

Catalytic ignition of deuterium–methane mixtures with air over palladium metal at pressures up to 2 atm

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The experiments were carried out under static conditions with stoichiometric gas mixtures ($60 \div 90\% \text{D}_2 + 40 \div 10\% \text{CH}_4$)_{stoich}+air over Pd surface at $20 \div 300^\circ \text{C}$. The stoichiometric composition was calculated for the sum of the fuels. The experiments were carried out in a heated cylindrical stainless steel reactor with a length of 25 cm and a diameter of 12 cm, equipped with removable lids and a leucosapphire optical window in one of the lids.^{S1} The accuracy of the temperature measurement of the inner surface of the reactor was 0.3 K. The pumped and heated reactor was rapidly filled with a gas mixture from a high pressure buffer volume to the required pressure. An electromagnetic valve was used to open and close the gas connections. Ignition and flame propagation were recorded using a Casio Exilim F1 Pro color high-speed camera (frame rate - 1200 s^{-1}). The video file was stored in the computer memory, and frame-by-frame processing was performed.^{S1} The pressure during gas injection and combustion was recorded by a CARAT DI precision pressure sensor, whose signal was sent to the ADC converter and computer. A Pd wire (0.3 mm thick and 80 mm long) located in the geometric center of the reactor was used for catalytic ignition. A gas mixture was ignited on this wire, and the temperature of the wire was measured when it was used as an arm of a Wheatstone bridge, previously calibrated by temperature. The signal was also sent to the ADC converter and the computer. Before each experiment, the reactor was pumped to 0.1 Torr. The upper limit of catalytic ignition was determined as the value of the temperature of the first ignition at a given pressure when approaching from low temperatures in a vessel not treated with ignitions. The lower limit of catalytic ignition was determined as the mean value between two temperature values, at the higher of which ignition was observed and at the lower of which it was absent in the vessel treated with ignitions of the mixture under study. The ignition delay time was considered as the time between the end of the gas supply and the beginning of the ignition along the pressure dependence on time. The total pressure in the reactor was controlled by an exemplary vacuum gauge, and the pressure in the buffer volume was controlled by an exemplary pressure gauge. Chemically pure gases and 99.85% Pd were used.

References

- S1 N. M. Rubtsov, K. Ya. Troshin and M. I. Alymov, *Catalytic Ignition of Hydrogen and Hydrogen-Hydrocarbon Blends Over Noble Metals (Heat and Mass Transfer)*, Springer Nature Switzerland AG, Cham, Switzerland, 2023; <https://doi.org/10.1007/978-3-031-28416-8>.