عنوان مقاله:

Numerical Assessment and Data-Driven Reduced Order Model for Natural Convection of Water-Copper Nanofluid in Porous Media

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خلاصه مقاله:

In this article, two computational frameworks are presented for the numerical simulation of flow and heat transfer under the effects of natural convection phenomena in a field containing water-copper Nano-fluid and including porous media. The first is a CFD model which is built based on accurate algorithms for spatial derivatives and time integration. The spatial derivatives have been calculated using first-order upwind and second-order central differencing approaches. Also, time integration is performed using the fourth-order Runge-Kutta method. In the second, a parametric reduced order model is developed to compute the whole flow field under the effects of some important parameters such as Darcy number and Rayleigh number. This model is constructed based on POD-snapshots method. The POD modes are calculated by the solution of an eigenvalues problem. The calculated eigenfunctions are POD modes which are ranked using energy-based criteria based on the total kinetic energy of the flow field. This approach leads to the development of a reduced-order model that can be used as a surrogate model of the CFD high-order approach. The results obtained from the reduced order model show relatively good agreements under variations of some important parameters such as Darcy and Rayleigh numbers and nanoparticles density on the flow and thermal fields with the benchmark DNS data. Also, from the results, it is concluded that the surrogate model has very small values of errors (order of ۱۰-۴ ~ ۱۰-۶) and the time spent on calculations is less than ۱۰% of the time required for direct numerical simulation.

کلمات کلیدی:

Natural convection, Nano-fluid, porous media, Model Order Reduction