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Combustion Characteristics of Wet Woody Biomass in a Grate Furnace: Including Measurements within the Bed

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Abstract : Biomass combustion is a growing technique for heat and power production due to the increasing stringent regulations with CO2 emissions. Grate-fired systems have been regarded as a common and popular combustion technology for burning woody biomass. However, some grate furnaces are not well optimized and may emit significant amount of unwanted compounds such as dust, NOx, CO, and unburned gaseous components. The combustion characteristics inside the fuel bed are of practical interest, as they are directly related to the release of volatiles and affect the stability and the efficiency of the fuel bed combustion. Although numerous studies have been presented on the grate firing of biomass, to the author's knowledge, none of them have conducted a detailed experimental study within the fuel bed. It is difficult to conduct measurements of temperature and gas species inside the burning bed of the fuel in full-scale boilers. Results from such inside bed measurements can also be applied by the numerical experts for modeling the fuel bed combustion. The current work presents an experimental investigation into the combustion behavior of wet woody biomass (53 %) in a 4 MW reciprocating grate boiler, by focusing on the gas species distribution along the height of the fuel bed. The local concentrations of gases (CO, CO2, CH4, NO, and O2) inside the fuel bed were measured through a glass port situated on the side wall of the furnace. The measurements were carried out at five different heights of the fuel bed, by means of a bent stainless steel probe containing a type-k thermocouple. The sample gas extracted from the fuel bed, through the probe, was filtered and dried and then was analyzed using two infrared spectrometers. Temperatures of about 200-1100 °C were measured close to the grate, indicating that char combustion is occurring at the bottom of the fuel bed and propagates upward. The CO and CO2 concentration varied in the range of 15-35 vol % and 3-16 vol %, respectively, and NO concentration varied between 10-140 ppm. The profile of the gas concentrations distribution along the bed height provided a good overview of the combustion sub-processes in the fuel bed.

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