

Ignition limits of hydrogen–methane–air mixtures over metallic Rh at a pressure of 1–2 atm

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The experiments were performed with gas stoichiometric mixtures of (40÷70% H₂ + 60÷30% CH₄)_{stoich} + air over Rh (stoichiometry composition was calculated for the sum of fuels) at 20⁰÷300⁰ 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} The accuracy of temperature measurements was 0.3K. 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. Monitoring of ignition and flame propagation was performed by means of a color high-speed camera Casio Exilim F1 Pro (frame frequency – 1200 s⁻¹). A video file was stored in computer memory and its time-lapse processing was performed.^{S2} A pressure transducer recorded pressure in the course of gas intake and combustion. The reactor was used to study thermal/catalytic ignition provided by Rh sample, which was made by electrochemical deposition of Rh layer 15 μ m 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, since wire made of pure Rh is relatively expensive. The Rh/Pd wire was used both, to ignite the flammable mix and to measure the temperature of the foil as Wheatstone bridge arm. Before each experiment, the reactor was pumped down to 0.1 Torr. The upper ignition limit was determined as the temperature of the first ignition at the given pressure for a bottom-up approach by increase in temperature in the “fresh” reactor, which was not treated with ignitions: at lower temperatures the ignition was missing, at higher one the ignition occurred. For a top-down approach by decrease in temperature in the treated reactor the lower ignition limit was determined as a mean of two temperatures: at higher one the ignition occurred at lower one the ignition was missing. 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.

References

S1 N. M. Rubtsov, V. I. Chernysh, G. I. Tsvetkov, K. Ya. Troshin and I. O. Shamshin, *Mendeleev Commun.*, 2018, **28**, 216.

S2 N. M. Rubtsov, V. I. Chernysh, G. I. Tsvetkov, K. Ya. Troshin and I. O. Shamshin, *Mendeleev Commun.*, 2021, **31**, 274.