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ON NUMERICAL MODELLING OF SWIRL FLOW IN THE COMBUSTION PROCESS

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The characteristics of flame are influenced by an external magnetic field and the swirl number. The present paper considers 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 cylindrical pipe with axial uniform magnetic field. 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, and fuel concentration in the cylindrical pipe are obtained for various values of parameters in the model.
We continue works of [1, 2] and consider the following equations:

$$\begin{cases} \frac{1}{r}\frac{\partial(ru)}{\partial r} + \frac{\partial w}{\partial x} = 0, \\ \frac{\partial u}{\partial t} + u\frac{\partial u}{\partial r} + w\frac{\partial u}{\partial x} - \Gamma^2\frac{v^2}{r} = -\frac{\partial p}{\partial r} - Su + \frac{1}{Re}\Delta' u, \\ \frac{\partial v}{\partial t} + u\frac{\partial v}{\partial r} + w\frac{\partial v}{\partial x} + \frac{u\,v}{r} = \frac{1}{Re}\Delta' v, \\ \frac{\partial w}{\partial t} + u\frac{\partial w}{\partial r} + w\frac{\partial w}{\partial x} = -\frac{\partial p}{\partial x} - \frac{Gr}{Re^2}T + \frac{1}{Re}\Delta w \end{cases} \tag{1}$$

and

$$\begin{cases} \frac{\partial T}{\partial t} + u\frac{\partial T}{\partial r} + w\frac{\partial T}{\partial x} = P_1\Delta T + \beta A\,C\exp(-\frac{\delta}{T}), \\ \frac{\partial C}{\partial t} + u\frac{\partial C}{\partial r} + w\frac{\partial C}{\partial x} = P_2\Delta C - A\,C\exp(-\frac{\delta}{T}), \end{cases} \tag{2}$$

where $P_1 = \frac{Le}{Pe}, P_2 = \frac{1}{Pe}$; Pe and Le are Péclet and Lewis numbers, Γ is the swirl number, β is the heat release parameter, δ - the scaled activation energy; Re, S and Gr are respectively Reynolds, Stewart and Grashof numbers.
Moreover we discuss the extension of the reaction-diffusion system with more species equations as well as obtain some numerical results for the dynamics of temperature and concentration fields.[1]

REFERENCES

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[2] Choi, J.J., Rusak, Z., Kapila, A.K.. Numerical simulation of premixed chemical reactions with swirl. *Combustion theory and modelling* , **6** 11.2007 863-887

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