Priority Subjects — Development of a Supply/Demand Infrastructure for Next-Generation Electric Power

Improvement of Operation and Control Technologies to Diversify Fuel Types for Pulverized Coal-fired Power Plants

Background and Objective

The utilization of low grade coals is sought by pulverized coal-fired power plants in order to diversify fuel types. To reduce maintenance and inspection costs, and achieve environmental preservation, coal-fired power plants require countermeasures for sulfidation corrosion of boiler tubes and trace element control.

In this research, a guideline for the operating conditions of a mill and a burner, the blending method of coals, etc. is being established to use low HGI coal*1 (Low grindability coal) and low volatile coal (Low combustibility coal) in existing pulverized coal-fired power plants. In regards to countermeasures for sulfidation corrosion, an evaluation method of sulfidation conditions and a coating technology for the tube will be developed. Prediction models for the behavior of trace elements such as Hg, B, Se, and release control technologies in flue gas and waste water treatment processes are also under development.

Main results

1 Combustibility and grindability of low HGI coal and bituminous coal blend

As the blending ratio of low HGI coal mined in Australia to low volatile bituminous coal increased using a bunker blending method*2, both emissions of NOx and unburned carbon were able to be reduced since low HGI coal has a high combustibility rate and low nitrogen content (Fig. 1). However, the grinding power of a roller mill reached its upper limit as the blending ratio of low HGI coal increased in the normal operating condition of a particle separator in a roller mill (weight ratio of pulverized coal passing 200 mesh (75 μm) sieve; 70~80%). When coarse particles were emitted to reduce grinding power in a roller mill, both emissions of NOx and unburned carbon became greater than those under normal operating condition of particle separator.

Using the in-furnace blending method, in which low HGI coal was ground into coarse particles and bituminous coal was ground to normal particle size by different roller mills then fired by different burners, both emissions of NOx and unburned carbon became approximately equivalent to the emissions in the bunker blending method under normal operating conditions of a particle separator (Fig. 2). This result indicates that the in-furnace blending method is effective for low HGI coal firing.

2 Development of a coating technology for preventing sulfidation corrosion of boiler tubes, and evaluation methods of sulfidation conditions

A coating technology to prevent sulfidation corrosion was applied to boiler tubes of an actual pulverized coal-fired plant. This method enabled approximately 100 m^2 coating within three days, and suggested that the method was a low cost and easy countermeasure for sulfidation (Fig. 3).

To upgrade the tool that evaluates the possibility of sulfidation corrosion on water wall tubes in a pulverized coal-fired boiler, a corrosion test was carried out under the transition range between sulfidation and oxidation (Fig. 4). The application range of the tool was extended by adding the test results.

3 Behavior elucidation and establishment of an emission control method for trace elements in coal-fired power generation plants

Recently, it was reported that selenium, which has a lower charge number than selenite, existed in FGD waste water, though the typical forms were considered to be selenite and selenate. The behavior of selenium in a conventional waste water treatment process was investigated through a basic experiment using standard reagents and speciation of selenium in actual waste water samples. These investigations revealed that the selenium whose change members were less than tetravalent was easily removed in the conventional waste water treatment process.

*1 HGI (Hardgrove Grindability Index) is the evaluating factor for the grindability of coal. As HGI decreases, it becomes harder to grind. The HGI of bituminous coal utilized in Japanese power stations ranges from 40 to 70. The HGI of low HGI coal referred to in this study is lower than 40.

*2 Bunker blending method is when two types of coal, which are blended in a bunker before grinding in a roller mill, are fired at the same blending ratio for each burner of a boiler.

