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THE EFFECT OF NON-ISENTROPIC PROCESSES ON DEFLAGRATION TO DETONATION TRANSITION IN GASEOUS COMBUSTIBLE MIXTURES

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ABSTRACT

Deflagration to detonation transition (DDT) in the most of gaseous combustible mixtures is known to take place in quite long ducts. In spite of intensive studies of the DDT phenomenon there is no universal theory so far. Zeldovich was one of the first who explained DDT as a result of shock-flame interaction. Manson has reported the results of thermodynamic calculations of flame and shock velocities relevant to DDT.

Oppenheim has demonstrated experimentally that the detonation wave arises suddenly after "explosion in explosion", somewhere in between the flame and the lead shock. So far, there is no adequate explanation for the phenomenon of "explosion in explosion". It follows from the experimental observations that a localized explosion, if it occurs, does not necessarily give rise to detonation . What conditions are then required for detonation onset ? Meyer, Urtiew and Oppenheim have analysed the thermodynamic parameters of the shock compressed gas under conditions relevant to DDT. It has been found that pressure and temperature of a critical particle (fluid particle located in the center of "explosion in explosion", appear to be outside the explosion limits, or in other words, that shock compression itself does not provide conditions for autoignition of a critical particle.

Wolanski has suggested the explanation of "explosion in explosion " based on considering non-isentropic processes after a lead shock. Kinetic energy dissipation at the duct wall can result in local temperature increase thus enhancing the localized chemical energy release.

In this paper, detailed study of the effect of the non-isentropic processes on auto-ignition of the mixture behind a shock wave is reported. Based on the theory of boundary layer, induction time for critical particle was calculated.

It was shown that kinetic energy dissipation in a compressible boundary layer behind a shock wave effects considerably reactive auto-ignition of the mixture . It has been estimated that particles entering a boundary layer have significantly smaller ignition induction time than in the free stream, which gives the explanation to the discrepancies observed between the simplified 1D free stream calculations and experimental findings.