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Finite element simulations of incompressible flow past a heated/cooled sphere. (English)

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Summary: We use a Galerkin finite element method to solve the three-dimensional incompressible Boussinesq equations in primitive variable form. Numerical simulations of flow around a heated/cooled sphere, for a range of Grashof numbers and moderate Reynolds numbers, are conducted. The drag coefficient for adiabatic flow shows good agreement with standard correlations over the range of the Reynolds numbers investigated. It is shown that the drag can vary considerably with heating of the sphere, and that computational fluid dynamics methods can be used to derive constitutive laws for macroscopic momentum and heat exchange in multiphase flows.

MSC:

76M10 Finite element methods applied to problems in fluid mechanics
76D99 Incompressible viscous fluids
80A20 Heat and mass transfer, heat flow (MSC2010)

Keywords:

Galerkin method; Boussinesq equations; drag coefficient; adiabatic flow; constitutive laws; macroscopic momentum; heat exchange; multiphase flows

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