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Mixed convection of electrically conducting and viscous fluid in a vertical channel using Robin boundary conditions
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Abstract
An analytical and semi-analytical method is used to solve two-fluid magneto-hydrodynanamic flow and heat transfer in the presence of a constant electric field in a vertical channel using Robin boundary conditions. The channel is filled with electrically conducting fluid in one region and non-conducting fluid in the other region, which are immiscible. The viscous and Ohmic dissipation terms are included in the energy equation. The fluids in both regions are incompressible and the transport properties are assumed to be constant. Separate solutions are matched at the interface using suitable matching conditions. First, the simple cases of the negligible Brinkman number or the negligible Grashof number are solved analytically. Then, the combined effects of buoyancy forces and viscous dissipation are analyzed by a perturbation series method (PM) valid for small values of the perturbation parameter. To relax the conditions on the perturbation parameter, the flow fields are solved by using the differential transform method (DTM). The results are presented for various values of mixed convection parameter, perturbation parameter, Hartman number, viscosity ratio, width ratio, conductivity ratio, and Biot numbers for open and short circuits. The effects of these parameters on the physical characteristics, such as the Nusselt number at the walls, is also studied. The solutions obtained by DTM are justified by comparing the solutions obtained by PM, and good agreement is found. © 2015 Published by NRC Research Press.

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