Single particle model for the pyrolysis of wheat straw pellets

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The pyrolysis of large biomass particles has been investigated experimentally with wheat straw pellets, and numerically with a single particle model, focusing on the heat and mass transfer phenomena.

Abstract

Biomass pyrolysis consists of heating the biomass in the absence of oxygen in order to obtain a range of useful products like chemicals and energy. Biomass is considered a renewable resource, and its thermo-chemical conversion is considered to be carbon neutral. To scale up biomass pyrolysis for industrial purposes, a good process design and control is necessary to predict and optimize the desired product yields for a given biomass. The main challenges in biomass pyrolysis simulation are related to its kinetics and transport processes. Due to the heterogeneity of biomass and potential interaction of its chemical components, there is not a definitive and generalizable kinetic mechanism able to render pyrolysis for all types of biomass and operating conditions. Also, in the case that a kinetic mechanism can be assumed or determined, it is still necessary to know how these reactions will proceed inside the biomass particle. For small particles, like powder, the reactions are going to happen in a thermally thin regime and pyrolysis is going to be kinetically-controlled, but for larger particles in the thermally thick regime, the particle is not going to heat uniformly, therefore it becomes necessary to know how the heat and mass are going to be transferred across the biomass particle. In this work, we investigate the pyrolysis of a biomass particle experimentally, with a wheat straw pellet, and numerically with a single particle model.

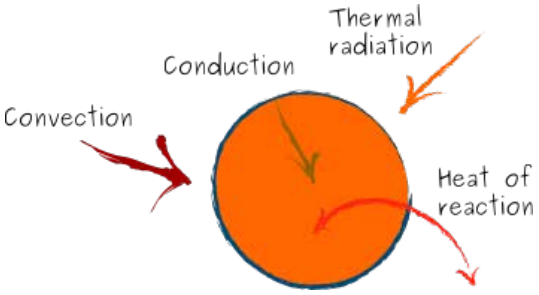

Figure 1: Heating of a single particle