CFD simulation of a Spouted Bed: comparison between the Discrete Element Method (DEM) and the Two Fluid Method (TFM)

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Highlights

- A prismatic spouted bed was modelled using CFD
- A comparison between discrete element method and two fluid model was performed
- Experimental data with different solids were used to validate both models

The interest in spouted beds has been triggered in ~~the~~ recent years to apply them in a broad range of applications, mostly related to drying processes, due to the high fluid-solid contact achieved. They currently stand out as a promising technology to carry out thermo-chemical reactions such as pyrolysis, gasification and combustion of different materials such as coal or waste products. Spouted beds are obtained by replacing the perforated plate of a conventional fluidisation reactor by a plate with a single orifice. Hence, an enhanced recirculation of solids is obtained with a particular multiphase pattern occurring inside the reactor [1].

CFD modelling has become a powerful tool for the study of multiphase flows thanks to develop computational power and the advance of numerical algorithms. Currently, two approaches are mainly applied: the Eulerian-Eulerian approach (Two Fluid Model, TFM) and the Eulerian-Lagrangian approach (Discrete Element Method, DEM). The former considers both the solid and the gas phase as interpenetrating continua and is feasible for industrial-scale facilities, but is highly dependent on parameters, while the later tracks the trajectory of each discrete particle, thus representing the most natural choice, but is more computationally complex and can be used up to lab-scale devices [2].

The main aim of this work is to compare both methods in terms of accuracy, benefits and limits through the simulation of a prismatic spouted bed device. The results were compared with experimental data using mixtures composed of glass beads as the bed material and different spheres with varying densities and diameters as the second solid phase [3]. All the simulations were performed with the aid of the Ansys Fluent© software.

The applicability of the governing equations and the implicit decisions according to the choice of the method were discussed. The accuracy of the results was assessed by comparing experimental and simulated data of the main operational parameters: onset velocity, minimum spouting velocity, pressure drop and fountain height. Finally, the main advantages and drawbacks of each of the applied methods were evaluated in detail and their suitability according to the particular case requirements (accuracy, time of calculation, …) was discussed.

References

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Keywords
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