Devolatilization kinetics of woody biomass at short residence times and high heating rates and peak temperatures - DTU Orbit (08/11/2017)

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This work combines experimental and computational fluid dynamics (CFD) results to derive global kinetics for biomass (pine wood) devolatilization during heating rates on the order of $10^5 Ks^{-1}$, bulk flow peak temperatures between 1405 and 1667K, and particle residence times below 0.1s. Experiments were conducted on a laboratory laminar entrained flow reactor (LFR) using solid fuel feed rates on the order of 10-20mgh^{-1}. Employing a simple single step first order (SFOR) mechanism with an Arrhenius type rate expression, the best fit of the pyrolysis kinetics was found to be: $A=18.9\times10^3 s^{-1}$, $E_a=21305 Jmol^{-1}$. The accuracy of the derived global kinetics was supported by comparing predictions to experimental results from a 15kW furnace. The work emphasizes the importance of characterizing the temperature history of the biomass particles when deriving pyrolysis kinetics. The present results indicate faster kinetics than found in the literature, leading to predicted residence times required for full conversion one order of magnitude lower than when compared to thermogravimetric analysis (TGA) derived kinetics.

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