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COMPUTATION AND EXPERIMENT OF FUEL REGRESSION RATE IN GOX-HTPB HYBRID ROCKET MOTORS

Abstract

A hybrid rocket motor stores propellant in two different states —liquid and solid. In a typical hybrid, the fuel is a solid and the oxidizer is a liquid. Hybrid rocket propulsion offers a number of advantages over traditional liquid and solid rocket systems particularly in the areas of safety, throttling, environmental cleanliness, grain robustness, low temperature sensitivity and low cost. Hybrid rocket systems can be used in sounding rocket, target missile and tactical missile. Study of hybrid rocket was developed increasingly since 1990s.

The combustion characteristic in classical hybrid rocket motors has been studied. The heat transfer process in the gas and the solid fuel has been considered. Coupling computation is presented by the regression rate equations based on the heat transfer theory and the Arrhenius law. The regression rate at various oxidizer mass flow rates, axis distances, ambient operating temperatures and times is obtained. Fuel regression rate mainly infects with oxidizer mass flow rate and axial distance. Regression rate increases as oxidizer mass flow rate increases and decreases as axial distance increases. The temperature sensitivity of solid fuel in a hybrid rocket motor is low and we need not assign a weight margin for variations in ambient operating temperatures. Adiabatic combustion temperature at various oxidizer mass flow rates and grain length is obtained by thermodynamic calculation and has a maximum as oxidizer mass flow rate increases. The results are in agreement with the some references and useful for further study.

The overall design, grain design, combustion chamber and nozzle design, ignition scheme design and oxizder injector design of the labscale hybrid motor used GOX/HTPB are presented. Black powder is selected for ignition and case-bonded casting method is used. The inner diameter of grain is 30 mm. and the outer diameter is 45 mm. The length is 500 mm. Operating time is set to 1s.

The solid fuel regression rate is obtained by measuring the mass of the combustion chamber before and after firing. The regression rate of the solid fuel is formulized using the results. The regression rate obtained by experiment is higher than that by transfer theory, because the burning time is not equal to 1s exactly. Combustion efficiency is calculated using characteristic velocity. Influencing factors in combustion are studied, which will be useful for the hybrid rocket motor design.