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Reactivities of Turkish Lignites during Oxygen Enriched Combustion

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Abstract : Lignitic coal holds its position as Turkey's most important indigenous energy source to generate energy in thermal power plants. Hence, efficient and environmental-friendly use of lignite in electricity generation is of great importance. Thus, clean coal technologies have been planned to mitigate emissions and provide more efficient burning in power plants. In this context, oxygen enriched combustion (oxy-combustion) is regarded as one of the clean coal technologies, which based on burning with oxygen concentrations higher than that in air. As it is known that the most of the Turkish coals are low rank with high mineral matter content, unburnt carbon trapped in ash is, unfortunately, high, and it leads significant losses in the overall efficiencies of the thermal plants. Besides, the necessity of burning huge amounts of these low calorific value lignites to get the desired amount of energy also results in the formation of large amounts of ash that is rich in unburnt carbon. Oxygen enriched combustion technology enables to increase the burning efficiency through the complete burning of almost all of the carbon content of the fuel. This also contributes to the protection of air quality and emission levels drop reasonably. The aim of this study is to investigate the unburnt carbon content and the burning reactivities of several different lignite samples under oxygen enriched conditions. For this reason, the combined effects of temperature and oxygen/nitrogen ratios in the burning atmosphere were investigated and interpreted. To do this, Turkish lignite samples from Adıyaman-Gölbaşı and Kütahya-Tunçbilek regions were characterized first by proximate and ultimate analyses and the burning profiles were derived using DTA (Differential Thermal Analysis) curves. Then, these lignites were subjected to slow burning process in a horizontal tube furnace at different temperatures (200ºC, 400ºC, 600ºC for Adıyaman-Gölbaşı lignite and 200ºC, 450ºC, 800ºC for Kütahya-Tunçbilek lignite) under atmospheres having O_2+N_2 proportions of 21%O_2+79%N_2, 30%O_2+70%N_2, 40%O_2+60%N_2, and 50%O_2+50%N_2. These burning temperatures were specified based on the burning profiles derived from the DTA curves. The residues obtained from these burning tests were also analyzed by proximate and ultimate analyses to detect the unburnt carbon content along with the unused energy potential. Reactivity of these lignites was calculated using several methodologies. Burning yield under air condition (21%O_2+79%N_2) was used a benchmark value to compare the effectiveness of oxygen enriched conditions. It was concluded that oxygen enriched combustion method enhanced the combustion efficiency and lowered the unburnt carbon content of ash. Combustion of low-rank coals under oxygen enriched conditions was found to be a promising way to improve the efficiency of the lignite-firing energy systems. However, cost-benefit analysis should be considered for a better justification of this method since the use of more oxygen brings an unignorable additional cost.

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