Ignition Performance of High-Density Suspension Fuel of Adding Al NPs

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Abstract: To study the ignition and combustion characteristics of suspended fuel containing metal particles, two kinds of high-density suspension fuels of HD-01 and quadricyclane(QC) with 5% aluminum nanoparticles(Al NPs) were prepared. The ignition delay of two kinds of suspended fuels at different pressure and temperature was measured by atomization shock tube. The apparent activation energy of ignition was obtained by fitting and calculating. The ignition and combustion mechanism of the suspension fuel were analyzed. The flow field images of ignition and combustion were recorded by high-speed camera. Results show that the suspended fuel can stand after 4 weeks without particle aggregation phenomenon; in the range of 0.05 MPa and 0.1 MPa, 1450 K and 1750 K, Al NPs can make the ignition delay of HD-01 and QC fuel shorten by about 50% and the apparent ignition activation energy reduce from 161.4 kJ·mol^{-1} and 120.3 kJ·mol^{-1} to 156.5 kJ·mol^{-1} and 112.8 kJ·mol^{-1}, respectively; Inferring that the combustion mechanism as that aluminum atoms preferentially react with O_2 to produce O radicals, thereby accelerating the combustion reaction. In addition, Al NPs can completely burn and promote the energy release during fuel combustion.

Key words: aluminum nanoparticle; high-density fuel; suspension fuel; shock tube; ignition delay; combustion

CLC number: TJ55 **Document code**: A **DOI**: 10.11943/j.issn.1006-9941.2018.04.001

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