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ANALYSIS OF THE HALL AND ION-SLIP EFFECTS IN A MHD CHANNEL FLOW: A HYBRID APPROACH

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ABSTRACT This paper reports the development of a hybrid (generalized integral transform) solution to the unsteady magneto-convection problem of an electrically conducting Newtonian fluid, with temperature-dependent transport properties, within a channel in which Hall and ion-slip effects are taken into account. Hall effects are important when the ratio between the fluid electron-cyclotron frequency and the electron-atom-collision frequency is high (the Hall parameter). Also, when the electromagnetic force is very large, the diffusion velocity of ions may also not be negligible. If the diffusional velocity of ions and electrons are included, we have the phenomena of ion slip. In spite of these phenomena, it is considered that the magnetic Reynolds number is small, i.e., the flow-induced magnetic fields are not enough strong to modify the applied transversal magnetic field. Here, in order to cover a broader range of problems, a time dependent pressure gradient, an inflow perpendicular to the plates (porous) and a non-zero upper plate velocity are also considered in the mathematical formulation. Results are illustrated and compared to the main numerical results from the literature for the related velocity and temperature potentials as function of the main governing parameters, namely, Hartmann, suction/injection, transport properties and electron and ion-slip parameters. In order to illustrate the consistency of the technique (GITT) and its use for benchmarking purposes in the area of magneto fluid dynamics, convergence analyses are carried out for the main potentials.