EXPERIMENTAL STUDIES OF LARGE-SCALE COMBUSTION OF HYDROGEN-AIR MIXTURES

D. A. Mastyuk[1, 2], E. V. Bezgodov[1], A. A. Tarakanov[1], S. D. Pasyukov[1], I. A. Popov[1]

[1]FSUE «RFNC – VNIITF named after Academ. E. I. Zababakhin», Snezhinsk, Russia

[2]FSAEI HE «South – Ural state-run university (NRU)», Chelyabinsk, Russia

Hydrogen is used in chemical [1] and oil [2] industries, and as an environmentalln mode; the pressure difference in detonation wave can reach 1.6 MPa, and the propagatioy friendly source of energy [3]. Hydrogen production and consumption increases annually. Hydrogen has a wide flammability range in air mixtures (from 4 to 75%) and minimal combustion initiation energy, which significantly increases the likelihood of an explosion in the event of an emergency leak. Hydrogen-air mixture detonation is the most hazardous combustion velocity can achieve 2000 m/s.

The aim of the work is to obtain experimental data on unconfined combustion of hydrogen-air mixtures. These data will be used to validate software packages and calculation methods for determining pressure loads, and to clarify regulatory documents.

Experimental studies were conducted on the KUPOL test stand. A frame with a shell was mounted on a concrete platform. The measuring equipment and obstructing structures were placed inside the frame depending on the experimental setup. A stoichiometric hydrogen-air mixture was pumped under the shell. Combustion could be initiated either by a low-intensity spark source or by detonating an explosive charge.

During the work the pressure difference across the shock wave was exceeded in comparison with the current methods of safety guides. The transition of combustion from slow deflagration to detonation in unconfined obstructed space was registered. The use of the Sachs variables for scaling hydrogen detonation effects was confirmed to be possible. Figure 1 shows the detonation process of hydrogen-air stoichiometric mixture recorded by high-speed camera.

The report will present the experimental results and their comparison with the methods given in safety guides and the results obtained by CFD simulation.

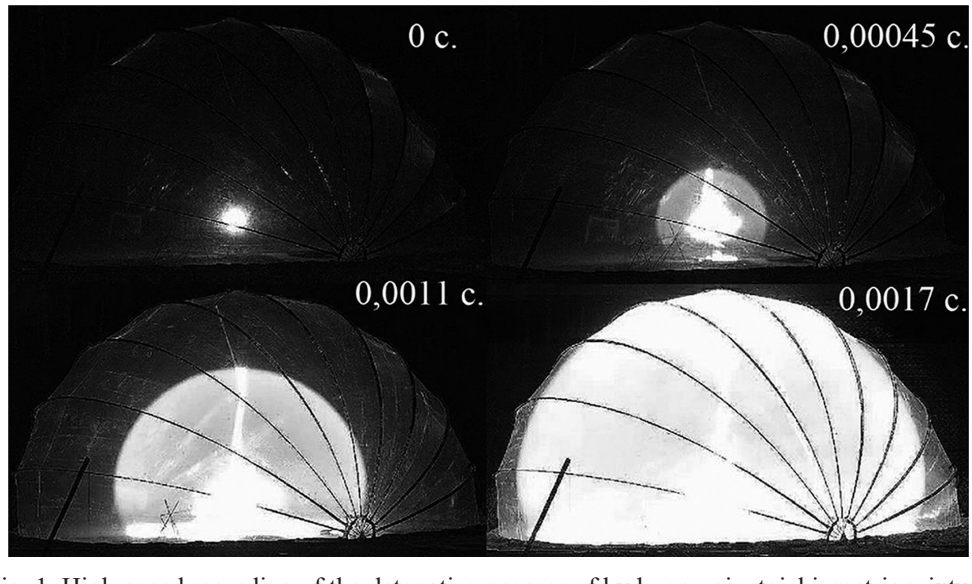

Fig. 1. High-speed recording of the detonation process of hydrogen-air stoichiometric mixture

References

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2. Combustible lubricants ; ed. by V. M. Shkolnikov. – M. : Tekhinform, 2010. – 157 p.
3. IEA (2021), Net Zero by 2050, IEA, Paris. https://www.iea.org/reports/net-zero-by-2050, License: CC BY 4.0.