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Short Communication

A New Approximate Method for Laminar Stagnation Flow

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Abstract

A new approximate method, based on recent developments in the Thermodynamics of Irreversible Processes, is applied to solve the problem of the laminar stagnation flow in two-dimensions. The governing principle of dissipative processes is formulated for the problem. Then the dual field method is used to get its variational solution. Using an elementary trial function for the velocity distribution, the boundary layer thickness and the shear stress are determined, the numerical values of which are quite close to the exact values given by Schlichting. The error is less than 4% which is quite satisfactory for most engineering purposes. The coincidence can be improved by increasing the number of parameters in the velocity profile.

1. Introduction

Recently Gyarmati [1, 2, 3] proposed a variational principle which describes the evolution of irreversible processes in space and time and is based on Onsager's theory of non-equilibrium systems. In its most general form, Gyarmati's principle is written as

$$\delta \int_V (\sigma - \Psi - \Phi)\, dV = 0 , \tag{1}$$

where σ is the entropy production density which is a bilinear function of currents and thermodynamic forces. Ψ and Φ are the non-equilibrium local dissipation potentials and are equal to half of the entropy production for Onsager's linear theory. The principle is quite applicable to various dissipative systems. For the description of viscous flow systems, this variational formulation was used by Vincze [4] to derive the equations of thermo-hydrodynamics. To obtain approximate variational solutions of viscous flow problems, it was used by Singh [5, 6, 7].