CALCULATION OF THE MICROSCALE FLOW THROUGH A PACKED BED USING FINITE VOLUME CFD.

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ABSTRACT

Packed beds are structures constructed by packing together numerous small and often irregular solid particles. The packing creates an irregular voidage structure through which a fluid can percolate. Such structures are common in industrial processes as they create an increased surface area for contact between the fluid and the material of the particles, which can be useful for heat or material exchange. The complex nature of the paths and the blockage factor of the particles results in an overall resistance to the flow of the fluid; thus the overall pressure drop across the bed is dependent on the details of the microstructure. Understanding the details of this flow is a challenging task which has in the past been tackled through experiment or through theoretical or computational analysis based on a simplified model of the bed. Experimental investigation faces challenges in probing the microstructure and microcirculation, whilst the theoretical and computational analyses, which usually represent the bed by a simplistic structure such as a tube bundle or a single unit cell [1], may not be sufficiently realistic. The computational power available for CFD has however now advanced sufficiently as to make full simulation of at least representative sections of the bed a realistic possibility. Here we present work done using Finite Volume CFD techniques on geometrically faithful and accurate packed bed domains. Bed geometries were created in two ways; by computational means using a Monte Carlo packing process, which could then be meshed using automatic mesh generation techniques, and by MRI scanning and Image Based Meshing [2] of real beds. CFD simulations were then performed using the commercial code Fluent. In the second method, the beds were available for experimentation, whilst for the first they could be synthesised using additive layer manufacturing techniques; thus experimental data was available for comparison in both cases. Both processes were found to produce excellent results in terms of macroscale correlations between superficial velocity and pressure drop. The problems of mesh generation through the two approaches are discussed, as well as the potential of such methods for probing the microscale structure of the flow.

REFERENCES

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