CONTROL ON THE BOUNDARY OF UNSTEADY NATURAL CONVECTIVE SLIP FLOW OF REACTIVE VISCOUS FLUID

Cansu EVCİN[1,*]

[1] *Department of Mathematics, Tekirdağ Namık Kemal University, Tekirdağ, Türkiye*

ABSTRACT

We consider the optimal control of unsteady natural convective flow of reactive viscous fluid with heat transfer. It is assumed that Newton's law follows the heat transfer within an exothermic reaction under Arrhenius kinetics and Navier slip condition on the lower surface of the channel. The flow is examined in a vertical channel formed by two infinite vertical parallel plates having a distance H between them. Time-dependent natural convective slip flow of reactive viscous fluid flow and heat transfer equations in [1] are solved in a unit interval using Galerkin-Finite Element Method (FEM) with quadratic finite elements in space and the implicit Euler method in time. The direct solutions are obtained for testing various values of the problem parameters, the Biot number, the Frank Kamenetskii parameter, the Navier slip parameter, and the computation of the skin friction and the Nusselt number Nu.

The optimal control problem is designed for the momentum and energy equations to derive the fluid-prescribed velocity and temperature profiles by defining controls on the boundary of the domain twofold: (a) controls are assigned as the time-dependent functions in the boundary conditions representing the slip velocity and the heat transfer rate. (b) controls are formulated as the parameters in the boundary conditions such as slip length and Biot number. Following a discretize-then-optimise approach to the control problem, optimisation is performed by the SLSQP (Sequential Least Squares Programming) algorithm, a subroutine of SciPy. Numerically simulated results show that the proposed approach successfully drives the flow to prescribed velocity and temperature profiles.

***K*eywords** natural convection · optimal control · finite element method

References

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[*] *Corresponding Author's E-mail: cbilgir@nku.edu.tr*