INFLUENCE OF ALUMINUM PARTICLE CLOUDS IN HYDROGEN–AIR MIXTURE ON THE STABILITY AND STRUCTURE OF CELLULAR DETONATION*

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Abstract: The study is aimed at identifying the main mechanisms of hybrid detonation propagation in a fuel-lean ($\varphi = 0.6$) hydrogen–air mixture with aluminum particles. Numerical modeling methods are used to analyze the interaction processes of steady-state plane or cellular detonation waves with clouds of aluminum particles of finite length. When the detonation structure in the cloud is regularized, the structures remain stable (with a regular cell structure) for some time after leaving the cloud. Increase in the zone of regularity preservation with cloud density is established. Comparison of the lengths of stability zones in one- and two-dimensional formulations is carried out.

Keywords: mathematical modeling; hybrid detonation; hydrogen–air mixtures; aluminum particles; finite clouds

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Figure Captions

Figure 1 Pressure profiles in a detonation wave propagating in a cloud of reacting particles with $d_2 = 1$ (*a*) and 3.5 μm (*b*): left column — density of the cloud $\rho_2 = 30$ g/m^3; and right column — $\rho_2 = 90$ g/m^3

Figure 2 Maximum pressure fields in the course of detonation wave propagation in a cloud of particles with $d_2 = 3.5$ μm, density of the cloud $\rho_2 = 90$ g/m^3

Figure 3 Maximum pressure fields in the detonation wave behind the cloud of particles with $d_2 = 3.5$ μm: (*a*) density of the cloud $\rho_2 = 30$ g/m^3; (*b*) 50; and (*c*) $\rho_2 = 90$ g/m^3

Figure 4 Maximum pressure fields in the detonation wave behind the cloud of particles of $d_2 = 1$ μm: (*a*) density of the cloud $\rho_2 = 30$ g/m^3; (*b*) 50; and (*c*) $\rho_2 = 90$ g/m^3

Figure 5 The length of the zone with a regular cellular structure vs. the density of the cloud of reacting particles: *1* — $d_2 = 1$ μm; *2* — $d_2 = 3.5$ μm; filled signs — two-dimensional calculations; and empty signs — one-dimensional calculations

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