FEATURES OF IGNITION OF THE THERMITE MIXTURE Al/CuO BY ELECTRIC DISCHARGE

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Abstract: The study of electric spark initiation of a chemical reaction in the porous mechanoactivated mixture of aluminum and copper oxide powders was carried out. The conditions of formation and parameters of an electric discharge are described. The influence of the geometry of the initiation node on the energy parameters of the spark discharge is determined. Based on the measurement results and a number of assumptions, the volume of penetration of the discharge plasma into the pores of the mixture has been estimated. The experiments have been carried out to initiate the combustion of charges in semiclosed volumes with a mass of up to 1 g to obtain indirect evidence of the completeness of chemical interaction. Experimental results have been approximated by the functions in the form of dependences of the delay in initiating the reaction on the energy density of the electric discharge and the rate of formation of the combustion torch of the mixture on the discharge energy. According to the found dependencies, the boundary values of the energy parameters of the electric spark discharge for the realization of stable ignition of the thermite mixture have been determined.

Keywords: combustion; thermite compositions; electric spark initiation; energy density

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Figure Captions

Figure 1 Schematic of the experimental setup for initiating thermite mixture by electric discharge: (*a*) assembly scheme (*1* — thermite mixture; *2* — charge shell; and *3* — electrodes); (*b*) flat electrode gap (*1* — electrodes; and *2* — calibrated dielectric insert); (*c*) diagram of electric field lines (*1* — electrodes; and *2* — electric field lines)

Figure 2 Schematic of the experimental assembly for the formation of a flat discharge in an adjustable gap under a glass plate: *1* — electrodes; and *2* — glass plate

Figure 3 Photographs of the areola on a glass plate after a discharge between flat electrodes of different shapes: (*a*) sharp-angled; (*b*) rectangular; and (*c*) rounded electrodes. To increase the contrast of the image of the halo on the glass plate, photographing was carried out in a microscope with side illumination

Figure 4 Enlarged photographs of the central (*a*), intermediate (*b*), and peripheral (*c*) zones of the surface of the glass plate after exposure to the energy of an electric spark

Figure 5 The relationship between the geometric and electrical parameters of the spark: (*a*) dependence of the area of thermal damage of glass plates on the spark current; and (*b*) dependence of the spark volume under the glass plate on the spark energy. The borders of the shaded area refer to the values of the air gap size of 0.1 and 0.05 mm

Figure 6 Photographs of traces of a spark discharge with a current of 660 A on glass plates between thin flat sharp-angled electrodes with an interval of 1.5 mm. The spark volume is formed by: (*a*) two glass plates with a gap of 0.1 mm; and (*b*) a powder of bulk density (micron-sized copper oxide), under the electrodes and a glass plate. The photographs are presented at the same scale

Figure 7 Dependence of the amplitude of the photomultiplier signal on the spark current during discharge in air (*1*) and in the gap under the glass plate (*2*) for the same discharge gap; and *3* — the ratio of the dependencies of the photomultiplier signals in the gap and on the open surface

Figure 8 Schematic of the experimental assembly with a disk charge of a thermite mixture: *1* — electrodes; *2* — dielectric washer; *3* — transparent lid; *4* — thermite mixture; and *5* — expected radial propagation of the reaction glow front

Figure 9 Chronological photos of the glow of the actual propagation of the reaction in the disk charge of the thermite mixture. The numbers below the photographs indicate the moment of the frame after the spark discharge

Figure 10 Schematic of the exerimental assembly: *1* — charge of the thermite mixture; *2* — torch; *3* — air gap; and *4* — dielectric washer with a hole

Figure 11 Dependence of the flame formation delay on the energy density of the thermal effect on the thermite mixture

Figure 12 Schematic of the experimental assembly: *1* — electrodes; *2* — torch; and *3* — charge of the thermite mixture

Figure 13 Dependence of the outflow rate of the torch material from the long channel on the energy of the electric discharge

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