INVESTIGATION OF COMBUSTION WAVE PROPAGATION IN THE SOLID LAYERED MATERIALS[1]

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Combustion waves in layered solid fuel samples is usually investigated due to its significance for applied technology of the production of advanced materials, Self-propagating High temperature Synthesis (SHS) [1] and in relation with the concept of chemical furnace [2, 3]. In this work we consider the model describing propagation of a combustion wave in a system of two layers of different solid energetic materials under conditions of thermal contact between them through a common surface. This system is directly relevant to chemical furnace regime of SHS when one of the reactants serves as a heat source (donor layer) for the other reacting material (acceptor layer) and facilitates the chemical reaction in the latter.

We undertook a detailed parametric study to find out which parameters affect the process of reaction wave propagation in this system based on the reaction sheet model and direct numerical simulations in one spatial dimension. It is shown that depending on the parameters of the problem a leading wave is formed in one of the layers. Propagation of the leading front creates the conditions for preheating of the secondary wave traveling behind it in the different layer and this can lead to the significantly superadiabatic temperature of combustion in the material in which the secondary front propagates. This flame structure is demonstrated in Fig. 1.

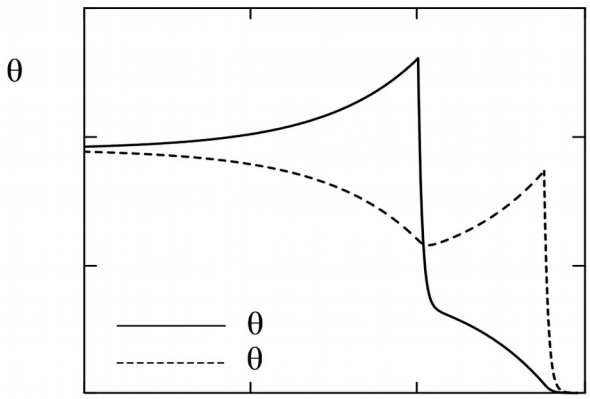

Fig.1. Distribution the temperature in donor (θ_1) and acceptor (θ_2) layers in co-moving coordinate frame.

The results of our work show which regimes of combustion wave propagation exist in the layered solid fuel systems and how they depend on the choice of thermophysical and chemical parameters of the reacting materials composing the layered structure as well as on geometrical properties of the latter. In particular, the results of stability analysis indicate the occurrence of nontrivial exchange of stability of combustion waves propagating in different layers.

REFERENCES

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