Utilization of Low Grade Fuels

Background and Objective

Coal supply and demand is going to be tight due to the increase of coal consumption in developing countries, and securing a coal supply is getting worse. This laboratory has been developing combustion technologies to improve the availability of low grade fuels in a wide load range. To increase sub-bituminous coal (up to 30% moisture) utilization in a conventional power plant designed for bituminous coal, this project develops co-combustion technologies of bituminous and sub-bituminous coals which enables a high mixing rate of sub-bituminous coal and stable combustion at low load. It also develops a countermeasure for sulfidation, evaluates fouling and slugging properties of ash, and clarifies the effect on the air pollution control facilities and trace element emissions, caused by the use of low grade fuels.

Main results

1. Co-firing technology of low grade fuels with bituminous coal

The grinding characteristic of bituminous and sub-bituminous coals in a roller mill was investigated to raise the blending ratio of sub-bituminous coal. The high moisture in sub-bituminous coal caused roller slip during the milling process and resulted in low grindability comparing with bituminous coal. It was also clarified that the blending ratio of sub-bituminous could be improved up to 50% from 30% by maintaining the mill exit temperature at 60˚C.

2. Countermeasures for sulfidation corrosion

A combustion control and coating technologies are under development as countermeasures which prevent sulfidation corrosion of coal fired boiler walls. Combustion tests using a coal combustion test furnace showed that H_2S formed between the burner and the two staged combustion air port (Fig. 1), and H2S concentration became higher when low fuel ratio coals were used (Fig. 2) [M 09004, M 09010].

The coating was applied to some thermal power plants to test the effect on the prevention of sulfidation. Some data was also obtained from the coating tests to verify the equation of corrosion rate. In addition, to support the maintenance planning of boiler walls, a corrosion estimation program based on flue gas compositions was added to the software which evaluated the sulfidation corrosion condition.

3. Characterization of ash adhesion properties

To evaluate ash adhesion characteristics on boiler tubes, the initial ash adhesion and the growth of attached ash layer were investigated using a cooling probe that simulated a boiler tube and an ash adhesion test piece without cooling, respectively (Fig. 3). Using these methods, the ash adhesion characteristics of various coals were observed in the coal combustion test furnace (Fig. 4).

4. Trace element behavior in coal combustion power plant

Estimation of trace element transfer from coal into coal fly ash and flue gas is useful for the selection and the use of coal, which improve the environmental protection of the plant and the control of fly ash quality. Trace element behaviors, such as vaporization during combustion, transfer from gas to ash particles in flue gas, chemical reactions in a wet FGD, were investigated to estimates the partition of trace elements in a power plant.

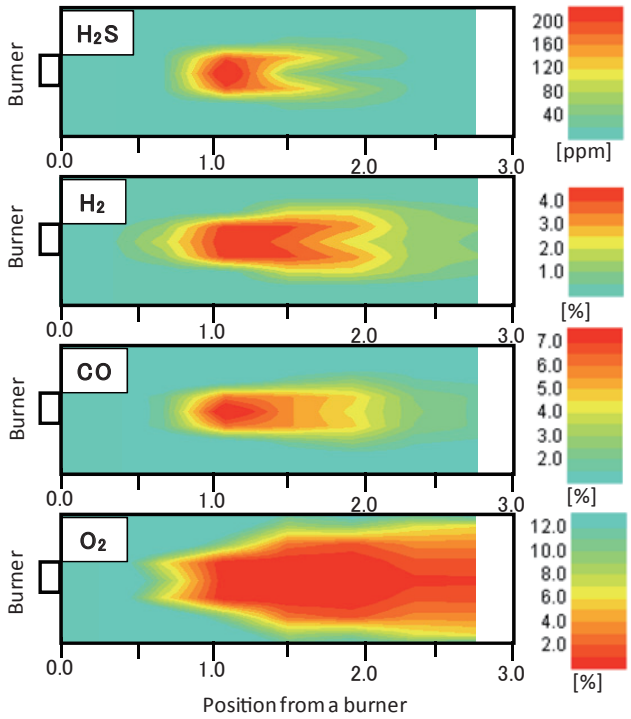

Fig. 1 H_2S, H_2, CO and O_2 concentration profiles in the coal combustion test furnace for SK coal

H_2S was formed between the burner and to two stage combustion air port. H_2S concentration profile was similar to those of H_2 and CO.

