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PERFORMANCE ADVANCEMENT OF HYBRID ROCKET ENGINE THROUGH HIGHER REGRESSION RATE AND COMBUSTION EFFICIENCY WITH MULTI-SECTION SWIRL INJECTION METHOD

Abstract

Recently developments of micro-satellites, whose weight is less than 100 kg, become quite active. As micro-satellite uses commercial, inexpensive components, the cost of micro-satellite becomes cheap and also the size of subsystem of micro-satellite becomes smaller and smaller. The latest micro-satellite for single mission becomes very useful for commercial use. Above situations of micro-satellite begin to request low-cost launcher to low earth orbit because a combination of low cost micro-satellite and low cost launcher can do develop micro-satellite business market. For this request hybrid rocket is one of the most promising propulsion systems. However, still some problems remain in hybrid rocket such as low regression rate, optimum scale rule, large thrust, vibration in the combustion chamber. The present authors proposed a new method for increase of regression rate of hybrid rocket. The new method is to introduce swirling flow at multi-sections along fuel and has been applied for high density polyethylene fuels and paraffin fuels with gaseous oxygen.

The results show the new method is quite useful for the increase of the regression rate and the increase of the thrust of hybrid rocket engines. For high density polyethylene fuel the regression rate of fuel with multi-section swirl injection system shows about 3 times larger than that of conventional normal injection method and 2 or 3 times larger than the method of swirl injection system at upstream single cross section swirl injection system. For paraffin fuel the regression rate of fuel with multi-section swirl injection system shows about 10 times with paraffin fuel compared with that of the conventional no-swirl injection method. The results show the new method of multi-section swirl injection system is quite useful both for high density polyethylene fuel and paraffin fuel in order to increase regression rate of fuel and increase the thrust of hybrid rocket engine.

Also recent combustion experiments with multi-section swirl injection method for long duration show quite steady combustion. The results show that the multi-swirl injection method is quite powerful method to increase the performance of hybrid rocket engine and also to increase many applications as low-cost space propulsion systems.