Combustion of non-uniformly hydrogen-air mixtures in partially obstructed closed volume

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Hydrogen-air mixture is combustible and explosive even with a low volumetric hydrogen content [1]. Research shows that evolution of a real emergency scenario with hydrogen combustion will most probably occur in non-uniform hydrogen-air mixtures with vertical gradients of hydrogen [2]. In that case, local regions of the mixtures with a stoichiometric ratio can form, the combustion of which often takes place in the regime of fast deflagration or detonation.

A quantitative description of thermobaric loads of probable emergency scenarios for large-scale facilities is carried out using numerical methods, the accuracy of which must be assessed based on the results of experimental data.

In this work, experiments on the combustion of a non-uniformly hydrogen-air mixture are carried out in a horizontally oriented channel of square cross-section 0.6 × 0.6 m and length 12 m. In previous work [3], it was shown that in a channel with obstacles (blockage ratio $BR = 0.6$) and at a stoichiometric ratio in the upper part of the facility, the flame propagated in the quasi-detonation regime. Probably, the transition to detonation did not occur because the presence of obstacles along the entire length of the channel contribute to “chocking” the flame. To test this assumption, an experimental study of combustion in a closed volume with obstacles installed only in the first half of the channel was carried out.

Purpose of the work is determine the effect of partially obstruction on the transition from deflagration to detonation, as well as to obtain experimental data to verify numerical methods.

In work the speed of propagation of the flame front along the channel, the overpressure of the combustion wave and the maximum overpressure was determined. It was revealed that the transition to detonation took place in an unobstructed part of the channel.

References

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