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Multiphase flows though porous structures

Abstract

Chemical industries are always in search of new supports for catalyst deposition to improve the energy efficiency of the chemical process. Metallic and ceramic foam packing, due to their high porosity, high specific surface area and low pressure drop are promising alternatives for packing internals used in chemical engineering processes. There are not many work performed with ceramic foams as reactor internal using CFD. Although, there are many closures available for trickle bed reactor studies where spherical particles are considered as reactor internals. A 3D CFD simulation of the evolving gas-liquid flow patterns in trickle bed reactors is performed and the results are validated with experiments Marcandelli et. al., (2000). Further these closures are extended for ceramic foams studies and are validated with experimental X-ray tomographic studies. A two-phase Eulerian model is used considering the flow domain as porous. The geometric specifications and experimental data are inspired from Marcandelli et. al., (2000). The influence of the liquid and gas (water and air) drag is added as external source terms to liquid and gas momentum equations separately. The drag forces between the phases have been taken into account using the relative permeability approach, which was developed by Saez and Carbonell (1985) and Fluid-Fluid model developed by Attou and Forschneider (1999). The advantages and disadvantages of both the closures are studied in detail. The major hydrodynamic parameters such as dynamic liquid holdup, liquid distribution at different heights of the column, pressure drop are studied and validated with experimental studies. The comparison is made in terms of percentage distribution by calculating the mal-distribution factor with the experiment Marcandelli et. Al. (2000). A robust model is formulated for implementation and analysis in pilot scale foam studies. First simulations are performed for Ceramic foams with data from the literature.