Devolatilization and Combustion of Tire Rubber and Pine Wood in a Pilot Scale Rotary Kiln

Cement production is highly energy intensive and requires large quantities of fuels. For both economical and environmental reasons, there is an increasing tendency for utilization of alternative fuels in the cement industry, examples being tire derived fuels, waste wood, or different types of industrial waste. In this study, devolatilization and combustion of large particles of tire rubber and pine wood with equivalent diameters of 10 mm to 26 mm are investigated in a pilot scale rotary kiln able to simulate the process conditions present in the material inlet end of cement rotary kilns. Investigated temperatures varied from 700 to 1000 °C, and oxygen concentrations varied from 5% v/v O2 to 21% v/v O2. The devolatilization time of tire rubber and pine wood were found to mainly depend on temperature and particle size and were within 40 to 170 s. Rate limiting parameters for char oxidation of tire rubber and pine wood were found to be bulk oxygen concentration, mass transfer rate of oxygen, raw material fill degree, raw material characteristics, and temperature. Kiln rotational speed only had a minor effect on the char oxidation when the raw material bed was in a rolling motion. Initial fuel particle size also influenced the char conversion time for pine wood char but had no influence on tire char conversion time, because the tire rubber crackled into several smaller char fragments immediately after devolatilization. The char conversion times were from 40 to 480 s for tire char and from 30 to 1300 s for pine wood char, depending on the conditions. Models for devolatilization and char oxidation of tire rubber and pine wood are validated against experimental results.

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