Numerical simulation of reactive flow in granular media using a LBM approach. Application to the study of biomass torrefaction.

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ABSTRACT

Torrefaction is a key step in the manufacturing process of fuel made from biomass pellets and has been studied widely in the literature [1]. During and after the process, safety issues have to be managed, due to the risk of self-heating, thermal runaway and self-ignition. The physical origins of these phenomena involve heat transfer, thermochemistry and kinetics. Although these mechanisms have been studied recently [2], the impact of hydrodynamics has not been investigated so far. Actually, packing structure, anisotropy and pore size distribution can induce strong heterogeneities of gas flow velocity, temperature and composition. Thus, to get a better understanding of the impact of these heterogeneities, it is necessary to consider the local structure of the packing.

The aim of this work is to propose a numerical simulation of gas flow on a few particles scale, coupling thermal and reactive aspects with hydrodynamics.

Simulations are run using a 2D CFD software which is being developed in our laboratory. It is based on a Lattice Boltzmann approach which is known to allow an easy implementation of coupled multiphysics models [3]. Fluid dynamics, thermal aspect and oxidation reaction have been implemented in the code.

Our results show indeed that strong heterogeneities of gas flow velocity and temperature field appear according to the local structure. The influence of input gas velocity is enhanced by the fact that the industrial operating conditions can lead to different flow regimes.

Thus, it appears that hydrodynamics aspects and packing structure have to be considered in the mean field approach which is commonly used to characterize the biomass chips behavior on the reactor scale.

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