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A NEW HYBRID-ROCKET-BASED COMBINED-CYCLE PROPULSION SYSTEM CONCEPT

Abstract

A new Hybrid-Rocket-Based Combined-Cycle (HRBCC) propulsion system concept, used for reusable launch vehicles or hypersonic vehicles, was presented in the paper. The HRBCC engine uses solid fuel hydroxyl terminated polybutadiene (HTPB), liquid oxidizer 98% hydrogen peroxide (98%H2O2) and ingested air for propellants. It combines ducted rocket, scramjet, and hybrid rocket engine cycles into one compact engine. The hybrid rocket motor is embedded within the scramjet duct. A typical HRBCC engine operates in essentially three modes, such as ejectorjet mode, scramjet mode and rocket mode, with the variable inlet and nozzle geometry.During the ejectorjet mode the ducted hybrid rocket provides the bulk of the thrust for takeoff and acceleration to transition speed (about 3Ma). A small part of the oxidizer 98% H2O2, injected from the forward end of the hybrid motor, burns with the solid fuel to produce intense fuel rich gas. The other 98% H2O2 is secondary injected and combusting in the hybrid motor aft-mixing chamber. Then the modest fuel rich exhaust gas is ejected to the scramjet chamber. It mixes and combusts with the ejector air. In scramjet mode, the vehicle velocity reaches about 3-6 Ma and the flow through the engine is supersonic. The secondary injection of the 98% H2O2 is turned off. The forward injected 98% H2O2 continues to combust with the solid fuel to form the intense fuel rich gas. The unburned fuel in the exhaust hybrid rocket plume combusts with the supersonic air in the scramjet chamber.When the vehicle reaches the outer limits of the atmosphere, the inlet is fully closed and the secondary injected 98% H2O2 restarted. The system transitions into hybrid rocket mode. The hybrid rocket motor works in the best mixture ratio until orbit insertion velocity is reached. In general, the principle advantages of this propulsion concept are showed as below. 1. The exhaust fuel-rich hot-gas of the hybrid rocket motor may be benefits for the scramjet ignition and combustion stability. 2. The engine structure is simple, because there is only one liquid oxidizer 98% H2O2 feeding system. It can be supplied by the catalyze decomposed 98% H2O2 gas-generator cycle. 3. The sensitivity of engine performance to inlet air is decreased. If the inlet air is not enough, more 98% h2o2 can be injected to keep the best mixture ratio. 4. The air drawn into the engine by the ejector effect provides significant thrust augmentation during boost.