Development of Technology for Reducing both Emissions of NOx and Unburned Carbon using In-Furnace Blending Method

Background

In pulverized coal fired power plants, it is important to reduce emissions of both NOx and unburned carbon from the viewpoint of environmental protection. Also, considering the security of fuel supply and the cost of fuel, it will become increasingly desirable for power plants to use different types of fuel. One method of reducing these emissions is to be fired with a high volatile content coal *1. When two types of coal are fired in a boiler, two different blending methods can be utilized. One is the line blending method, in which the two types of coal are stored in a bunker on the mill. The other is the in-furnace blending method, in which each type of coal is fired by each burner without prior blending in the bunker (Fig.1). In general, the line blending method is utilized in Japanese coal fired power plants. On the other hand, the in-furnace blending method is expected to reduce emissions of both NOx and unburned carbon. However, the effect of the in-furnace blending method on these emissions has not yet been clarified.

Objectives

The effect of the coal properties on the emissions of both NOx and unburned carbon by the in-furnace blending method is clarified using a coal combustion test furnace (MARINE furnace) with three staged burners.

Principal Results

1. Combustion of blended bituminous coals

In the case of the in-furnace blending method, which means that high volatile content coal is fired by the upper burner and low volatile content coal is fired by the middle and lower burners, the emissions of both NOx and unburned carbon are the lowest among other types of in-furnace blending method and the line blending method (Fig.2). The reason for the reduction of these emissions is considered to be that a large amount of NOx formed in the region of the middle and lower burners is decomposed by the reduction matter in high volatile content coal in the region of the upper burner. On the other hand, the reason for the decrease in unburned carbon is considered to be that the combustion time of low volatile content coal in the furnace is able to be lengthened by firing from the middle and lower burners.

Furthermore, from the viewpoint of the blending combination between two types of coal, the effect of the in-furnace blending method on reducing emissions of both NOx and unburned carbon becomes high using lower volatile content coal, which exhausts a large amount of NOx. Also, as the volatile matter content of higher volatile content coal is high, this reduction becomes considerable.

2. Combustion of sub-bituminous coal blended with bituminous coal

When the in-furnace blending method is utilized for the combustion of blended sub-bituminous coal, sub-bituminous coal is fired from the upper burner instead of bituminous coal with high volatile content. Then, NOx emission at the exit of the furnace was decreased compared with that for the line blending method (Fig.3).

For the line blending combustion of sub-bituminous coal, unburned carbon concentration in fly ash becomes much higher as the moisture content of the sub-bituminous coal increases. The reason for this is considered to be that the combustibility of bituminous coal is inhibited because of moisture vaporized from the sub-bituminous coal. In the case of the in-furnace blending method, the increase in unburned carbon at high moisture content in sub-bituminous coal was able to be reduced compared with that for the line blending method. The reason was considered to be that the combustion flames of bituminous coal and sub-bituminous coal were separated (Fig.4).

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Reference

M. Ikeda et al., 2008, “Development of Technology for Reducing NOx Emission and Unburned Carbon Concentration in Fly Ash using In-Furnace Blending Method”, CRIEPI Report M07007 (in Japanese)

*1 : Emissions of both NOx and unburned carbon decrease as the volatile content in coal becomes high. (Makino et al., JIE Jarrnal, 74, 906 (1994)

