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MATHEMATICAL MODELING OF UNSTATIONARY COMBUSTION OF GASLESS SYSTEMS WITH A CONVECTIVE FLOW OF THE MELT

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One of the features of the synthesis of ceramic materials in the combustion mode of gasless powder compacts is the melting and spreading of one or more components of a heterogeneous system in a matrix of refractory components and reaction products [1]. The thermocapillary mechanism of melt flow is due to the action of surface tension forces in a porous medium. "Abnormal" dependences of the combustion rate on the particle size of titanium for Ti+Si and Ti+Fe powder systems have been experimentally obtained [2-3]. The convective mechanism of mixing of system components takes place along with a diffusion and capillary mass transfer. The melting of the reagent and the wetting of the refractory component of the mixture by the melt increases the heat release rate and raises the temperature in the combustion front.

In this work, we consider a combustion mathematical model for a binary mixture, one of the components of which is a fusible metal. Let a system under consideration be formed by three interpenetrating continua – high-melting reagent A, low-melting reagent B, and pores. The reaction scheme can be represented as $st_1 A(solid) + st_2 B(solid, liquid) = P(solid)$, where st_1 and st_2 stand for respective stoichiometric coefficients. The mathematical model of the combustion process is described in the work [4]. In this work, we take into account the change in the reaction rate with the appearance of a liquid phase.

The typical dynamics of porosity formation in non-stationary combustion mode is shown in Figure 1. The main goal of solving the problem was to calculate the burning rate of the binary mixture A + B, as the main integral characteristic of high-temperature synthesis.

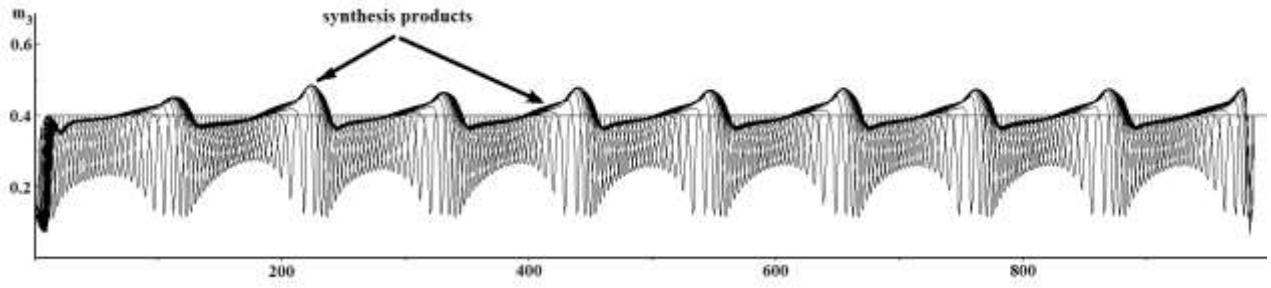

Fig.1. Distributions of porosity in non-stationary combustion mode with an excess of component B (initial porosity – m_0= 0.4).

The calculated dependences of the burning rate on the initial porosity are in qualitative agreement with the experimental data.

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