On the Modeling of Thermal Effects in Forchheimer Flow

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Abstract

In this paper, we study the Forchheimer–extended Darcy–Brinkman–Boussinesq fluid flow through a thin channel filled with porous medium using methods of asymptotic analysis. The fluid inside the channel is cooled (or heated) by the surrounding medium and the flow is governed by the prescribed pressure drop between the pipe's ends. Employing asymptotic analysis with respect to the small parameter representing the channel's thickness, we derive a first–order asymptotic approximation for the velocity, pressure and temperature. The velocity approximation explicitly acknowledges the thermal effects as well as the inertial effects. These effects are clearly visualized in the provided numerical examples. Finally, we rigorously justify the obtained asymptotic model via the error estimates in suitable norms in order to indicate the order of accuracy of the proposed approximate solution.

References

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