Promotion of methane ignition by the laser heating of suspended nanoparticles

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The development of new methods of ignition promotion is an actual task. The influence of additions of nanoparticles on methane combustion was studied previously [1] and resulted in twofold acceleration of ignition at T < 1400 K. The goal of the present study was the investigation of the impact of laser-heated nanoparticles on methane-oxygen mixture ignition. The nanoparticles were synthesized in pyrolysis of 0.5–1% Fe(CO)₅ and 1–2% of C₆H₆ diluted in argon in the experiment before the ignition test. The residual nanoparticles were pulled into the flow behind the shock wave and their volume fraction was measured by laser light extinction. Just after the reflected shock wave propagation particles were heated by the impulse of Nd:Yag laser. Temperatures of heated particles were estimated using laser-induced incandescence methods. Modern kinetics of methane combustion was used for the modeling and analysis. A significant decrease of ignition induction times was observed as a result of a laser impulse. Analysis performed has shown that the effect supposedly involves catalytic reactions of methane decomposition on the surface of heated particles and allowed estimating their effective activation energy. This work was supported by Russian Science Foundation grant No. 14-19-00025.