Soot formation in pyrolysis of acetylene with hydrocarbon additions

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Soot formation is a topical problem in combustion science both in terms of reduction of harmful combustion emissions and synthesis of nanomaterials. One of insufficiently studied problem is acetylene combustion and pyrolysis kinetics with the following soot formation. Therefore the new experimental data obtained for the mixtures of acetylene with different hydrocarbons can clarify the kinetics features of these processes. This work is devoted to experimental study of methyl radical influence on soot formation during acetylene pyrolysis behind shock waves. The experiments were carried out in standard shock tube reactor. The laser light extinction was used for soot volume fraction and induction time of particle inception measurements and laser-induced incandescence was used for carbon nanoparticles sizing. Methane, dimethyl ether (DME) and diacetyl were used as additives to the acetylene. A fivefold increase in soot volume fraction with addition of 1% of methane to 2% of acetylene diluted in argon was observed. The less significant increase of soot volume fraction with addition of diacetyl was observed. And negligible increase of soot volume fraction with addition of DME was observed. Besides that, the additions of methane and DME caused the soot formation at lower temperatures comparing to pure acetylene mixtures. Qualitative kinetic analysis has shown that the reason of observed increase of soot volume fraction at low temperatures is the propargyl recombination leading to the acceleration of first aromatic ring formation. And the main channel of propargyl formation is recombination of methylene and methyl radicals, forming in the primary reactions of decomposition of used additives, with acetylene molecules.