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Development of CFD-DEM model for prediction of pyrolysis and combustion of biomass in a packed bed

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Due to the environmental problems related to carbon dioxide and other greenhouse gas emissions and the limitation of fossil fuels, demands for using biomass as a renewable source of energy is dramatically increasing. In order to improve the performance of gasifiers, appropriate knowledge of all the processes occurring within the reactor is necessary. Combustion of biomass particles is a very complex process, as several physical and chemical phenomena are involved. During combustion of biomass in a fixed bed, each particle experiences a sequence of processes such as heating, drying, pyrolysis and char combustion. Furthermore, in the gas phase the pyrolysis products may react with oxygen and produce heat. Experimental investigations of biomass combustion in a packed bed are usually difficult to carry out due to the limited access to the bed. While numerical modelling is a promising way helping to understand the details of the complex processes inside the reactor. The objective of this investigation is to propose a high level Euler-Lagrange model arranged on the advanced simulation platform of the Extended Discrete Element Method (XDEM) to predict accurately all the phenomena occur during combustion of biomass. In XDEM fluid phase is a continuous phase and each particle is tracked with a Lagrangian approach. Energy, mass and momentum conservation are applied for each single particle and the interaction of particles with each other in the bed and with a surrounding gas phase are taken into account. Hence the sum of all particle processes represents the entire process of the fixed bed conversion. In order to validate the presented model, simulation results are compared with measurements and good agreement was achieved.