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Lattice Boltzmann Simulation of Fluid Flow and Heat Transfer Through Porous Media by Means of Pore-Scale Approach: Effect of Obstacles Size and Arrangement on Tortuosity and Heat Transfer for a Porosity Degree

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Abstract : The size and arrangement of the obstacles in the porous media has an influential effect on the fluid flow and heat transfer, even in the same porosity. Regarding to this, in the present study, several different amounts of obstacles, in both regular and stagger arrangements, in the analogous porosity have been simulated through a channel. In order to compare the effect of stagger and regular arrangements, as well as different quantity of obstacles in the same porosity, on fluid flow and heat transfer. In the present study, the Single Relaxation Time Lattice Boltzmann Method, with Bhatnagar-Gross-Ktook (BGK) approximation and D2Q9 model, is implemented for the numerical simulation. Also, the temperature field is modeled through a Double Distribution Function (DDF) approach. Results are presented in terms of velocity and temperature fields, streamlines, percentage of pressure drop and Nusselt number of the obstacles walls. Also, the correlation between tortuosity and Nusselt number of the obstacles walls, for both regular and staggered arrangements, has been proposed. On the other hand, the results illustrated that by increasing the amount of obstacles, as well as changing their arrangement from regular to staggered, in the same porosity, the rate of tortuosity and Nusselt number of the obstacles walls increased.

Keywords : lattice boltzmann method, heat transfer, porous media, pore-scale, porosity, tortuosity
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