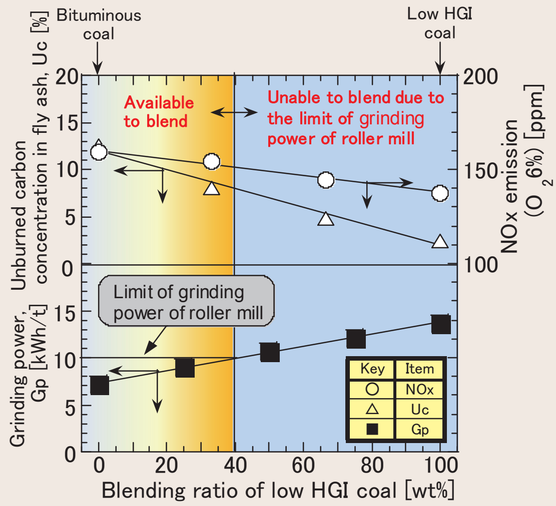

Fig. 1: Combustibility and grindability of low HGI coal at blending

As the blending ratio of low HGI coal to low volatile bituminous coal increased, both emissions of NOx and unburned carbon reduced as low HGI coal has a high fuel rate and low nitrogen content. However, the grinding capacity of the roller mill reached its limit due to the high blending ratio of low HGI coal. (In the case of this study, the limit of blending ratio of low HGI coal was approx. 40%.)

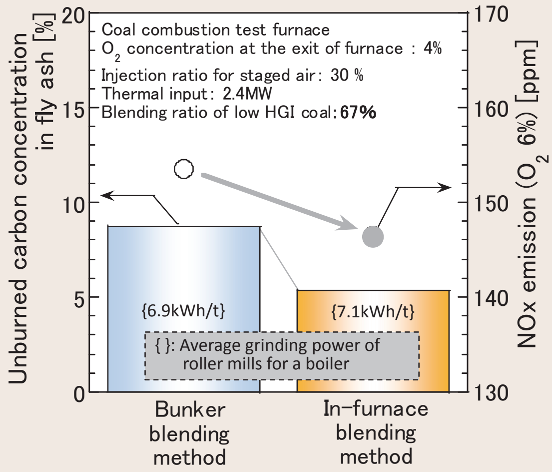

Fig. 2: Effect of low HGI coal blending method

Using the bunker blending method, when particles were made coarser to reduce the grinding force of the roller mill, the blending ratio of low HGI coal could be increased. However, both emissions of NOx and unburned carbon in fly ash were increased. Using the in-furnace blending method, in which low HGI coal was coarsely ground and bituminous coal was ground to ordinary particle size by their respective roller mills then fired in separate burners, both emissions of NOx and unburned carbon could be reduced.

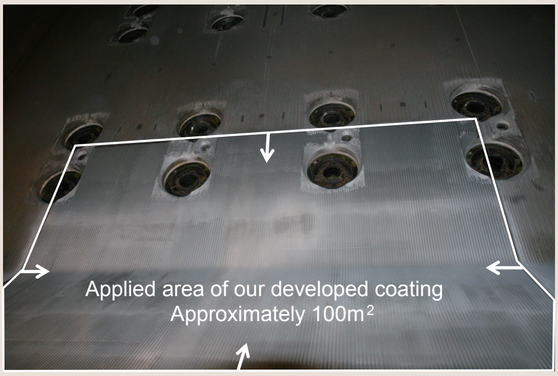

Fig. 3: Application of CRIEPI-developed coating to an actual boiler

The coating consists of 4 layers, which were SiO_2, TiO_2, Al_2O_3, and TiO_2 from the substrate side, and its application required three days for an area of approximately 100 m^2. The total coating time of each layer was around 6 hours, and over 6 hours of drying time was required for each layer.

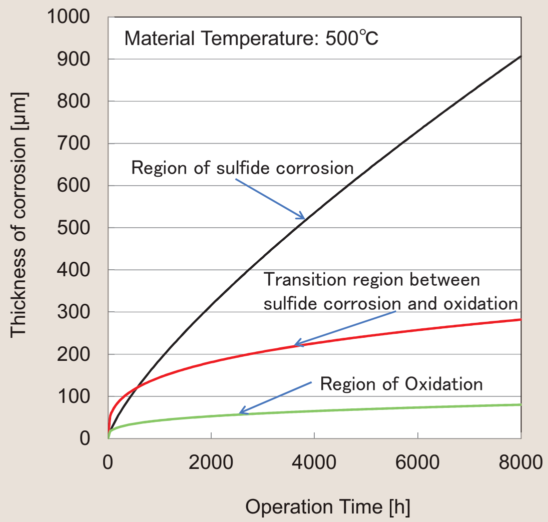

Fig. 4: Example of evaluated corrosion rate

The growth of a corrosion layer in the transition range between sulfidation and oxidation was investigated in a laboratory test. The thickness of a corrosion layer in a transition state was between that of oxidation and sulfidation.