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EFFECT OF H2O2 CONCENTRATION AND CATALYTIC RATIO ON THE AUTOIGNITION CHARACTERISTICS OF RP-3 KEROSENE UNDER CATALYTIC IGNITION ENGINE-LIKE CONDITIONS

Abstract

Since the hypergolic characteristics of hydrogen peroxide/kerosene bipropellants, the application of catalytic ignition based on H2O2/kerosene rocket engine has significant advantages in avoiding redundant ignition devices and reducing system complexity. However, the catalytic ignition of hydrogen peroxide/kerosene would encounter some problems in case of deviation from the standard operating conditions, including deterioration of ignition reliability and long ignition response time. A three-component surrogate fuel detailed chemical kinetic mechanism of RP-3 aviation kerosene was adopted to investigate the effects of H2O2 concentration and catalytic ratio on autoignition characteristic of RP-3 kerosene numerically, including ignition delay time (IDT) and laminar flame velocity. To consider the different ignition conditions of the engine, the research was developed at pressures of 0.1 to 4.0MPa over a range of temperatures from 600 to 1800K and for equivalence ratios from 0.5 to 2.0. Results showed that as the increase of ignition temperature depending on H2O2 concentration, it is observed that the IDT decreases significantly, and the impact of ignition temperature on IDT is most sensitive at 700-900K. A higher the ignition pressure could reduce IDT, which presents a higher sensitivity in the range of 0.1-1.0MPa. The increasement of hydrogen peroxide catalytic ratio results in a logarithmic decrease and linear increase of IDT and laminar flame velocity, respectively. It could be further proved that the participation of H2O2 without catalytic decomposition in the chemical reaction causes a sharp shortening of IDT and enhancement of laminar flame speed to a certain extent, so as to promote the occurrence of ignition and the self-sustained combustion after ignition. The negative temperature coefficient (NTC) behavior was observed, and the effect of hydrogen peroxide catalytic ratio on NTC intensity was evaluated under different ignition pressures and equivalence ratios. Sensitivity analyses were performed to identify the key reactions dominating the ignition delay and combustion intensity. The current work would provide insights and references for understanding the ignition process and ignition scheme optimization of H2O2/kerosene rocket engine.