The Existence and Behavior of Viscous Structure for Plane Detonation Waves

A Thesis Submitted to Department of Mathematical Sciences
Sharif University of Technology

By
M. R. Pournaki

In Partial
Fulfillment of the Requirements for the
Degree of Master of Science (M.Sc.) in
Pure Mathematics

Supervisor
Professor M. Hesaaraki

Abstract

A necessary condition and a sufficient condition are proved for the existence of steady plane wave solutions to the Navier-Stokes equations for a reacting gas. These solutions represent plane detonation waves, and converge to ZND detonation waves as the viscosity, heat conductivity, and species diffusion rates tend to zero. It is assumed that the Prandtl number is 3/4, but arbitrary Lewis numbers are permitted. No assumption is made concerning the activation energy. It is shown that the stagnation enthalpy and the entropy flux are always monotone for such solutions, and that the mass density and pressure are nearly always not monotone, as predicted by the ZND theory. In certain parameter ranges, typically that of large diffusion, many of these waves have the appearance of a weak detonation followed by an inert shock wave.