

SIMULATION OF THE BUNSEN METHANE FLAME IN A WEAK TRANSVERSE ELECTRIC FIELD

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Abstract: The paper presents the results of three-dimensional direct numerical simulation of a laminar conical flame of a methane–air mixture (fuel/air ratio $\Phi = 1.03$) in a weak transverse electric field. The changes in the shape of the flame, concentration of charged particles, gas temperature, electric field strength, and volumetric force acting on charged particles after switching on an external electric field are investigated. The separation of charges in the flame front region is considered. It is found that a positive charge is concentrated in the area close to the flame front. The largest charge is observed in the vicinity of the tip of the flame cone and at the base of the flame cone. Accordingly, in these regions, the volumetric force has the greatest effect. At the same time, the electric field inside the flame cone is completely shielded. It is also found that the ion wind has the greatest influence in the region above the flame cone.

Keywords: OpenFoam; methane; laminar conical flame; electric field; ion wind; charged particle concentration

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Figure Captions

Figure 1 Simulation geometry with a mesh and coordinate system: (a) bottom view; and (b) cross-sectional view $z = 0$

Figure 2 Calculated spatial distributions of mass concentration of H_3O^+ (a) and electrons (b) in a transverse electric field. The maximum value has been reduced by a factor of 100 for better visualization

Figure 3 Calculated spatial distributions of charge concentration (a) and x -component of the electric field (b)

Figure 4 Calculated spatial distributions of mass concentration of O_2^- ions

Figure 5 The calculated x -component of the electric field in section $z = 0$ at heights of 6 (1), 12 (2), and 18 mm (3) above the nozzle

Figure 6 The calculated spatial distribution of temperature field when applying potential to the electrodes (a) and visualization of the flame shape in the experiment (b)

Figure 7 The calculated spatial distribution of x -component of the volumetric force density

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