ACEX2019

13th International Conference on Advanced Computational Engineering and Experimenting
ATHENS (Greece) from 1-5 July, 2019

Multilevel Modelling of Particles-Wall Interaction in Slagging Coal Gasifiers: Towards Matching of Experimental Evidences

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Entrained flow slagging gasifiers represent a fundamental processing unit for both material and energy production. They allow the transformation of solid materials, like coal or biomasses, into primary gas products useful for the subsequent synthesis of more complex products for the chemical and energy industry or for the direct production of clean energy from fossil fuels, like in IGCC plants. Because of extreme conditions (temperature higher than the melting temperature of ashes, corrosive atmosphere, etc.) a direct diagnostic of the reactor behaviour is difficult, while very complex phenomena, ranging from the gasification of solid material to the multiphase (pulverized solid, water and gas) turbulent flow and the collection of particles into the slag layer at the wall coexist. Therefore, there is a high interest in developing comprehensive models to obtain reliable predictions for a proper design, dimensioning and scaling up of these units.

This objective is currently hindered, apart from the inherent difficulty to deal with a so complex system characterized by a very large span of characteristic scales, by the unclear knowledge of some very important aspects. Focus of this presentation will be on the interaction of the particles with the walls, a fundamental mechanism responsible for the separation of material residues in the form of a molten slag collected at the walls from the final useful products. A multilevel strategy, ranging from the CFD simulation of particle laden turbulent flows to the DEM simulation of idealized configuration of particles impinging on walls, has been developed [1, 2] to get useful insights on this interaction and obtain useful indications for the development of comprehensive models.

[1] F.S. Marra, M. Troiano, F. Montagnaro, P. Salatino, R. Solimene, I.J.Mult.Flow, 91, 142 (2017).
[2] F. Ambrosino, A. Aprovitola, P Brachi, F.S. Marra, F. Montagnaro, P. Salatino, Fuel, 114, 44 (2013)