

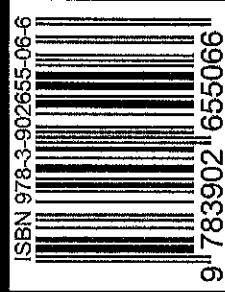
Book of Abstracts

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Deflagration to detonation transition in meta-stable systems.

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In a broad sense, the regimes of deflagration and detonation mean propagation of self-sustaining exothermal waves in meta-stable medium, and the difference of mechanisms brings to essential difference in the wave structure and to subsonic and supersonic propagation velocity. In a narrow sense, those regimes are waves of combustion and detonation in combustible mixtures, when the exothermal feature is a sequence of heat release in chemical reactions. The waves of overheated liquid boiling up are also relevant to those regimes; accumulated heat energy is transformed there into the energy of compressed vapor.

Analyzing a detonation initiation by means of local heat release, one can distinguish two scenarios. The first takes place when a strong shock wave develops in gas, and activation of chemical reactions increases behind the wave due to the increase of temperature and pressure. The second scenario of detonation initiation can take place when the shock wave developed after a local heat release not strong enough to activate the chemical reactions before it fades away; however, the temperature increase in the heat release core is enough to activate chemical reactions there. In this case, a normal combustion wave propagates from the heat release core (ignition location). Heating from burnt layers due to thermal conduction, not compression in a shock wave, is the primary mechanism of the wave propagation. Developing in gas, the combustion wave accelerates and disturbs the flow ahead of the front; this brings to further acceleration of the flame. Compression waves ahead of the combustion front converge into one or several shocks overtaking each other. Finally, either stabilization of the flame velocity, or detonation developing is possible; in the last case the velocity of detonation wave propagation stabilizes on the level of self-sustaining detonation. This process of detonation onset is known as deflagration to detonation transition (DDT). Lecture will consider such processes; details of transition mechanisms in different media will be investigated and their sensitivity to change of external governing parameters will be discussed.

Most of rocket and aviation engines have pulverized in air fuels combustion serving the base of their working cycle. Thus combustible mixtures formation and deflagration or detonation initiation in poly-dispersed fuel - air mixtures are the key aspects providing different limitations for operation of those engines. Combustion processes in heterogeneous mixtures differ greatly from that in homogeneous mixtures, because they are governed not only by chemistry but also by physical processes of combustible mixture formation, such as droplet atomization, evaporation and diffusive mixing of fuel vapor with an oxidant. Results on sensitivity of detonation onset to mixture parameters non-uniformity (spatial non-uniformity of dispersed phase, size distribution function, etc.) for both strong and mild initiation will be presented.

This lecture contains a review of the last results obtained in theoretical and experimental investigations of DDT processes in gases and poly-dispersed mixtures. Influence of internal geometry, flow turbulence, dispersed phase non-uniformity on the detonation onset is considered; influence of temperature and fuel concentration in unburned mixture is discussed.

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PAH/VOC Abatement Assisted by H₂O and H₂ in Mild Combustion Condition

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Abstract

In industrial systems the abatement of PAH and/or VOC present in the exhausted gases is realized through several technologies, i.e. thermal or catalytic oxidation, absorption or condensation in dependence of pollutant concentration and their physical properties. In particular thermal oxidation relies on a high temperature and adequate retention time at that high temperature for the full conversion of hydrocarbons to carbon dioxide and water vapor. The typical combustion chamber temperatures range from of 950K up to 1100K and the residence time ranges from 0.5 up to 1 sec. Thermal oxidizers are designed to achieve from 95% to 99% of removal efficiency.

The low PAH/VOC concentration in the exhaust gases implies chamber temperatures not high enough for sustaining the reaction process, thus an auxiliary fuel is required. Unfortunately, the contemporary use of a reactant pre-heating and of an supplementary fuel can lead to the potential formation of undesirable by-products, such as NO_x. However, for a pre-heating of reactants at a temperature higher than the PAH/VOC autoignition temperature, thermal oxidation can fall in Mild Combustion regime, whether mixtures sufficiently diluted are used. In this case both the clean and cleaning characteristics of Mild combustion are simultaneously effective in the same process.

Moreover, the suitable choice of the diluent can improve the abatement efficiency of the system. This is the case of water diluted Mild Combustion where the diluent can favor the PAH oxidation for its propensity to give radicals in the thermal conditions typical of the process. In addition, the water used as diluent allows for separating particles from flue gas in a downstream condensation unit.

The high dilution level, typical of Mild combustion condition, can also allow for the use of hydrogen as a fuel enhancer in a more easily controllable system. It can increase the pollutant oxidation efficiency by increasing radicals amount and can reduce the characteristic times (autoignition and oxidation) of the process diminishing both the residence time and the dimension of furnaces and plant equipments.

In this framework, the paper aims to show a preliminary analysis of PAH oxidation in Mild combustion regime. The effect of diluent has been evaluated by comparing results obtained using both nitrogen and/or water as diluent. Furthermore hydrogen has been added in different quantity in order to study its influence on characteristic times of the process.