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NUMERICAL INVESTIGATION OF FREE CONVECTION BOUNDARY LAYER FLOW ON A VERTICAL SURFACE WITH PRESCRIBED WALL TEMPERATURE AND HEAT FLUX

(Kajian Berangka bagi Aliran Lapisan Sempadan Olakan Bebas terhadap Permukaan Menegak dengan Suhu dan Fluks Haba Permukaan Ditetapkan)

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ABSTRACT

In this paper, the existing model first considered by Merkin (1985) for free convection boundary layer flow on a vertical surface with prescribed wall temperature (PWT) and prescribed heat flux (PHF) is investigated numerically. The transformed boundary layer equations are solved using an efficient numerical scheme known as the Keller-Box method. Numerical solutions are obtained for the skin friction coefficient, local heat transfer coefficient, wall temperature as well as the velocity and temperature profiles. The features of the flow and heat transfer characteristics for large range of values of the Prandtl number are analyzed and discussed. Comparisons with previous work by other method for the cases of Pr = 0.72, 1 and 7 show very good agreement. In addition, results for small (Pr << 1) and large (Pr >> 1) values of Prandtl number (Pr) are also presented.

Keywords: boundary layer; free convection; numerical solution; prescribed wall temperature; prescribed heat flux

ABSTRAK

Dalam makalah ini, suatu model sedia ada yang pertama kali dipertimbangkan oleh Merkin (1985) bagi aliran lapisan sempadan olakan biasa terhadap suhu dinding dan fluks haba yang ditetapkan, dikaji secara berangka. Persamaan lapisan sempadan terjelma diselesaikan dengan suatu skema berangka yang cekap yang dikenali sebagai kaedah kotak Keller. Penyelesaian berangka diperoleh bagi pekali geseran kulit, pekali pemindahan haba setempat, suhu dinding serta profil halaju dan suhu. Ciri-ciri aliran dan pemindahan haba bagi nilai nombor Prandtl yang berbeza dianalisis dan dibincangkan. Perbandingan keputusan dengan kaedah lain bagi Pr = 0.72, 1 dan 7 menunjukkan hasil perbandingan yang sangat baik. Selain itu, keputusan bagi nilai nombor Prandtl (Pr) yang kecil (Pr << 1) dan besar (Pr >> 1) juga diberikan.

Kata kunci: lapisan sempadan; olakan biasa; penyelesaian berangka; suhu dinding yang ditetapkan; fluks haba yang ditetapkan

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