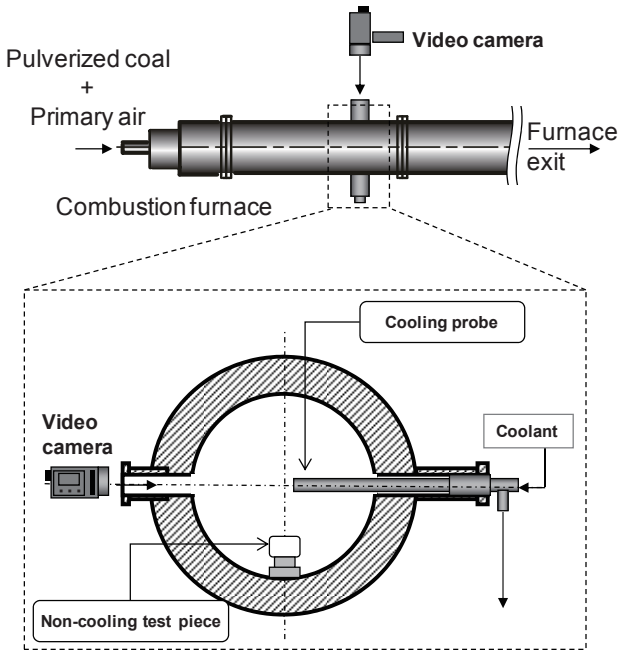

Fig. 3 Ash adhesion test device installed in the coal combustion test furnace.

The cooling probe simulates initial ash adhesion on boiler tube surfaces. The non-cooled test piece was used to observe the adhered ash layer on the test piece surfaces at the furnace gas temperature.

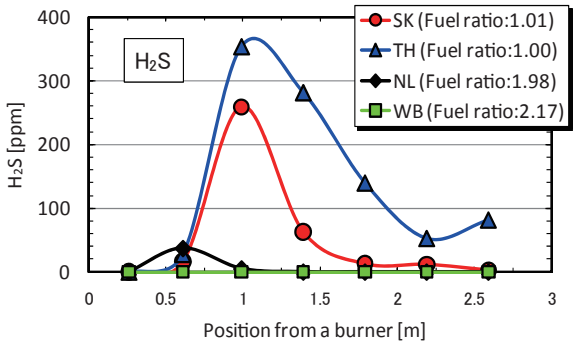

Fig. 2 H_2S concentrations on the central axis of the coal combustion test furnace obtained from four different coals

Lower fuel ratio coals (SK, TH) showed higher H_2S concentrations than higher fuel ratio coals (NL, WB).

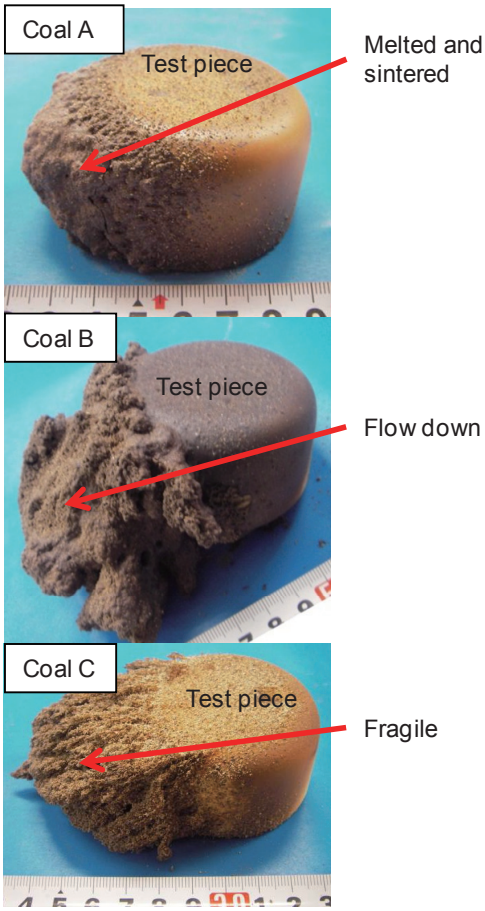

Fig. 4 Ashes layers formed on non-cooling test pieces.

The differences in ash adhesion caused by ash melting point, additives, etc. were observed. The ash of coal A was sintered and adhered strongly to the test piece. The coal B ash was melted and flowed down. The coal C ash was not melted and was fragile.