DETONATION WAVES IN THE CHANNELS CONTAINING OBSTACLES

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Examination of initiation and propagation of detonation is one of the fundamental branches of the gas-dynamics. Detailed information about the features of these processes is very important for solving the problems connecting both with prevention of detonation regimes of combustion to increase the blast safety and with applications of detonation to technological processes. In the present research the numerical investigation of detonation propagation in the plane encumbered channels filled by a stoichiometrical hydrogen-air mixture under normal conditions is carried out. Detonation is initiated by the electrical discharge of narrow layer form near the closed end of the channel. It is supposed the electrical energy is transformed instantaneously into internal energy of the gas mixture. The set of gas dynamic equations jointly with the set of chemical kinetic equations [1], which takes into consideration the principal features of chemical interaction of hydrogen with oxygen, is solved by a finite-difference method based on Godunov's scheme [2].

The propagation of a formed detonation wave in the plane channel with parallel walls has been examined. It has been established that the plane detonation front is curved with time due to the instability of the combustion zone and the cellular detonation structure is formed (figure 1).

The propagation of a detonation wave in the channel with an obstacle that is placed across the channel has been investigated under consideration that the obstacle height l_w is smaller than the width channel.

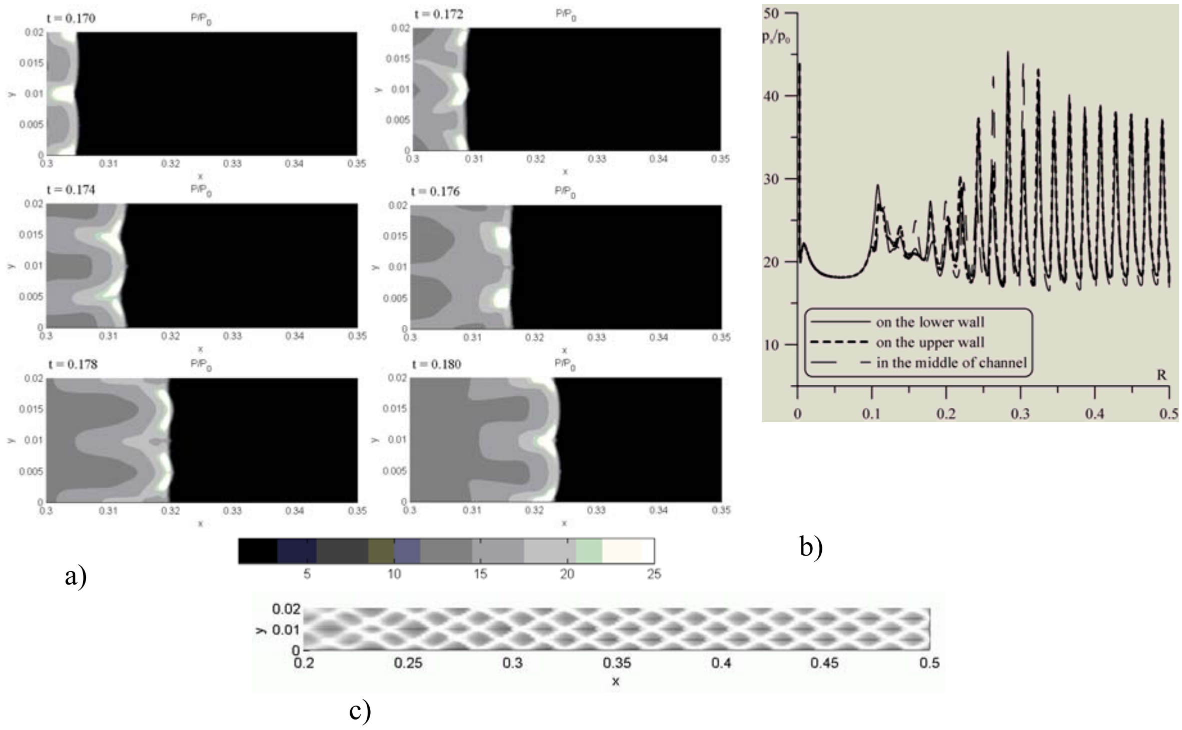
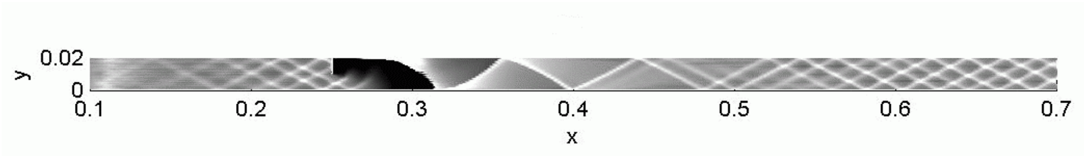


Fig. 1. Formation of cellular detonation in the plane channel: time variation of pressure field (a), the pressure dependences on the wave coordinate at the some points of front (b) and the trajectories of triple points (c)

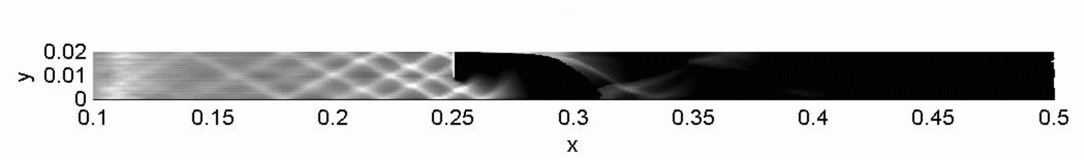
It has been established that there is a critical value of the obstacle height such that the detonation is failure if the height of the obstacle is larger than critical one. In the case of conservation of detonation after the passing of the obstacle the sell detonation structure is restored (figure 2). It has been obtained that in the case of a destroyable obstacle with the height being larger than critical one the detonation is conserved under the condition that the time of obstacle existence does not exceed some critical one.

The numerical calculations of detonation wave propagation in the plane channel containing the partition (that is parallel to channel walls) of length l_1, which is placed near the closed end of the channel at the distance L_1 from the upper wall was carried out too. It was supposed that an additional rigid wall with a slot, which is perpendicular to the channel walls, is situated in the channel at the distance l_2 ($l_2 > l_1$) from the closed channel end. The detonation is initiated by the energy input in the layer near the closed end of the channel part with width L_1. The conditions under which the "back" detonation is formed in the other part of channel have been determined.

The other interesting problem under consideration is about the behaviour of the cellular detonation in the case of sharp widening of the channel cross section. The critical conditions of detonation formation after transition into the wide part of the channel have been obtained.



a) l_w =0.01



b) l_w =0.012

Fig. 2. Conservation (a) and destruction (b) of detonation when the obstacle is placed across the channel

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References

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[2] Godunov S.K., Zabrodin A.V., et al. (1976) Numerical Solution of Multidimensional Problems in Gas Dynamics. Nauka, Moscow.