Non-classical detonation regimes of liquid high explosives

Utkin A V\textsuperscript{1,2,\textcopyright} and Mochalova V M\textsuperscript{1,2}

\textsuperscript{1} Institute of Problems of Chemical Physics of the Russian Academy of Sciences, Academician Semenov Avenue 1, Chernogolovka, Moscow Region 142432, Russia
\textsuperscript{2} Tomsk State University, Lenina Avenue 36, Tomsk 634050, Russia

\textcopyright utkin@icp.ac.ru

To date there are a lot of data about the detonation waves structure that cannot be explained within the framework of the classical model. For example, in some pressed high explosives (HE) an increase in pressure in the reaction zone was observed instead of the Von Neumann spike. The aim of this work is the proof of the existence of a similar detonation waves in liquid HE. As objects of study selected liquid HE (nitromethane, tetranitromethane, and bis-(2-fluoro-2.2-dinitrobutyl)-formal (FEFO)) and their mixtures with not detonating liquids (methanol, nitrobenzene and diethylenetriamine). Recording the structure of the reaction zone was carried out by the interferometer VISAR. As a result of experiments the following results were obtained. In nitromethane in the reaction zone Von Neumann spike is formed. In a mixture of nitromethane–diethylenetriamine clearly pronounced Von Neumann spike virtually nonexistent. In the reaction zone of tetranitromethane, as in nitromethane, the flow corresponds to the classical model of detonation. However, the situation fundamentally changes when you add methanol or nitrobenzene. In the compositions close to the solutions with zero oxygen balance Von Neumann spike disappears. In FEFO, there is partial decomposition of HE in front of the shock wave. Addition of methanol or nitrobenzene, in this case, reduce the rate of chemical reactions and reduce the fraction of HE reacted in front. The results showed thus that non-classical detonation regimes do not represent an exceptional phenomenon. They are observed in experiments not only with pressed (heterogeneous), but with a liquid (homogeneous) HE. The study was financially supported by the Russian Foundation for Basic Research, project No. 16-29-01002.