Simulating Forced Convection in a Bingham Plastic Fluid

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Abstract

In this work, the momentum and heat transfer characteristics of two heated cylinders of square cross-section immersed in a streaming bingham plastic medium have been studied. The study is done using COMSOL Multiphysics® simulation software using the fluid flow and heat transfer interfaces. The governing differential equations (continuity, momentum and thermal energy) have been solved numerically over wide range of conditions as: plastic Reynolds number, $0.1 \leq Re \leq 40$, Prandtl number, $1 \leq Pr \leq 100$, Bingham number, $0 \leq Bn \leq 10$ and Distance between the two heated cylinders, S. Over this range of conditions, the flow is expected to be symmetric and steady. The detailed flow and temperature fields in the vicinity of the cylindrical surfaces are examined in terms of streamline and isotherm profiles respectively. The Nusselt number shows a positive dependence on the both Reynolds and Prandtl numbers. It is observed that the average Nusselt number increases with increasing Bingham number. Simulation results are validated with the available literature.

Figures used in the abstract

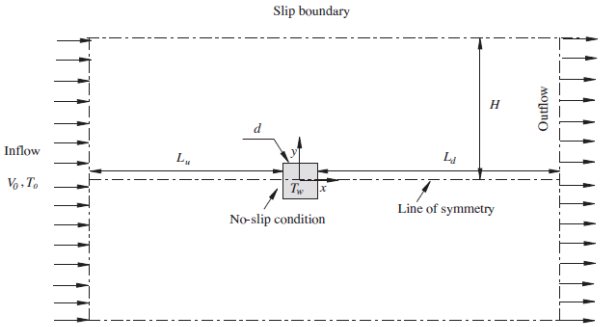

Figure 1: Schematics of flow and computational domain with a single heated square cylinder.

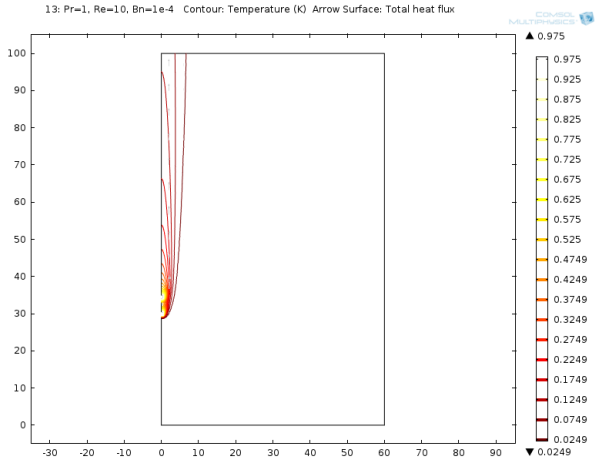

Figure 2: Isothermal Contour at Pr=1, Re=10, Bn=1e-4, S=4.5.

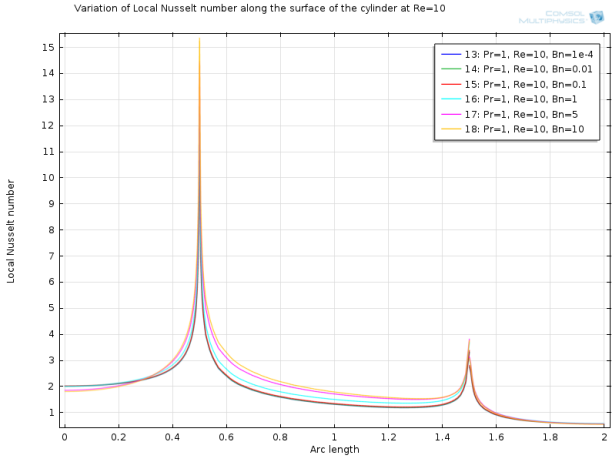

Figure 3: Variation of Local Nusselt number along the surface of the first cylinder at Re=10.