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A STUDY ON NEW HYBRID ROCKET ENGINE WITH MULTI-SECTION SWIRL INJECTION AND AFT COUNTER-SWIRL INJECTION METHOD

Abstract

The authors have proposed a new combustion method which can increase fuel regression rate and combustion efficiency. The new method is a combination of two technique. The first technique is named as Multi-Section Swirl Injection Method, which generates swirling flows at several cross-sections in combustion chamber. The method is quite powerful to increase fuel regression rate by 3 to 8 times compared with that of conventional method. The second technique is named as aft counter-swirl injection method, in which oxidizer is injected into mixing chamber located after combustion chamber with counter direction against swirl direction of oxidizer at combustion chamber. The combination of two methods is tested experimentally and higher fuel egression rate and higher combustion efficiency have been realized. For the problem of O/F shift during long combustion interval experimental study has been tested to overcome this problem. In the present study mass flow rate of oxidizer is controlled during combustion at each injection port including injection port of mixing chamber. The purpose of the injection at mixing chamber is to provide oxidizer to unburned gas without increasing fuel regression rate directly. The method works quite good and almost constant O/F values are kept constant during combustion. Also with this method increase of thrust is realized. By using the same system throttling capability of the system with optimum O/F has been proved. Also flight experiments have been conducted to check capability of a new method under acceleration environment. The hybrid rocket engine with the new method operates normally under 4 G acceleration environment. The results show the proposed new method has capability as high performance hybrid rocket engine For the practical application vaporization technique of liquid oxygen is one of the key technology to realize swirl injection for higher fuel regression rate. Pressured LOX is spread out through special spray nozzle and small particles of liquid oxygen are injected into vaporization chamber. In the vaporization chamber hot gas, which is obtained from pre-burner of small hybrid rocket engine, is injected into those small particles of LOX. Almost all the small particles of LOX are vaporized and gaseous oxygen are sent to main combustion chamber to realize A-SOFT Multi-Section swirl injection method. In the present study a whole system starting from LOX tank to Hybrid Rocket Engine with Multi-Section Swirl Injection and Aft Counter-Swirl Injection Method.