STUDY OF THE PROPAGATION AND DECAY INTO SEPARATE CENTERS OF HYDROGEN-AIR FLAME IN A NARROW GAP

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When flame propagates in narrow gaps, the relative influence of the bounding walls on the combustible mixture flow, the chemical reaction zone, and combustion products is significant throughout the entire combustion time [1]. The combustion front propagates in the hydrodynamic boundary layer of the combustible mixture flow. The characteristic cooling length of the combustion products is comparable to the gap width. Under conditions of significant heat losses, diffusive-thermal instability, appearing in lean hydrogen-air flames in the form of cells, is accompanied by complete flame extinction in concave parts. High heat losses lead to the decay of the flame front into individual cells in combustible mixtures, where a continuous flame propagates without heat loss [2]. Thus, instability models describing a freely propagating flame front are inapplicable to flames in narrow gaps. To construct combustion models in gaps, an experimental study of the main mechanisms of flame propagation and extinction under such conditions is required.

The work presents the description of an experimental study of the propagation of a hydrogen-air flame in narrow gaps, the analysis of the mechanisms of existence and propagation of a flame, as well as the formulation of a criterion for the decay of the front into individual foci.

During the experimental study, flame propagation in hydrogen-air mixtures with hydrogen content of 7 and 10 vol.% was visualized in a horizontal chamber with a diameter of 120 mm and a gap width of 3 to 5 mm (Fig. 1). Visualization was performed using a high-speed IR camera Infratec ImageIR 8300 with a frame rate of up to 300 fps in the wavelength range of 1.5–5 μm.

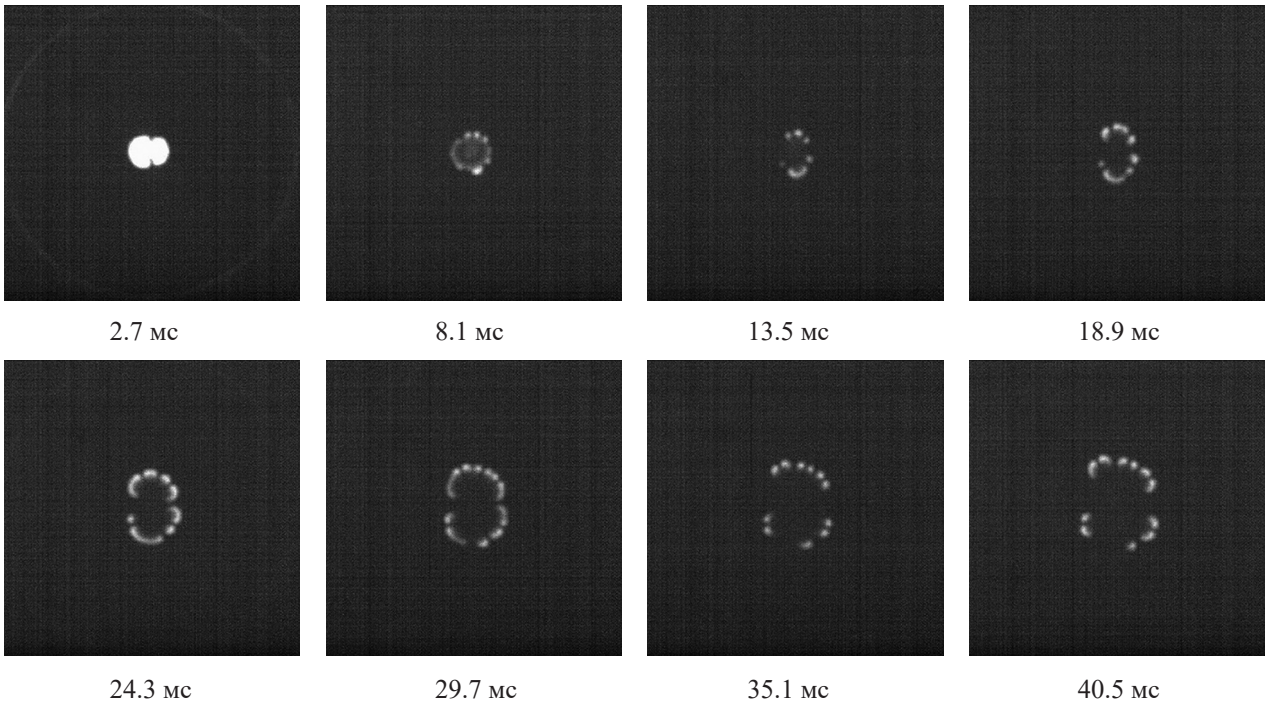

Fig. 1. A series of infrared images of a propagating flame in a mixture with 10 vol.% hydrogen in a 3 mm thick gap at different points in time

References

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