

Variation of Flow Quantities Along Streamlines and Their Principal Normals and Binormals in Three-Dimensional Gas Flows

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Communicated by T. Y. THOMAS

Introduction. In this paper* we discuss three-dimensional steady rotational gas flows of non-viscous and non-heat-conducting fluids. The main purpose is to investigate various dynamical and kinematical relations connecting the flow quantities with the geometrical parameters of the streamline trajectories. The expressions for the tangent, principal normal and binormal vectors and the curvature and torsion of the streamlines are given in terms of the velocity components, pressure and density. The variation of pressure along the streamlines and their principal normals and binormals is found. It is observed that the pressure along the binormals remains constant. Furthermore the relations connecting the vorticity components with the gradient of entropy are investigated. Finally the vorticity components are found in terms of the curvature of the streamlines and the velocity gradients along the streamlines and their principal normals and binormals. In plane gas flows these results reduce to well known results of CROCCO and THOMAS.

1. Equations of motion. We consider the equations of motion governing the flow of a stationary ideal gas with viscosity and thermal conductivity zero, namely [1]

$$(1) \quad p_{,i} + \rho u_i u_{i,i} = 0 \quad (\text{equations of motion}),$$

$$(2) \quad \rho_{,i} u_i + \rho u_{i,i} = 0 \quad (\text{equation of continuity}),$$

in which p , ρ and u_i denote the pressure, density and velocity components respectively. We assume the motion referred to a system of rectangular coordinates x^i ; then comma in the above equations and in the following equations represents

* This work was carried out under N. S. F. Contract No. G 2256 with Indiana University.