</td>
<td>Pressure (Mpa)</td>
<td></td>
</tr>
<tr>
<td>Subcritical 300 MW</td>
<td>538/538</td>
<td>16.67</td>
<td>298</td>
</tr>
<tr>
<td>Subcritical 600 MW</td>
<td>538/538</td>
<td>16.67</td>
<td>296</td>
</tr>
<tr>
<td>Supercritical 600 MW</td>
<td>566/566</td>
<td>24.2</td>
<td>282</td>
</tr>
<tr>
<td>Ultra-supercritical 600 MW</td>
<td>600/600</td>
<td>25</td>
<td>271</td>
</tr>
<tr>
<td>Ultra-supercritical 1,000 MW</td>
<td>600/600</td>
<td>27</td>
<td>267</td>
</tr>
<tr>
<td>Ultra-supercritical 1,000 MW</td>
<td>600/610/610</td>
<td>31</td>
<td>256</td>
</tr>
</tbody>
</table>

Source: Report on the Advancement of Clean Technology in Chinese Coal-Fired Power Generation (CEC)
Improvement in the emission of air pollutants by coal power plants has improved largely due to stricter national emission standards.

Starting in 1996, a regulatory value was established for the concentration of nitrogen oxides in the "Thermal power plant atmospheric pollutant emission standard" (GB 13223-1996). In 2003, regulatory values for soot, sulfur dioxide, and nitrogen oxide concentrations became strict in the "Emission standards for air pollutants at thermal power plants" (GB 13223-2003). Regulatory values became more strict in the "Emission standards for air pollutants at thermal power plants" (GB 13223-2011) of 2011, and regulatory values were established for the first time regarding the discharge of mercury and its compounds in flue gas. Starting from 2014, China established the strictest emissions standards in the world by comprehensively implementing ultra-low emission and energy saving renovation of coal-fired power plants.

2. Recent activities related to the Japan-China Joint Committee

On Tuesday, August 29, 2017, the First Japan-China Joint Committee was held in Beijing in a CEC meeting room, and the results of a questionnaire survey on improving the efficiency and the environment of Chinese thermal power plants were announced by CEC. This questionnaire was conducted for 300-MW, 600-MW and 1000-MW units in China in order to understand the issues and needs of thermal power generation in China and promote the matching and introduction of Japanese seed technology. The survey was divided into six sections: energy saving, maintenance, operation management, power plant management, environmental preservation, and facility maintenance. Out of 200 questionnaires distributed, 150 were collected, and of these, 143 were valid responses. The chairman of the Chinese delegation, CEC Vice Chairman Gan, summarized the findings of the questionnaire as follows.

Figure 2 Emission standards for atmospheric pollutants at coal-fired power plants
Source: General Council on Electric Power Specifications and Design (Clean Coal Day 2017, International Conference)
[Peak adjustments using coal-fired power]
- Politically, the Chinese government is trying to develop renewable clean energy, but peak adjustment is emerging as a challenge.
- Most wind power, hydroelectric power, and solar power that is generated is not actually used very effectively. Reasons include problems with the grid structure as well as structural problems with peak adjustment.
- For example, making heat for indoor heating is required in the North-Eastern region during winter. At such times, the minimum operating load of the power plant is actually higher than the minimum load of demand. Although the government would like to utilize hydraulic, wind or solar power to make peak adjustments, peak adjustments must be made using coal-fired power because there is not enough hydraulic, wind and solar power available in winter. Since peak adjustments using coal-fired power are therefore unavoidable in winter, coal-fired power plants must be renovated in order to make such peak adjustments.
- These peak adjustments must cover overall demand first and also must meet economic and environmental standards. Although gas-fired power plants are of course the most efficient plants for making peak adjustments, use of coal-fired power is particularly high in the North-Eastern region due to the high construction cost of gas-fired power plants. Plants must therefore be renovated because the government wants to use coal-fired power plants for peak adjustments as much as possible.

[Wastewater treatment]
- Water is a major issue in the release of pollutants into the environment. How can zero emissions be achieved for waste water?

[Alternate desulfurization technology]
- Many power plants use wet desulfurization facilities for desulfurization. With the limestone method of treatment, limestone must be further and further excavated, making sustainable development difficult. An alternate desulfurization technology is therefore being sought.

[Desulfurization byproducts and waste]
- Technologies to adequately recycle by-products produced by desulfurization are also being sought.
- Various waste products are generated, collected and stored in the power plant during the desulfurization and denitration processes that recover pollutants. Methods for treating and disposing of this waste are needed.
- The mined limestone utilized for desulfurization turns into gypsum. However, in some regions, the gypsum is not recycled and accumulates inside the plant. Although nothing can be seen after 10 or 20 years, it can become a major issue after 30 to 100 years. Recycling technology for gypsum is therefore also required. Although China is seeking methods of reducing the emission of pollutants, as a matter of fact, the problem of treating waste materials recovered after reduction is critical and must also be resolved.
The problem of reducing CO2 emissions is the same. There are mature technologies for reducing CO2 emissions, but the cost is very high and they cannot be used. As described in the previous section, the improvement of coal-fired power generation technology and the emission of air pollutants has advanced rapidly in China in recent years. Meanwhile, the committee has clarified new challenges facing coal-fired power generation in China.

The committee set up working groups and aimed to match Japanese seed technology to meet these issues and needs in China.

Basically, the Japan-China Joint Committee has come to be held closely linked with the “Japan-China Energy Conservation Environment General Forum” held alternately every year in Japan and China. This year, the 11th Japan-China Energy Conservation Environment General Forum was held in Tokyo on Sunday, December 24, and the 2nd Japan-China Joint Committee met on the following day, Monday, December 25 also in Tokyo.

The Chinese delegation consisted of 45 visitors to Japan from government, organizations, electric power companies, environment and power generation equipment manufacturers, and so on. To deepen their understanding of Japan's clean technology and environmental technology, after attending the Japan-China Energy Conservation Environment General Forum and the Japan-China Joint Committee, the delegation visited and inspected a sewage sludge digestion gas power generation project in Toyonaka-shi, Isogo Power Plant of Electric Power Development Co., Ltd., Biwako Plant of HORIBA, Ltd., Kawasaki Heavy Industries, Ltd. and the JFE-Fuso Consortium.

During the general meeting held in the morning at the Japan-China Energy Conservation Environment General Forum, JCOAL and CEC signed a "Memorandum of agreement on environmental countermeasures at Chinese coal-fired power plants" and MHPS, HORIBA, Ltd., Chung Hsin Electric Power, JCOAL and CEC all signed a "Basic Agreement for Conducting a Japan-China Model Project FS". The "Clean Coal Technology and Coal-fired Power Generation Subcommittee" met in the afternoon. For details, please see the Japan-China Economic Association website.

http://www.jc-web.or.jp/jcbase/publics/index/169/

During the Japan-China Joint Committee, the Japanese delegation presented lectures and booth exhibits on the following seed technologies: (i) AQCS high-performance smoke exhaust treatment system (including WSD) by MHPS, (ii) environmental monitoring technology by HORIBA, Ltd., (iii) NAS batteries by NGK Insulators, Ltd., (iv) ion exchange membranes and electrodialysis method by Kuraray, Co., Ltd., and (v) eco technology by JCOAL. JCOAL gave a lecture on the effective utilization of bio-coke and fly ash and booth exhibits were set up. There was a lively exchange of opinions with participants from the Chinese delegation.
Photo 1 Second Japan-China Joint Committee Meeting of 2017

Chinese participants on the left and Japanese participants on the right