THE ROLE OF CHAIN PROCESSES IN COOL FLAMES AND SOOT FORMATION

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Abstract: The 125th anniversary of Academician N. N. Semenov, the great natural scientist of the 20th century, is a significant event for the world scientific community. With his discoveries and tireless scientific, organizational, pedagogical, and social activities, he made an invaluable contribution to the formation of chemical physics and to the development of physics, chemistry, and biology. Nobel Prize laureate, academician N. N. Semenov played a huge role in the creation of the Department of Chemical Kinetics and Combustion of the Al-Farabi Kazakh National University and the Institute for Problems in Combustion. Contacts with the disciples of Academician N. N. Semenov made it possible for the researchers of the Institute for Problems in Combustion to discuss their candidate and doctoral dissertations at the seminars of the Institute of Chemical Physics in Moscow. With the support of N. N. Semenov, Ya. B. Zel'dovich, and A. G. Merzhanov, All-Union Symposia on Combustion and Explosion (1980 in Alma-Ata) and on Structural Macrokinetics (1984 in Alma-Ata) were organized. The article provides an overview of the author's works on studying the structure of the front of cool flames of diethyl ether and butane, the preflame zone of normal propane flames, and soot formation during combustion of hydrocarbons. The phenomenology, kinetics and mechanism of soot formation, and the influence of various factors on the formation of polycyclic aromatic hydrocarbons, carbon nanotubes, fullerenes, graphene, and soot are considered.

Keywords: hydrogen atoms; peroxide radicals; cool flames; oscillatory mode; nanoparticles; soot formation

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Figure Captions

Figure 1 Profiles of temperature (*a*) and concentration (*b*) of peroxide radicals. The shaded areas correspond to the fronts of cool and blue flames [5]

Figure 2 Profiles of temperature and hydrogen atom concentration: $T_1 = 443$ K, $T_2 = 730$ K, $C_4H_{10} : O_2 = 1 : 2$ [7, 13]

Figure 3 Time histories of temperature and radical concentration in the mode of steady-state oscillations along the axis of the second section of the reactor ($T_1 = 453$ K, $T_2 = 673$ K, $\tau = 0$ s; $C_4H_{10} : O_2 = 1 : 2$) [16]: (*a*) $x = 5$ cm; (*b*) 6; (*c*) 7; (*d*) 8; (*e*) 9; and (*f*) $x = 10$ cm

Figure 4 Phase portrait of butane oxidation in the mode of damping oscillations [7, 17]

Figure 5 Electron microscopic images of the sample: *1* — carbon nanotubes; and *2* — in a carbon shell [30]

Figure 6 Photograph of the experimental setup (*a*) and a liquid drop on the superhydrophobic surface (*b*) [31]

Figure 7 Raman spectra of carbon structures in the zones of the surface layer (*a*) and a photograph of the nickel substrate (*b*) with the indication of the zones formed in the surface layer at low pressure

Figure 8 Scheme of soot formation in a fuel-rich flame [36, 37]

Table Caption

Extraction of soot obtained at low-temperature combustion of methane and propane (the mass of extracted soot is 1 g; flow rate of methane is 2000 cm^3/min; and flow rate of propane is 1600 cm^3/min) [20, 21]

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