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Author: Mr. Hongjae Kang
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, newkhj878@kaist.ac.kr

Mr. Eunkwang Lee
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, zamenhof@kaist.ac.kr
Mr. Youngil Kim
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, hikimyi@kaist.ac.kr
Prof. Sejin Kwon
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, trumpet@kaist.ac.kr

SODIUM BOROHYDRIDE-BASED NONTOXIC HYPERGOLIC FUELS WITH H2O2 AS AN OXIDIZER

Abstract

Various kinds of nontoxic hypergolic fuels are developed and tested to replace the currently used hydrazine-based fuels which are highly toxic, corrosive and carcinogenic. This article is to suggest the combinations of nontoxic hypergolic bipropellants, sodium borohydride-based nontoxic hypergolic fuels and high-test hydrogen peroxide as an oxidizer. Sodium borohydride as a strong reducing agent can directly combust with hydrogen peroxide through a reduction-oxidation reaction when they contact each other. That means sodium borohydride can be used as an ignition source for hypergolic interactions. However, although sodium borohydride is commonly available, finding an energetic solvent for sodium borohydride still need to be explored. Herein, several energetic hydrocarbon solvents were selected and the chemical compatibility of the mixture between the fuels and sodium borohydride was tested. The combination between the solvents and sodium borohydride was determined based on the following criteria: vacuum specific impulse should reach around 310 s with 98 wt.A 500 N scale hypergolic bipropellant thruster was designed to evaluate the performance of the newly developed non-toxic hypergolic combinations in an actual operating condition. To avoid combustion instability especially occurred during the start transient of the thruster, the injector was designed in a particular way. The injector has small flow channels for the fuel and oxidizer respectively, and the channels branch off from the main flow channels. Through the branched small flow paths, infinitesimal amounts of the propellants are injected into the chamber and initiate the hypergolic ignition before the main stream of the propellants is sprayed. By doing so, it is possible to remove the risk of a hard start which is vulnerable to a hypergolic bipropellant thruster. In short, this research makes an effort to discover promising candidates for the combinations of nontoxic hypergolic bipropellants in future and introduce a novel concept of the injector for 500 N scale hypergolic bipropellant thruster.