FLUID DYNAMICS RESEARCH Vol.18,165-182 (01-AUG-96)

# Numerical simulation of premixed flame propagation in a closed tube

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Received 03-JUL-95

in revised form 04-DEC-95

Premixed flame propagation of methane–air mixture in a closed tube is estimated through a direct numerical simulation of the three-dimensional unsteady Navier–Stokes equations coupled with chemical reaction. In order to deal with a combusting flow, an extended version of the MAC method, which can be applied to a compressible flow with strong density variation, is employed as a numerical method. The chemical reaction is assumed to be an irreversible single step reaction between methane and oxygen. The chemical species are CH4, O2, N2, CO2, and H2O. In this simulation, we reproduce a formation of a tulip flame in a closed tube during the flame propagation. Furthermore we estimate not only a two-dimensional shape but also a three-dimensional structure of the flame and flame-induced vortices, which cannot be observed in the experiments. The agreement between the calculated results and the experimental data is satisfactory, and we compare the phenomenon near the side wall with the one in the corner of the tube.