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ON THE VORTEX FORMATION IN THE COMBUSTION PROCESS WITH SIMPLE CHEMICAL REACTION AND AXIAL MAGNETIC FIELD

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The characteristics of a flame are influenced by external magnetic field and the swirl number. We consider a simplified model taking into account the interplay of swirl flow and the MHD effects due to the Lorentz force acting on the weakly ionised gas. We present the results of a numerical study of the viscous, incompressible, laminar, axisymmetric swirling flow in a cylindical pipe with axial uniform magnetic field.

The swirl number is introduced by controlling the axial and azimuthal velocity components at the inlet. Uniform velocity profile is prescribed at the inlet in the radial direction. The azimuthal component is introduced by rotating a part of the boundary. A similar experiment is reported in [1], where the fuel (propane) is injected axially into the sectioned water-cooled channel, swirl motion is generated by a tangential air inlet.

In this paper we focus on a configuration in which a steady, low-speed ($0.01\frac{m}{s}$), laminar flame exists in a straight pipe in the base state. Our purpose is to understand how this base state is affected by the introduction of swirl, and how the first appearance of vortex breakdown is influenced by the heat release. This process of the magnetohydrodynamics (MHD) is considered with the so-called inductionless approximation.

The present paper continues the study of Choi, Rusak et al. [2] by conducting a numerical investigation in cylindical pipe of the inviscid, axisymmetric, steady swirling flow for the low Mach number approximation.

The combustion process is modelled by a single step exothermic chemical reaction of fuel and oxidant. The rate of the reaction is given by one-step first-order Arrhenius kinetics. Fields of stream function, vorticity, temperature, circulation and fuel concentration in the cylindrical pipe are obtained for various values of the uniform axial magnetic field and specific heat of the reaction. The approximations of the nonlinear problems are based on the implicit finite-diference and alternating direction (ADI) methods [1].

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