RECUPERATION THROUGH RADIATION IN LAYERED SOLID FUEL COMBUSTION[1]

V.V. GUBERNOV[1], E.V.SERESHCHENKO[1], S.S.MINAEV[1]

[1] *P.N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow, Russia*

In this work we investigate the properties and stability of the combustion waves propagating in a system of layered solid fuel material in which the neighboring fuel sheets can recuperate heat via thermal electromagnetic radiation. The analysis is undertaken within the flame sheet model which allows us to determine the combustion wave speed and structure and derive the dispersion relation characterizing the stability of the reaction front.

It is found that the dependencies of the combustion wave speed and temperature in the reaction zone are triple-valued function of the Zel'dovich number. There are upper, middle and lower solution branches arranged in the order of descending of combustion temperature and velocity. The stability analysis indicates that the lower and upper branches are unstable, while the middle brunch is partly stable. The travelling combustion waves belonging to the mid-branch lose stability once the Zel'dovich exceeds the critical value due to the Hopf bifurcation, leading to the emergence of the pulsating instabilities.

It is shown that for the current system the proper choice of parameters allows us to shift the boundary of stability towards the values significantly larger than the critical Zel'dovich number for the onset of pulsating instabilities for the adiabatic combustion waves. In other words the stability of reaction waves can be strongly enhanced once the parameters of the system are properly tailored. Besides that the temperature of combustion in the reaction zone can be increased over tens of percents and reaction wave velocity – in several times. This opens new perspectives in control of combustion synthesis of materials, which were not possible in standard SHS.

REFERENCES

[1] BJ Matkowsky and GI Sivashinsky. Propagation of a pulsating reaction front in solid fuel combustion. SIAM Journal on Applied Mathematics, 35(3):465–478, 1978.

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