Effect of modifier additives on burning rate and condensed combustion products parameters of composite aluminized propellant

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The objects under study were model composite propellants, consisting of ammonium perchlorate (AP, ≈ 60 % by weight), aluminum (≈ 20 %), active binder (≈ 20 %) and optionally a modifier additive (1.0 % – 3.5 % over 100 %). Components: AP – sieve fraction 500 – 630 μm, or 180 – 250 μm; AVl: ASD-4 [1]; binder - methylpolivinyl-tetrazole polymer plasticized with nitroether-nitramine plasticizer [1–2]; additive – one of the following substances: TiB_2, $AlMgB_{14}$, $(NH_4)_2TiF_6$, NH_4BF_4, $Ca_3(PO_4)_2$. Experiments on the combustion of composite propellants were carried in a pressure vessel (bomb) in nitrogen at a pressure of 0.35 MPa. The bomb has a volume of 0.33 liters and working pressure up to 3 MPa. The bomb is provided with 30 mm diameter windows for video recording the combustion process, a pressure control system and it is designed to collect condensed combustion products (CCP) into the liquid. The experiments are aimed at determining the propellant's burning rate and the characteristics of agglomerates leaving the burning surface. A video recording of the combustion process was made at a shooting speed of 24 fps. The sampling of CCP was carried out into a 100 ml glass poured with distilled water and placed inside the bomb. The following agglomerate characteristics are determined: mass (as the mass of the particles with size larger than 80 μm), size distribution function and mean sizes, and combustion completeness. The effects of additive modifiers on registered parameters are revealed. Some of effects found are of practical interest for burning rate control and improvement the CCP characteristics. However, none of the five tested additives resulted in a simultaneous reduction in mass and size of the agglomerates. It was concluded that the work should be continued for searching new additives capable of reducing the aluminum agglomeration intensity.

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