SPACE PROPULSION SYMPOSIUM (C4)
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Author: Prof. Taegyu Kim
Chosun University, Korea, Republic of

DESIGN AND DEVELOPMENT OF PARAFFIN/N2O HYBRID PROPULSION SYSTEM WITH CATALYTIC IGNITER

Abstract

Hybrid propulsion system with a nitrous oxide catalytic igniter was designed and developed in the present study. Hybrid propulsion systems have mainly used a spark ignition, in which pressure vibrations cause combustion instability. Catalytic igniter utilizes the reaction heat of nitrous oxide decomposition as the ignition source. Nitrous oxide decomposition is a catalytic process, not causing the pressure vibration, and combustion instability is not induced. The nitrous oxide decomposition was accelerated by a high-performance catalyst, reducing the preheat temperature requirement to as low as 200 oC to initiate decomposition. Nitrous oxide decomposes exothermically with an adiabatic decomposition temperature of 1640 oC. The test result has shown that after an initial input of heat to initiate the catalytic decomposition, the reaction can become self-sustaining. The oxygen released by nitrous oxide decomposition could be combusted with a solid fuel in the combustion chamber. The hybrid propulsion system consists of a preheater, catalytic igniter, and combustion chamber casing paraffin as a solid fuel. The catalytic igniter had a multistage catalyst bed for the efficient decomposition of nitrous oxide; one stage is for the reaction initiation at low temperature and the other is for sustaining the decomposition reaction at high temperature. The thermal capacitance of the system was minimized to enable fast startup transients. The various catalysts were tested to find out the minimum preheat temperature for the initiation of nitrous oxide decomposition. The optimal catalyst bed length was determined to minimize the pressure drop through the catalytic igniter. The amount of catalytic material required for maximizing the c* efficiency of the reaction was determined. The exhaust gas temperature of catalytic igniter was maximized for a reliable ignition and the restart capability was demonstrated. This catalytic igniter was very reliable and durable for a paraffin/N2O hybrid propulsion system.