

FINITE AMPLITUDE PRESSURE WAVE PROPAGATION IN CHEMICALLY ACTIVE HETEROGENEOUS MEDIA

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Introduction. This paper presents a mathematical analysis of pressure wave propagation in gas media containing particles and proposed mathematical model of the process.

Methodology. It is assumed that particles consist of the material which could be ignited in the surrounding gas if the temperature rises to necessary level. Due to pressure wave propagating in the media the temperature in the gas phase of the mixture is rising. Depending on the wave amplitude and wave profile three different scenarios are possible. The 1st scenario: the pressure wave is propagating in the heterogeneous media and due to low amplitude of the wave is dissipating in the mixture containing particles as a result of interphase exchange processes and the temperature of the gas does not reach values necessary for the beginning of the chemical reaction. The 2nd scenario: the pressure wave amplitude propagating in the mixture is sufficient for temperature of the gas surrounding particles to reach level necessary for the beginning of chemical reaction but due to wave profile that temperature level is held for a short period of time and the chemical reaction is not started. The 3rd scenario: the pressure wave propagating in the heterogeneous media containing chemically active mixture has necessary amplitude and profile to create temperature level and hold it for the time necessary for the beginning of chemical reaction. In the last scenario it is also possible to have different developments of the pressure wave propagation.

Results and discussion. Depending on the concentration of particles in the mixture energy release as a result of heat generation due to chemical reaction can be less than necessary to support pressure wave propagation as the wave energy is spent on the dissipation in the process of propagation. It is possible that generated energy will support steady propagation of the pressure wave in the mixture if the energy dissipated due to interphase exchange processes will be fully recovered by heat generation from chemical reaction. If the heat generation from chemical reaction is prevailing over the energy dissipation the process is accelerating and as a result we have a process which will be leading to increase of the pressure wave amplitude depending on the particles concentration. The proposed model estimates the wave evolution under different conditions of interphase interactions and possibility to have chemical reaction. Conservation equations describing the propagation and structure of finite amplitude perturbations in such a medium, with correction for heat transfer, momentum exchange and heat generation from chemical reaction between the phases, have been employed to obtain the wave profile during the pressure wave propagation. The model is capable of describing the evolution of waves at any ratio between characteristic times of the internal processes and the characteristic period of the pressure wave. The solution can be used to determine the profile and energy dissipation or generation during pressure wave propagation through the gas medium with suspended particles.