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Features of ignition of mixtures of hydrogen with hydrocarbons (C_2, C_3 and C_5) over rhodium and palladium at pressures of 1–2 atm

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The experiments were performed with gas stoichiometric mixtures of 5%÷40%H_2- air over Rh and (30÷70% H_2 + 70÷30%C_2H_6 (and C_2H_4))$_{stoich}$ + air over Rh and Pd (stoichiometry composition was calculated for the sum of fuels) and 5 ÷ 40% H_2 + air at 20^0 ÷ 300^0 C. A heated cylindrical stainless steel reactor 25 cm in length and 12 cm in diameter, equipped with demountable covers and an optical sapphire window in one of the covers was used in experiments [S1,S2,S3 5, 10,11]. The accuracy of temperature measurements was 0.3K. Registration of ignition and flame propagation was performed by means of a color high-speed camera Casio Exilim F1 Pro (frame frequency – 600 s^{-1}). A video file was stored in computer memory and its time-lapse processing was performed [S2, S3 10, 11]. The pumped and heated reactor was quickly filled with the gas mixture from a high-pressure buffer volume to necessary pressure. An electromagnetic valve was used to open and close gas communications. A pressure transducer recorded pressure in the course of gas intake and combustion. The reactor was used for studying thermal/catalytic ignition provided by Pd wire (0.3 mm thick 80 mm long) as well as Rh sample, which was made by electrochemical deposition of Rh layer 15 μm thick on Pd wire (0.3 mm thick 80 mm long). Pd was chosen because its coefficient of thermal expansion is the closest to that of Rh and Ru [S4 12], since Rh wire is relatively expensive. The Pd or Rh/Pd wires were used both to ignite the flammable mix and to measure the temperature of the foil as a bridge arm. Before each experiment, the reactor was pumped down to 0.1 Torr. Catalytic ignition limits were considered as the mean of two temperatures at the given pressure: a) for a bottom-up approach by temperature at lower temperature, the ignition was missing, at higher one the ignition occurred, all other things being equal; the temperature was increased in steps of 10^0, there were no ignitions above the noble metal wire before. b) for a top-down approach: at higher temperature the ignition occurred, at lower one the ignition was missing; the temperature was reduced in steps of 10^0. It is evident that the ignition limit value measured over the wire, which is not treated with ignitions (a bottom-up approach), is higher than the value measured with a top-down approach. Each value of the catalytic ignition limit given in the graphs below is the arithmetic mean of 6 experimental values.

Total pressure in the reactor was monitored with a vacuum gauge, and the pressure in the buffer volume was controlled with a manometer. Chemically pure gases and 99.85% Pd were used.

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