COMBUSTION OF COMPOSITE PROPELLANT WITH TITANIUM IN RELATION TO THE PROBLEM OF OBTAINING HIGHLY DISPERSED TITANIUM DIOXIDE

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Abstract: Combustion of titanium particles in air has recently attracted attention of researchers in connection with the idea of using titanium dioxide in the form of an aerosol consisting of particles of nanometer size range to decontaminate atmospheric pollution. The possible implementation of this idea — the design of a pyrotechnic TiO_2 generator — requires the study of combustion of titanium-containing composite propellants. In this paper, effects of the size and morphology of the initial titanium powder and the mass fraction of titanium powder fuel in the propellant on the burning rate and characteristics of titanium agglomeration during combustion propellant have been investigated. Data on condensed combustion products (CCP) of propellant in air at pressure of 0.1 MPa, in nitrogen at 0.35 MPa, and in argon at 2, 4, and 8 MPa are presented. It is shown that it is preferable to use titanium powder of the smallest possible size and set the mass fraction of titanium in the propellant equal to 24%. A high oxygen content is found in the CCP particles which allows one to hope that conversion of titanium into titanium oxide is sufficiently complete.

Keywords: titanium particles; combustion; fragmentation; condensed combustion products; dispersed titanium dioxide; propellant with titanium fuel

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Figure Captions

Figure 1 Morphology of the investigated titanium powders: (*a*) spongy; (*b*) rolled porous; (*c*) fused; and (*d*) spherical

Figure 2 Propellant burning rate r (*a*), dimensionless agglomerate mass m_{80} (*b*), and agglomerates mean size D_{43} (*c*) vs. average size D_{Ti} of titanium particles: *1* — Ti PTM; *2* — rolled porous; *3* — fused; and *4* — Ti PTOM

Figure 3 Propellant burning rate r (*1*), dimensionless agglomerate mass m_{80} (*2*), and agglomerates mean size D_{43} (*3*) vs. content of titanium powder in the propellant

Figure 4 The burning rate of the $\mathrm{AP/binder/Ti} = 55/21/24$ propellant at high argon pressure

Figure 5 The view of CCP of propellant with PTM-1 titanium powder under an optical microscope; burning in nitrogen at 0.35 MPa, quenching in liquid at a distance of 1.5 cm: (*a*) propellant S04, $D_{\mathrm{Ti}} \leq 36$ μm; and (*b*) propellant S11, $D_{\mathrm{Ti}} = 40$–50 μm

Figure 6 The scanning electron microscope images of CCP particles for the propellant S07; burning in nitrogen at 0.35 MPa, quenching in liquid at a distance of 1.5 cm: (*a*) propellant S07, $D_{\mathrm{Ti}} = 67$–71 μm; and (*b*) the same propellant, enlarged fragment

Table Captions

Table 1 Mean particle sizes D_{mn} (μm) for the propellant ingredients and the propellant designations

Table 2 The burning rate data and approximation parameters of burning rate law in the form $r = Bp^n$

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