Hydrocarbon-Air Mixtures Ignition at High Pressures

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An auto-ignition of lean hydrocarbon-air mixtures ($\phi = 0.5$) was studied in the shock tube behind the reflected shock wave at the wide pressure P = 3-500 atm and temperature range T = 1200-1750 K. A special heating system of our shock tube enables to study every hydrocarbon fuel mixtures at the high pressures. Reflected-shock pressure and temperature were calculated from the incident shock wave velocity using frozen chemistry one-dimensional shock wave theory. Ignition delay times were determined using emission at 306 nm $OH(X^2\Pi \leftarrow A^2\Sigma^+)$ and absorption at 3.3922 μm (component $F^{(2)}_1\ (v_3=1) \leftarrow F^{(2)}_2(v_3=0)$ of $P(7)$ line of v_3 mode of CH_4 molecule) diagnostics (Fig.1). The experimental data obtained were compared with the calculated by different mechanisms.

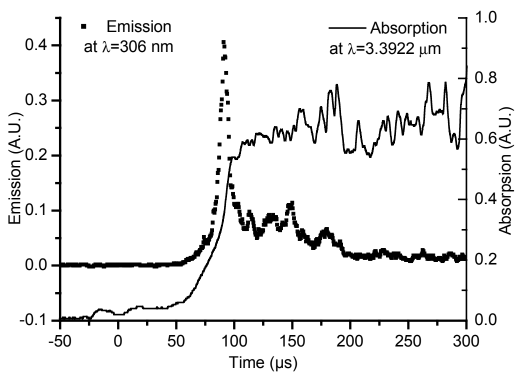


Figure 1. Absorption (CH_4) and emission (OH^*) profiles behind reflected shock wave. 4.8% CH_4 + Air. T_5 = 1265 K, P_5 = 173 atm.

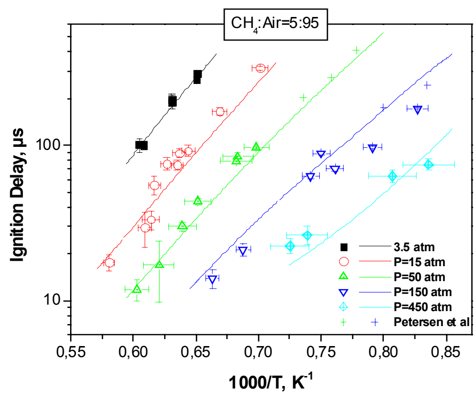
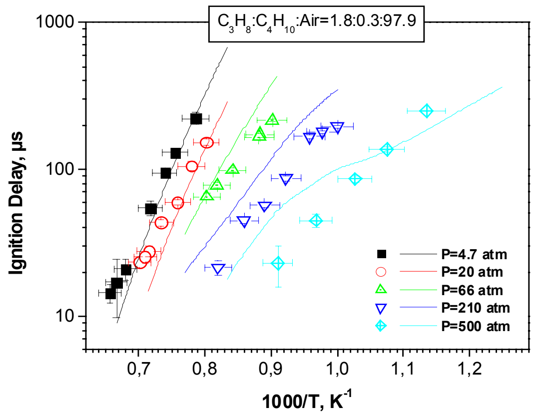


Figure 2. Ignition delay time for methane-air mixture in dependence on the pressure. Mixture 4.8% CH_4 + Air.



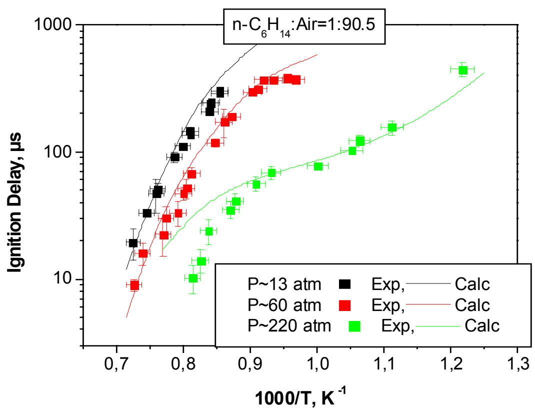


Figure 3. Ignition delay time for propane-butane-air mixture in dependence on the pressure.

Figure 4. Ignition delay time for hexane-air mixture in dependence on the pressure.

Thus, in the present work the data on the ignition delay times for methane-air mixtures were obtained in the wide range of parameters. GRIMech 3.0 mechanism [1] was validated in the wide range of parameters. It was shown that this mechanism is in a good agreement with the experimental data for lean mixtures and is able to describe the ignition delay time in the methane-air mixtures up to 450 atmospheres. This mechanism was expended for propane, butane and hexane – air mixtures on the basis of mechanism [2]. Good agreement between calculated and measured values in the wide pressure range was observed (Fig. 3, 4).

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References

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