ABOUT CONVECTIVE BURNING OF ALUMINUM POWDER PAP-2 WITH WATER

V. E. Khrapovskii and B. S. Ermolaev

N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation

Abstract: Burning of the stoichiometric mixture of aluminum (flake powder of the trademark PAP-2) with water in the closed volume bomb has been studied. It is shown that depending on the sample diameter and pressure generated by the igniter, there are three situations observed: the mixture does not burn, the mixture burns in a slow mode (layer-by-layer burning mode), or the mixture burns rapidly with participation of the convective burning mode. The process behavior observed in the rapid burning mode, especially, effects of pressure generated by the igniter and of length and initial density of the sample, are, in general, similar to the behavior of the convective burning which had been studied in tests with powder mixtures of aluminum and oxidizer (ammonium perchlorate or ammonium nitrate) and presented in the literature. The difference is that due to rather low activity of water as oxidizer, convective burning of the mixture of aluminum with water proceeds at rather low velocities and is harder initiated.

Keywords: burning of aluminum; hydrogen; aluminum oxide, convective burning

DOI: 10.30826/CE19120112

Acknowledgments

The work was partly supported by the subsidy given to the N. N. Semenov Institute of Chemical Physics to implement the state assignment on the topics 0082-2016-0011 (state registration number AAAA-A17-117040610346-5) and 0082-2018-0004 (AAAA-A18-118031590088-8).

References

1. Ingenito, A., and C. Bruno. 2004. Using aluminum for space propulsion. *J. Propul. Power* 20(6):1056–1063.
2. Shafirovich, E., V. Diakov, and A. Varma. 2006. Combustion of novel chemical mixtures for hydrogen generation. *Combust. Flame* 144(1-2):415–418.
3. Wood, T. D., M. A. Pfeil, T. L. Pourpoint, *et al.* 2009. Feasibility study and demonstration of an aluminum and ice solid propellant. AIAA Paper No 2009-4890.
4. Pourpoint, T. L., T. D. Wood, M. A. Pfeil, *et al.* 2012. Feasibility study and demonstration of aluminum and ice solid propelant. *Int. J. Aerospace Eng.* Article ID 874076. 11 p.
5. Komissarov, P. V., R. H. Ibragimov, G. N. Sokolov, and A. A. Borisov. 2009. Pirotekhnicheskiy istochnik vodoroda na osnove goreniya smesey aluminiya s vodoy [Pyrotechnic source of hydrogen based on combustion of alumina mixtures with water]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 2:73–77.
6. Shmelev, V. M., and S. V. Finjakov. 2013. Osobennosti goreniya smesey alyuminiya s vodoy [Specific features of aluminum combustion in water environment]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 6:169–173.
7. Khrapovskii, V. E., and V. G. Khudaverdiev. 2010. Onset and development of convective burning in highly porous charges of ammonium perchlorate and its mixtures with aluminum. *Russ. J. Phys. Chem. B* 4(1):53–62.
8. Khrapovskii, V. E., V. G. Khudaverdiyev, and A. A. Sulimov. 2013. Konvektivnoe gorenie i perekhod vo vzryv v melkodispersnykh smesyakh ammiachnoy selitry s alyuminiem [Convective burning and transition to explosion in fine mixtures of ammonium nitrate and aluminum]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 6:211–213.
9. Dolgoborodov, A. Yu., N. E. Safronov, V. A. Teselkin, and A. N. Streletskii. 2013. Perekhod goreniya v detonatsiyu i chuvstvitel'nost' mekhanoaktivirovannykh smesey alyuminiya s perkhloratom kaliya [Deflagration-to-detonation transition and sensitivity of mechanoactivated mixtures of aluminum with potassium perchlorate]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 6:302–306.
10. Beljaev, A. F., V. K. Bobolev, A. I. Korotkov, A. A. Sulimov, and S. V. Chujko. 1973. *Perekhod goreniya kondensirovannykh sistem vo vzryv* [Transition of combustion of condensed systems to explosion]. Moscow: Nauka. 292 p.

Received December 25, 2018

Contributors

Khrapovskii Vladimir E. (b. 1945) — Candidate of Science in physics and mathematics, senior research scientist, N. N. Semenov Institute of Chemical Physics, Russian Academy of Science, 4 Kosygin Str., Moscow 119991, Russian Federation; khrapovsky @mail.ru

Ermolaev Boris S. (b. 1940) — Candidate of Science in physics and mathematics, head of laboratory, N. N. Semenov Institute of Chemical Physics, Russian Academy of Science, 4 Kosygin Str., Moscow 119991, Russian Federation; boris.ermolaev44@mail.ru