MATHEMATICAL MODELING OF POROUS MATERIAL SYNTHESIS SUPPORTED BY THE FILTRATION COMBUSTION OF A GAS MIXTURE

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Nomenclature of substances obtained by self-propagating high-temperature synthesis is limited by the green mixture requirements, the main of which is high exothermicity. This circumstance does not allow us to synthesize many substances with increased physical and chemical properties. Therefore, postheating of condensed components is a perspective method for the synthesis of materials from low-calorie mixtures [1 - 3]. For this purpose, filtration combustion of gas can be effectively used in a porous medium formed by granules from a powder mixture of condensed substances. Forced gas blow is conducted through porous permeable samples during filtration combustion. In this case, there is heat and mass transfer, which substantially intensifies the process of chemical transformations in the solid phase, and also allows us to vary the structure parameters of final products in the wide range. Combustion of gas in the pore space is controlled by the gas feed rate, the composition, filtration resistance, the parameters of heat exchange with a condensed phase and an external environment. These factors determine the dynamics and efficiency of porous material synthesis. This type of filtration combustion, covering a wide class of reacting systems, is called hybrid combustion [4, 5]. For example, the work [6] provides a two-temperature mathematical model of hybrid filtration combustion to describe chemical reactions in the gas phase and heterogeneous reactions on the surface of particles in the layer of a catalyst.

This work considers a mathematical model for the synthesis of porous materials from a granular low-calorie gas-free powder mixture, the reaction of which is supported by the filtration combustion of a gas mixture. The dynamics of synthesis is described by the equations as follows: the heat balance in the condensed and gas phases, the motion of the gas phase, the rate of reactions in phases, the conservation of momentum with additional relations. Numerical study was carried out using finite-difference methods. Mechanisms and modes are determined for the propagation of reaction fronts in phases, depending on the characteristics of gas flow during coflowing and counter filtration, the ratio of the gas-phase and solid-phase reaction constants, and the parameters of interphase heat transfer.

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