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HYBRID FE/FV METHODS FOR EVALUATING WALL EFFECTS IN STRUCTURED POROUS MEDIA

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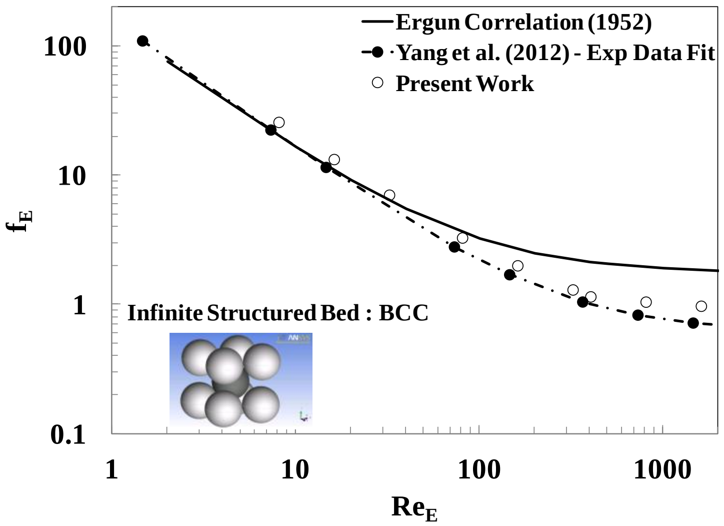
Effects of confining walls on the friction factors and pressure drop characteristics in structured porous media are numerically investigated in this study using hybrid FE/FV methods. Structured porous media packing's are significantly different from random packing's for both infinite media and also in terms of finite wall effects [1, 2]. In this study, the influence of confining walls on the flow physics and pressure drop for structured packing's are studied in detail using sophisticated numerical techniques such as hybrid FE/FV methods. Hybrid FE/FV methods take advantage of both finite element and finite volume methods and are particularly suited for complicated porous media geometries requiring high aspect ratio elements and also for solving elliptical equations such as Poission equation resulting from the segregated hybrid methodology used in this study.

Three dimensional numerical simulations are conducted using our hybrid FE/FV flow solver for thoroughly analyzing the wall effects. Structured porous media in this study is represented through spherical particles arranged in different regular configurations such as Simple Cubic (SC), Body Centered Cubic (BCC), and Face Centered Cubic (FCC). Finite wall effects are analyzed by placing the structured porous media in channels with different tube-to-particle diameters ratios (D_s/d_p = 1 to ∞) for all three packing configurations. Additionally, the flow is studied in both laminar and turbulent regimes for Reynolds numbers varying from 1< Re_E < 5000. Our results have previously been validated for SC structured packing's [2] which showed significantly different flow characteristics compared to random beds. Random beds overpredicted the friction factors compared to SC beds, particularly in turbulent flow regimes.

Influence of confining walls on the pressured drop for SC beds in both laminar and turbulent flow regimes was different compared to the observed behavior in literature for wall bounded random beds. Fig.1 shows the comparison of our results with recent experimental data [3] for friction factors in infinite structured BCC beds. It can be seen from the figure that Ergun equation [4] which is typically used for predicting the pressure drop in random beds clearly over predicts the friction factor in structured BCC beds. Detailed investigations are presently ongoing for analyzing the wall effects in different types of structured media including BCC and FCC packing's. Our results will be compared thoroughly with previously published theoretical, empirical correlations, and also with experimental data from structured and random porous media literature. Different existing correlations on pressure drop will be thoroughly reviewed and potential differences with correlations for wall bounded random porous media will be particularly elucidated. Finally, new generalized correlations for evaluating the friction factors in wall bounded structured porous media will be proposed.



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