NUMERICAL STUDY OF THE SINTERING PROCESS OF LOW-CALORIFIC SOLID FUEL SUPPORTED BY FILTRATIONAL COMBUSTION WAVE*

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The paper presents the results of a numerical study of the dynamic behavior of a chemical reaction in a low-calorific solid material thermally coupled with a filtration gas combustion wave. The system under consideration is represented by a cylindrical solid fuel surrounded by a coaxial porous tube through which a gaseous air-fuel mixture flowed. This system has been studied in terms of promising ways to control the combustion of low-calorific solid fuels. This problem is relevant for the use of solid fuels in rocket engines [1] and the production of new advanced materials [2-3]. The main problems in this case is that the heat released during combustion is not enough to maintain a self-propagating chemical reaction wave, as well as the presence of pulsating diffusive-thermal instability [4-6].

Numerical studies were carried out in the framework of one-dimensional model, which had previously proved itself in studies of a similar type problems [4, 6]. Within the framework of the proposed model, the influence of the chemical properties of the solid material and the gas velocity on the dynamic behavior of thermally coupled combustion waves was numerically investigated. It was shown that, depending on the problem parameters, various combustion modes are realized. So, for the case when the filtrational combustion wave propagates downstream, the burning velocity of solid energetic material increases significantly and creates difficulties in organizing stable combustion in the considered system. For the case when the combustion wave propagates upstream, the combustion waves in the gas and solid phases propagate together in a strong thermal coupling, and thus the burning rate of the solid material can be controlled by the flow rate of the gas mixture. Numerical results shown that thermal interaction extends the extinction limits of solid phase flame and can stabilize oscillations caused by diffusion-thermal pulsating instability. The results obtained indicate that the proposed system can be used for sintering of low-calorie solid fuels.

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