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NUMERICAL STUDY OF THE COMBUSTION FRONT PROPAGATION FEATURES IN GAS MIXTURES WITH LOW LEWIS NUMBERS*

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In the last decade, there are a trend towards a transition to the ecofriendly technologies, more sparing to the environment. Examples of such promising technologies are the methods of lean hydrocarbon fuels burning and the transition to hydrogen power. Dilution of lean hydrocarbon fuels with hydrogen can increase flammability limits and efficiency, as well as reduce emissions. In this regard, the study of the combustion of lean gas mixtures with a low Lewis numbers is a relevant task.

The present study is devoted to a numerical study of the combustion front propagation dynamics of a premixed gas mixture in straight channels, as well as of a spherical diffusion flame in the framework of a three-dimensional reaction-diffusion models. In both cases, mixtures with a low Lewis numbers are considered. Numerical results shown that the combustion wave can be a continuous cellular front and sporadic flames (see Fig. 1). For the case of sporadic combustion wave consisting of sets of individual flame spots, a method for determining the propagation velocity of a flame front is proposed. The dependences of the propagation velocity of a sporadic combustion wave, the concentration of residual fuel, and the number of flame spots are obtained as functions of the channel size, mass flow rate, and radiative heat losses *h*. The continuous flame fronts are formed at small *h* whereas at large *h* it consists of separate cup-like flames.

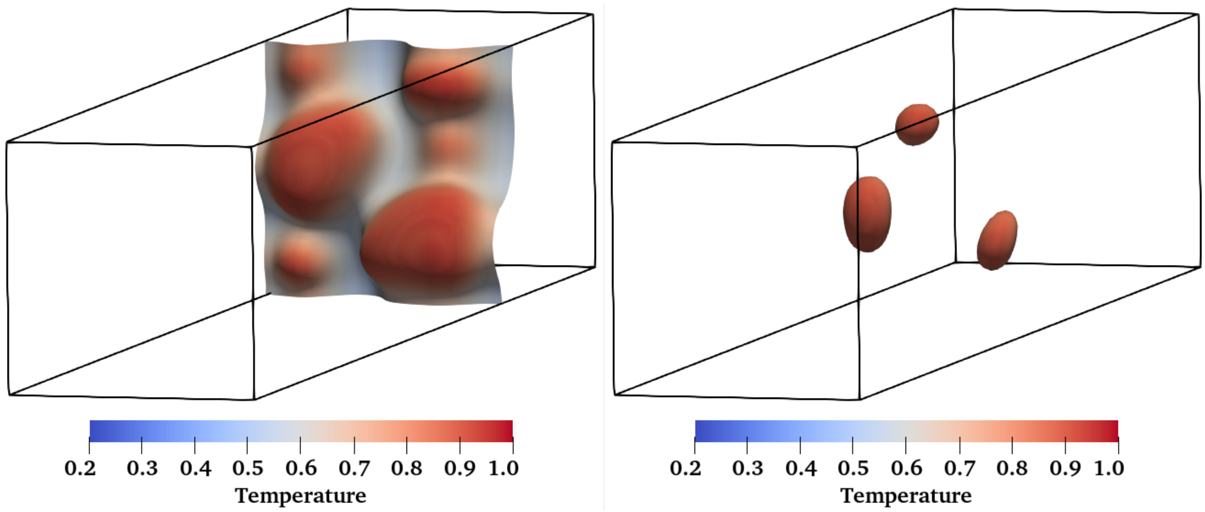

Fig.1. Isosurfaces of the concentration *C*=0.1 colored according to the gas temperature and illustrating the surface of the reaction front in straight channels: continuous cellular flame front (on the left) and sporadic combustion wave (on the right).

Analysis of the numerical results shown the existence of a special transverse channel size *D**, starting from which, as the channel size increases, the number of flame spots increases in proportion to the increase in the transverse channel size area. This critical diameter *D** is proportional to the radiative heat loss intensity *h* which is characterized by the mixture equivalence ratio. Thus, the presence of a universal size of flame spots is shown, which for its existence requires a certain area around it filled with a fresh mixture. It is also numerically shown that the dynamics of combustion wave does not depend on the geometry of the channel inlet section and is determined by its area. Solution of this fundamental problem is important for the development of eco-friendly lean gas combustion technologies and energy saving.

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