TETRAMETHYLAMMONIUM PERCHLORATE: MECHANISM OF ACTION IN COMPOSITIONS

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Abstract: The combustion behavior of compositions of tetramethylammonium perchlorate (TMAP) with inert additives, ammonium perchlorate (AP), and solid rocket propellants were studied. The reasons for the lack of combustion of TMAP in its pure form are explained. It turned out that the addition of Al_2O_3 to TMAP, due to higher thermal conductivity, leads to combustion increasing the heat feedback from the gas zone and compensating for the heat losses of the leading reaction in the condensed zone. With an increase in the proportion of Al_2O_3 or the use of nanotubes, the heat feedback from the gas phase increases so much that the combustion rate begins to be determined by the very rapid kinetics of decomposition of methyl perchlorate in the gas zone. On the example of the study of combustion of mixtures of TMAP with AP and propellants, it is shown that the efficiency of TMAP action depends on the mechanism of combustion of the composition: in the composition with the leading reaction in the condensed phase, TMAP plays the role of an inert additive and in compositions which burning rate is controlled by the gas-phase mechanism, TMAP plays the role of a fast heat-generating additive in the gas zone.

Keywords: energetic materials; perchlorates; tetramethylammonium perchlorate; combustion; combustion mechanism

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Figure Captions

Figure 1 Dependence of combustion rate on pressure for mixtures of TMAP with Al_2O_3 (*1* — TMAP/Al_2O_3 50/50; *2* — 70/30; and *3* — TMAP/Al_2O_3 80/20) and nanotubes (CNTs) (*4* — TMAP/CNTs 90/10); dashed line — estimated burning rate of TMAP

Figure 2 Comparison of surface temperatures of AP (dashed line) and the TMAP / 20%Al_2O_3 mixture (solid line): *1* — at pressure of 5 atm; *2* — from data on combustion rates; and *3* — decomposition temperature

Figure 3 Dependence of burning rate on pressure of binary AP/TMAP compositions containing 5% and 10% TMAP

Figure 4 Dependence of burning rate on pressure of binary AP/TMAP compositions containing 20% and 30% TMAP

Figure 5 Dependence of combustion rate on pressure of propellants based on polyetherurethane polymer (*1*) with TMAP additives: *2* — 60%; *3* — 40%; *4* — 20%; *5* — 10%; and *6* — 5%

Figure 6 Dependence of combustion rate on pressure of propellants containing (black curves) and not containing (grey curve) ferrocene catalyst with 20% TMAP additives (solid curves)

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