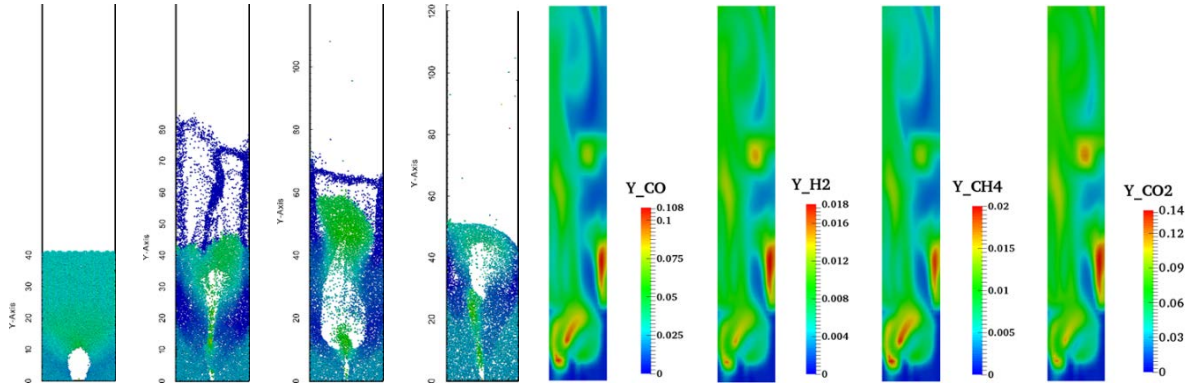
DEM-based method study of steam biomass gasification in a fluidized bed reactor

Shuai Wang*, Kun Luo, Liyan Sun, Chenshu Hu, Junjie Lin, Jianren Fan
State Key Laboratory of Clean Energy Utilization, Zhejiang University,
Hangzhou 310027, P. R. China
Email: wshuai2014@zju.edu.cn

In this paper, we proposed a coarse-grained CFD-DEM to study steam biomass gasification in a fluidized bed reactor. This method is based on Eulerian-Lagrangian concept, where the gas phase is solved under Eulerian framework and solid phase is tracked using a discrete element method (DEM). In order to reduce computational load, the numerical parcel assumption is used. Via careful treatments on inter-phase and inter-particle interactions, the coarse-grained method is extended to heat transfer and chemical reaction. Specifically, particle collisions, hydrodynamics of dense gas-particle flow, turbulence, heat and mass transfer, radiation, particle shrinkage, pyrolysis, and homogeneous and heterogeneous chemical reactions are all considered during biomass gasification with steam. Numerical results agree well with experimental data. Effects of various operating conditions on gasification performance are comprehensively investigated, and the results shed light on the design, operation, and optimization of fluidized bed reactors.

Keywords: Coarse-grained CFD-DEM; fluidized bed reactor; model validation; flow dynamics; chemical reactions.



(a) (b) (c) (d) (e)

Fig. 1. (a) Snapshots of the solid motion at 0.1s, 1.0 s, 5.0 s and 10.0 s; (b-e) contour plots of CO, H_2, CH_4, and CO_2.

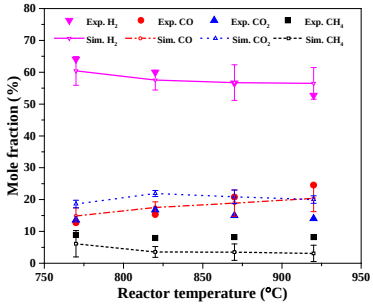


Fig. 2. Effect of reactor temperature on syngas compositions.