Analysis of non-Newtonian fluid flow and heat transfer in an internally finned square channel

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ABSTRACT

In the present paper non-Newtonian fluid flow and heat transfer in an internally finned square channel is described. Newtonian fluid flow and heat transfer was previously considered for example by Foong *et al.* [1]. The problem is solved using a meshless procedure based on the method of fundamental solutions (MFS) [2] and the radial basis functions (RBF) [3].

Firstly the problem of non-Newtonian fluid flow is solved. The nonlinear governing equation is transformed into a sequence of inhomogeneous equations using the Picard iteration method. Then on each iteration step the solution of the problem consists of two parts - the general solution and the particular solution. The particular solutions is obtained using the RBF. The general solution is solved using the MFS in which approximate solution is a linear combination of fundamental solutions. The fundamental solution is a function of distance between the point in the considered domain and the source point which is located outside the domain. Unknown coefficients of the approximate solutions are calculated using the boundary collocation technique [4]. The fluid flow problem was considered with non-slip boundary condition.

There are two solutions in the heat transfer problem - the temperature of the fluid and the temperature of the wall. The temperature of the fluid is governed by a nonlinear equation and the same numerical procedure was applied as above in order to solve the problem. The temperature of the wall is described by the Laplace equation and can be solved using only the MFS. The heat transfer problem was solved assuming known uniform temperature on the outer boundary of the duct, continuity of the temperature and the flux on the boundary between the fluid and the wall.

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References

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