ABSTRACT

Heat Transfer Studies of Coupled Fluid Flow Within Porous Media

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This thesis examines the temperature and heat transfer profiles of coupled fluid flow within porous media. The main goal is to understand the way in which the heat transfer coefficient, the Nusselt number is affected by permeability. Although previous studies have been attempted in this field, this thesis serves to augment and improve on existing ideas using new models supported by analytical and numerical solutions.

There are three main geometries that are investigated. Firstly the heat transfer profile is determined for fluid flow within a channel, the top of which is driven by an accelerating surface velocity whereas the bottom comprises a naturally permeable wall. Both walls are maintained at different temperatures. Here analytical solutions are obtained for small Reynolds number flow and numerical solutions are studied for larger Reynolds numbers. Secondly, the heat transfer profiles are studied for flow trapped between two permeable rotating discs, where the top disc is set to advance toward the lower disc. Both discs are maintained at unique temperatures within an orthogonal magnetic field. Thirdly, heat transfer is investigated in the case of a porous permeable shell placed within a Stokesian flow field. The inner and outer radii of the shell are made deformable.

In all three cases studied, it can be seen that permeability serves to enhance heat transfer to the fluid that is coupled within each configuration. For the channel, the lower permeable wall serves to transfer more heat towards fluid at the centre of the channel. In the case of the discs, permeability enhances heat transfer when the two discs are maintained at isothermal temperatures as opposed to the lower disc being subjected to a heat flux. With a deformable permeable shell,there is an increase in the Nusselt number for small permeability values however the effect falls off with progressively higher permeabilities.

These studies can thus be effectively applied in industrial settings where the use of naturally permeable materials may serve to enhance heat dissipation and heat transfer.

Keywords: Rosemarie Evita Mohais; Heat Transfer; Coupled Fluid Flow; Porous; Discs; Channel; Spherical Shell