Mathematical Simulation of the Processes of Ignition of a Gaseous Suspension of Solid Particles in the Mixture of Oxidative Medium - Combustible Gas (The spark ignition)

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The model of spot ignition was considered in the present study of the process of gaseous suspension ignition with a spark discharge. The model used presupposed that the initial temperature distribution in the gas could be described by the piecewise constant function and the temperature of all particles was equal to the initial temperature of the process. The advantage of such statement of the problem was retaining of the specific features of the spark ignition (instantaneous local evolution of the energy). Moreover it allowed significant simplification of the calculation procedure, analytical solution of the problem as simple dependences of the limiting size of the spot on the major parameters of the process for high values of the dimensionless coefficient of heat exchange Z between the gas and the particles (Z is an analog of the Semenov criterion), and elucidation of the role of the gas-phase reactions in the process of the spark ignition of the gaseous suspension of the solid particles. The minimum (critical) size of the spot that could provide the gaseous suspension ignition appeared to be exponentially dependent on the value of the equilibrium temperatures in the spot, *i.e.* on the temperature attained by the particles and the gas upon equalizing of their temperatures in the spot without account made of the conductive heat removal into the cold surrounding of the gaseous suspension. As shown by the approximate analysis, the value of this temperature was on the first hand dependent on the mass portion of the combustible component in the gas, the thermic effect of the gas-phase reaction, the mass portion of the solid particles in the gaseous suspension, and the ratio of the rate of heat release during the gas-phase reaction at the initial temperature of the spot W1 to the rate of the gas cooling with the solid particles W2. It was found that there was a region of minimum spot sizes on the dependences of the spot critical size on the parameter Z. The boundaries of the region were outlined. The analytical solutions obtained allowed one to predict the influence of the combustible gas addition on the critical conditions of the spot ignition of the gaseous suspension when using the data of the on the kinetics, the thermic effect, and the mechanism of the reactions of the condensed and gaseous phases oxidation. Consequently, the energy required for spark-discharge ignition of a hybrid gaseous suspension could be also calculated.

These data are needed for the development of the adequate requirements to the systems of the fire prevention and suppression. The data obtained can be also used for explanation of a known in practice sharp (by 20-30 times) decrease in the minimum energy of ignition of the coal dust at the increase of the methane concentration from 0 to 3%, which cannot be explained within the scope of the existing representations on the mechanisms of the gaseous suspension ignition.

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