Analysis of instability of non-equilibrium two-phase reacting system

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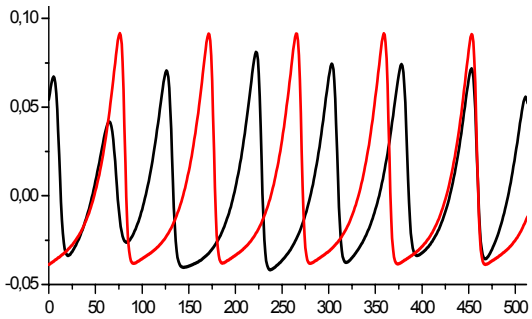
ABSTRACT

Dynamics of weak finite-amplitude perturbations in two-phase homogeneous medium (gas + solid particles) with non-equilibrium chemical reaction in gas is studied theoretically. Non-linear model of plane perturbation evolution is substantiated. The model takes into account wave-kinetic interaction and dissipation effects, including inter-phase heat and momentum transfer. Stability conditions for uniform state of the system are analyzed. Non-linear equation describing evolution of plane perturbation is derived under weak dispersion and dissipation effects.

The criterion for low-frequency perturbation amplification is substantiated. It is shown that instability has threshold character: perturbations increase when reaction heat release predominates over dissipative losses of energy. As a consequence the uniform reaction regime changes spontaneously. The role of non-linearity in perturbation spectrum stabilization is analyzed. As a result of instability and non-linearity self-sustained oscillations (weak shock waves) are generated in the system. Numerical simulation of evolution of gas-dynamic perturbations is carried out under different kinetic and dissipation parameters.



Dynamics of perturbations of gas-dynamic parameters

The obtained results demonstrate self-organization in initially homogeneous system: steady-state periodic structure arises, its period, amplitude and velocity depends on the features of the medium (see figure). The dependencies of these parameters on dissipation and chemical kinetics are analyzed. The obtained results develop the approach [1].

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REFERENCES

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