NONCLASSICAL DIFFRACTION REGIMES OF COMBUSTION AND DETONATION WAVES

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Up to now the classical regimes of diffraction in chemically active mixtures have been investigated quite explicitly for the case, when the self-sustaining detonation wave (DW) passes from a tube into a half-space (or from a narrow channel into a sharply expanding channel). It has been established that depending on the relation of the channel size to the characteristic size of DW-structure (cell size) the reinitiation of divergent DW (spherical or cylindrical) is observed after DW-exit, or the failure of the detonation regime and the consequent transformation to the regime of high-speed turbulent combustion of a mixture are registered. The numerical estimation of the criteria of DW-diffraction was formulated for the first time in the paper by Prof. R.I. Soloukhin (with V.V. Mitrofanov coauthor, Doklady Akademii Nauk SSSR, 1964, v.159, n.5, pp.1003-1006).

In the present paper different diffraction schemes and experimental results are analyzed. The diffraction angle, relation of sizes of narrow and wider channels, degree of a wave overdriven, boundary type (linear or curvilinear, expanding or converging) influence the conditions of the DW-reinitiation.

Non-classical regimes of diffraction of stationary and non-stationary flames, including the regime of transition of combustion into detonation (DDT), are less investigated. The characteristic propagation velocities of the chemical reaction front in a combustible mixture range from centimeters per one second (laminar and turbulent flame) up to kilometers per one second (quasi-detonation, self-sustained and overdriven detonation). In the given report a large variety of regimes of propagation of combustion and detonation waves is revealed in the initial channel (pipe) of constant cross-section as well as after diffraction. For example, together with the predicted cases of the DW behavior after diffraction (DW-reinitiation or transformation to a combustion regime), the regime of the complete failure not only of detonations, but also of combustions is observed under certain conditions, exhibits the vanishing of luminescence products. The similar effect is revealed not only for self-sustaining, but also for overdriven DW.

Varying the energy of an initiator, the initial pressure of a mixture, the length of an initiating section, etc. it is possible to achieve the case, when the point of DDT will be located near the cross-section with sharp expanding. The non-traditional behavior of a diffracted wave in this case is of special interest, as at DDT the maximum pressure is realized at the expense of strong DW overdriven, much more exceeding the pressure of the products of self-sustaining DW. The results of DDT diffraction are presented and discussed in this report.
It is noted that the non-traditional regimes of diffractions investigated in the given work represent a good test material for future numerical modeling. Such modeling has not been realized by anyone up to day.

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