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Transonic flow of steam with non-equilibrium and homogenous condensation AKASHDEEP SINGH VIRK, ZVI RUSAK, Rensselaer Polytechnic Institute — A small-disturbance model for studying the physical behavior of a steady transonic flow of steam with non-equilibrium and homogeneous condensation around a thin airfoil is derived. The steam thermodynamic behavior is described by van der Waals equation of state. The water condensation rate is calculated according to classical nucleation and droplet growth models. The current study is based on an asymptotic analysis of the fluid flow and condensation equations and boundary conditions in terms of the small thickness of the airfoil, small angle of attack, closeness of upstream flow Mach number to unity and small amount of condensate. The asymptotic analysis gives the similarity parameters that govern the problem. The flow field may be described by a non-homogeneous transonic small-disturbance equation coupled with a set of four ordinary differential equations for the calculation of the condensate mass fraction. An iterative numerical scheme which combines Murman & Cole's (1971) method with Simpson's integration rule is applied to solve the coupled system of equations. The model is used to study the effects of energy release from condensation on the aerodynamic performance of airfoils operating at high pressures and temperatures and near the vapor-liquid saturation conditions.

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