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# NUMERICAL SIMULATION OF INNER FLOW FIELD OF A PINTLE INJECTOR VARIABLE THRUST HYBRID ROCKET ENGINE

**Abstract**

A century ago, R.H.Goddard had claimed the necessity of developing variable thrust rocket. In manned space launch mission it can control the overload which astronauts suffered by using variable thrust rocket. In planetary descent missions such as Apollo program and Chang'E program the variable thrust rocket is the only useful method to make it. Since the mid-1950's the pintle injector concept was proposed by TRW Company, it had been widely used in liquid deep throttling rocket in American. This injector has some unique characteristics comparing with traditional injector, such as a simplicity structure, it can optimize performance by replace two simple parts, high combustion efficiency while changing thrust, inherent combustion stability and face shutoff feature. The most famous pintle injector rocket is the throttling Lunar Module Descent Engine. This engine can maintain the drop pressure while provide variable thrust. Because hybrid rocket motors (HRM) have some advantages such as inherent operational safety, throttle ability, start/stop/restart capability and low cost compared with liquid/solid rocket motor, it can be used in boosters, spacecrafts, space engines, target drone and missiles. The drop pressure has a strong influence on performance of axial/swirl injectors, and the response time is too long to control the thrust immediately. On account of these reasons, the pintle injector can be used in HRMs to adjust thrust rapidly while maintain stable drop pressure. There still have some difficulties need to be settled when utilize pintle injector in HRMs. First, typical HRMs use a liquid oxidant and a solid fuel as propellant, so the distribution of the oxidizer mass flux in two flow path in pintle injector has a strong influence on liquid atomization and combined combustion with solid fuel. Then the structure parameters of pintle injector such as depth in chamber, inject angle and so on also influence the efficiency of combustion. A CFD code is used to simulate the flow field and performance of HRMs with pintle injector and orifice element, which applying 98