SYNOPSIS

The present thesis deals with problems of free and forced convection heat transfer in viscous incompressible fluids. A brief review of the previous results directly related to the present work is given in the introduction.

The thesis is divided into six chapters. The first four chapters deal with problems on free convection while in the last two chapters forced convection problems are discussed.

In Chapter I we discuss the unsteady free convection from an infinite vertical plate with suction. Two cases are considered i) the plate is suddenly raised to a uniform higher temperature ii) the plate suddenly begins to generate uniform heat flux at its surface. The suction velocity is assumed to be proportional to $t^{-1/2}$. The effect of suction on the velocity and temperature profiles is studied. It is found that the skin friction at the plate decreases while the coefficient of heat transfer increases with suction.

Chapter II is devoted to a study of unsteady free convection from a semi infinite vertical plate. By introducing the concept of 'similarity' the complete Navier-Stokes equations and the energy equation are reduced to a set of ordinary non-linear differential equations and are then integrated using momentum integral method. The solution in dimensionless form depends on two parameters the Prandtl number and A characterising the unsteadiness in the plate temperature. Numerical results are given for various values of A and P . The most interesting feature of the solution is that temperature profiles for different values of A cross each other towards the edge of the boundary layer.

Chapter III is devoted to a discussion of the effect of wall porosity on fully developed free convection flow between two parallel plates maintained at constant temperature. Frictional heating terms are also included in the energy equation. The solution is obtained by a process of successive approximation, the zeroth approximation corresponding to negligible frictional heating. It is found that the effect of suction is to pull the velocity and temperature profiles towards the suction wall, the points of maximum velocity and temperature getting closer to it as the suction increases.

In Chapter IV we consider combined free and forced convection flow in three dimensions. The boundary layer equations are integrated by an approximate integral method due to Epstein[1]. The specific problem considered is the steady flow near the stagnation line of an infinite swept wing. Buoyancy effects are considered in the span-wise direction only. The boundary layer equations in this case reduce to an independent two dimensional flow in the chord-wise direction but the span-wise flow depends on the chord-wise flow and the temperature within the boundary layer. The buoyancy effects depend upon a parameter λ , which is the ratio of Grashof and Reynolds numbers. Numerical results are given for different values of σ and λ .

Chapter V deals with the problem of 'Heat transfer by laminar flow due to torsional oscillations of a disk in the presence of another disk'. The velocity field as obtained by Rosenblat[2)] is taken as the starting point for temperature distribution. Asymptotic expressions for the temperature distribution and coefficients of heat transfer at the disks, valid for large and small Reynolds number, are obtained. For small values of R with $\sigma = 1$ the fluctuating part of the coefficient of heat transfer per unit area of the oscillating disk is in phase with the disk oscillations, while that at the stationary disk always has a phase lag. For large values of R the temperature field near the oscillating disk is of the boundary layer type.

In the last chapter the flow and heat transfer of an incompressible viscous liquid between two plates with axial sinusoidal roughness maintained at constant temperature is studied. The solution for slow motion is obtained in a closed form. From non-slow motion the solution is given in the form of a power series the convergence of which is rigorously established.

References

1. Epstein, Melvin, Ph.D. Dissertation, Polytechnic Institute of Brooklyn, 1958.

2. Rosenblat, S. J. Fluid Mech. 8, 888, 1960.