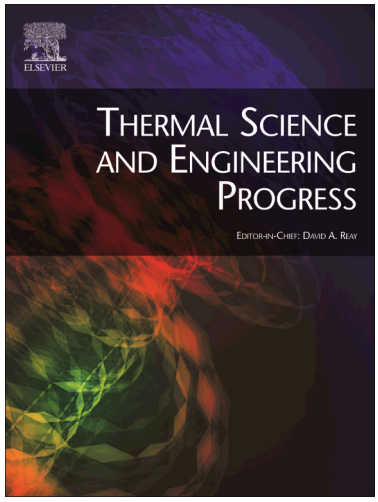

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Thermal Performance Analysis of a Natural Convection Porous Fin with Temperature-Dependent Thermal Conductivity and Internal Heat Generation

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ABSTRACT

In this study, thermal performance analysis of a natural convection porous fin with temperature-dependent thermal conductivity and internal heat generation operating is carried out using Galerkin's method of weighted residual. The developed symbolic heat transfer models were used to investigate the effects of various parameters on the thermal performance of the porous fin.It is found that increase in porosity parameter, Nusselt, Darcy and Rayleigh numbers and the thickness-length ratio of the fin increase the rate of heat transfer from the base of the fin and consequently improve the efficiency of the fin. Also, decreasing thermal conductivity parameter results in an increase in the rate of heat transfer from the base of the fin. However, an optimum value is reached beyond which further increase in porosity, Nusselt, Darcy and Rayleigh numbers, thermal conductivity ratio and thickness-length ratio has no significant influence on the rate of heat transfer. For the purpose of validation of the results, exact analytical solutions were developed. The results of the Galerkin's method for the second-order approximation function are found to be in excellent agreements with the results of the exact analytical solutions and also with that of the numerical methods and homotopy perturbation method.

Keywords: Galerkin's method of weighted residual; Natural convection**;**Porous Fin; Thermal performance**;** Temperature-Dependent Thermal Conductivity and Internal Heat Generation

1.0 Introduction

Heat transfer enhancement in extended surfaces has been a subject of vital importance which has led to extensive research on the use of porous fins. The pioneer work on the heat transfer enhancement through the use of porous was carried out by Kiwan and Al-Nimr [1]. They applied numerical method to investigate the thermal analysis of porous fin while Kiwan [2-4] developed a simple method to study the performance of porous fins in natural convection environment. Also, the same author investigated the effects of radiative losses on the heat transfer from porous fins.Gorla and Bakier [5] numerically carried out the thermal analysis of natural convection and radiation in a rectangular porous fin. Kundu and Bhanja [6] presented analytical model for the analysis of performance and optimization of porous fins. Kundu*et al.* [7] proposed a model for computing maximum heat transfer in porous fins. Taklifi*et al.* [8] investigated the effects of magnetohydrodynamics (MHD) on the performance of a rectangular porous fin. In the work, that by imposing MHD in system except near the fin tip, heat transfer rate from the porous fin decreases. Bhanja and Kundu [9] analytically investigated thermal analysis of a constructal T-shape porous fin with radiation effects. An increase in heat transfer is found by choosing porous medium condition in the fin. Recently, Kundu*et al.* [10] applied Adomian decomposition method on the performance and optimum design analysis of porous fin of various profiles operating in convection environment transient heat transfer analysis of variable section pin fins.Saedodin and Sadeghi [11] analyzedthe heat transfer in a cylindrical porous fin while Saedodin and Olank [12]. Darvishi*et al.* [13] studied