BURNING OF EXTENDED POWDER ELEMENTS IN THE COMBUSTION CHAMBER

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Abstract: The study of powder charge combustion is important for the design of technical products. In the present work, the combustion of charge from powder elements in the form of plates of split and slotted tubes has been studied. The elements were subjected to combustion in a model open combustion chamber with variation in charge density and initial temperature. As a result of experiments, pressure diagrams $p(t)$ recorded on photo paper were obtained. The analysis of the diagrams showed that the value of the charge density significantly affects the value of the maximum pressure in the chamber. At the same time, the change in the initial temperature affects the maximum pressure less significantly. Plates and split tubes are the regressive powder elements and have similar pressure diagrams. The slit elements are subjected to destruction, the burning surface of the slotted sample increases and then decreases. The analysis of pressure diagrams showed that the slotted elements allow obtaining larger pressures at lower charge densities and in less time as compared to the elements that maintain their integrity. To facilitate the search for charge parameters, an approximate general solution of the continuity equation is proposed and possible methods for obtaining function $p(t)$ for different powder elements from this solution are indicated.

Keywords: combustion chamber; powder element; piling; charge; charge density; pressure diagram; fragmentation; burning velocity

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Figure Captions

Figure 1 Schematic of experimental installation: *1* — combustion chamber; *2* — protective grid; *3* — propellant charge (piling); *4* — pyrometer cartridge; *5* and *6* — inductance instrument presser DD-20 ($p_k = 620$ atm); *7* — black powder (2–3 g); *8* — thermocouple; *9* — combustion chamber head; *10* — potentiometer KCP-4; *11* — induction high-frequency transducer IVP-2; and *12* — oscillograph

Figure 2 Cross sections of powder elements: cutting tube (*a*) and equivalent simplified representations of its surface during combustion as prism (*b*) and cylinder (*c*); and slot-hole tube (*d*) and the equivalent simplified representation of its surface by prisms having the bases as segment (*e*) and truncated sector (*f*)

Figure 3 Pressure diagram $p_1(t)$ for charges from plates (*a*), cutting tubes (*b*), and slot-hole tubes (*c*) at $T_0 = +17$ °C and diameter of a nozzle $d_\sigma = 6$ mm at charge density variation Δ_0: *1* — 0.164; *2* — 0.123; *3* — 0.176; *4* — 0.129; *5* — 0.122; *6* — 0.073; and *7* — 0.06

Figure 4 Pressure diagram $p_1(t)$ for charges from plates, $\Delta_0 = 0.164$ (*a*), cutting tubes, $\Delta_0 = 0.129$ (*b*), and slot-hole tubes, $\Delta_0 = 0.073$ (*c*) at diameter of a nozzle $d_\sigma = 6$ mm at a reference temperature variation T_0: *1* — +50 °C; *2* — +17; and *3* — −40 °C

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