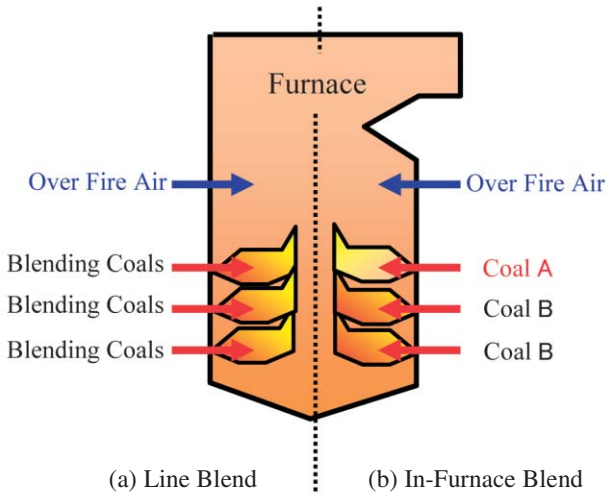

Fig.1 Concept of two types of blending method

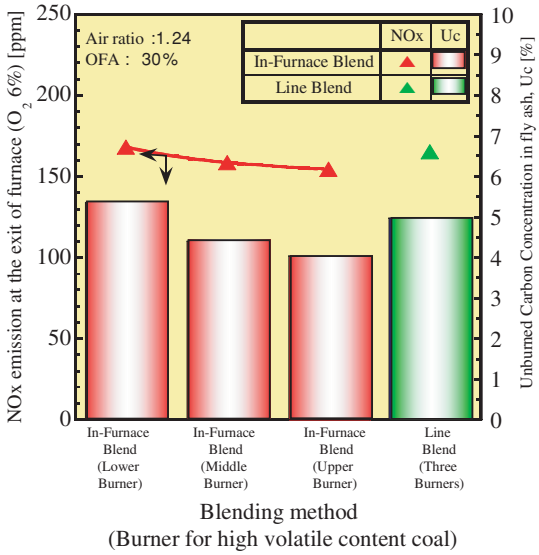

Fig.2 Influence of blending method on emissions of NOx and unburned carbon during blending combustion between two types of coal

Line Blend: Two types of coal are stored in the bunker on the mill
In-Furnace Blend : Each coal is fired by each burner without prior blending in the bunker

In the case of in-furnace blending method, in which high volatile content coal is fired by upper burner and low volatile content coal is fired by middle and lower burners, emissions of both NOxand unburned carbon are lower than these emissions on the line blending method

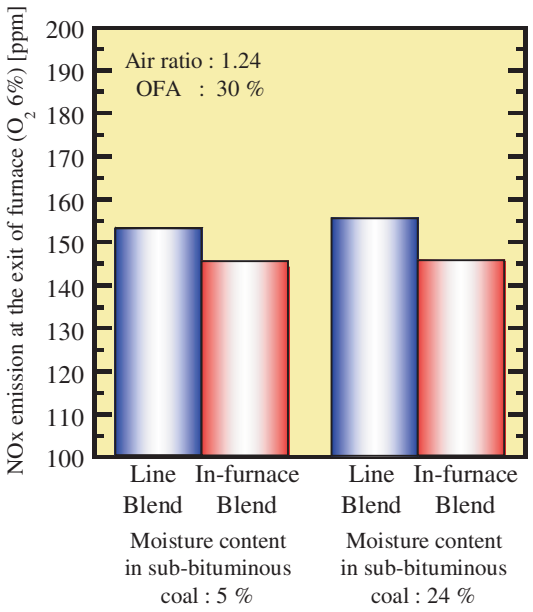

Fig.3 Relation between NOxemission at the exit of furnace and blending combustion of sub-bituminous coal

When the in-furnace blending method is utilized for blending combustion of sub-bituminous coal, NOx emission at the exit of furnace is decreased compared with that for the line blending method

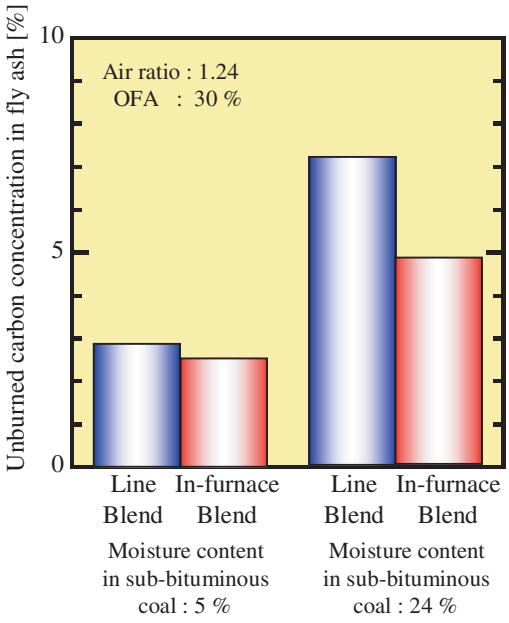

Fig.4 Relation between unburned carbon concentration in fly ash and blending combustion of sub-bituminous coal

In the case of in-furnace blending combustion of sub-bituminous coal, the increase in unburned carbon is able to be reduced compared with that for the line blending method