Paper ID: 29745
poster

66th International Astronautical Congress 2015

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

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DEVELOPMENT OF A MOVEABLE SLEEVE INJECTOR WITH A FIXED PINTLE FOR A THROTTLEABLE ROCKET COMBUSTOR

Abstract

Recently, deep throttling with high-efficiency is required as important technique to reduce fuel consumption, engine weight and launch cost. Using the proper continuous throttling, optimized thrust control can be achieved. There are many throttling methods such as dual manifold and pulse modulation, however, these fixed shape methods has disadvantages; low efficiency at lower throttling condition, shallow throttling performance and discontinuous control. An injector with variable injection areas can overcome these limitations due to variability of spray structures at various flow rates. The typical variable area injectors used moving pintle with extra flow control system in supply lines, but the remote flow control system which is away from the injection point has slowly responsive control performance. Thus, the new type injector was designed to develop variable thrust rocket combustor which has fast throttling response.

Before new injector design, spray characteristics of the typical moving pintle injector were studied using water and air as simulants at the atmospheric condition. At the various flow rates and pintle opening distances, fundamental spray characteristics were studied; spray angles, patterns and droplet diameter distributions. In this case, the pintle controlled spray structure as well as flow rate simultaneously. For the reason, spray sheet was not uniform and flow rate control was controlled as nonlinearly when the pintle opened a little. It means that poor performance would be expected at lower thrust conditions. In addition, it was difficult to maintain concentricity of the long pintle rod when the pintle was moving and this injector required additional flow control system. As a result, the new design concept was required to separate the flow rate control and spray structure control.

In order to improve these disadvantages, moveable sleeve type injector was newly designed and the prototype was verified through the atmospheric experiment with similar conditions of the pintle injectors. The new injector has slightly opened pintle tip same as the moveable pintle injector, but the pintle tip was fixed and outer sleeve controlled flow rate of bipropellants at same time. Also, uniform spray structure was obtained regardless the flow rate conditions and fast response was possible.

In the future, using this new injector, spray characteristics will be compared to those of the previous pintle injector and sleeve design will be improved to control flow rate maintaining the optimal mixture ratio. Furthermore, the dynamic flow characteristics will be studied regarding to combustion chamber pressure calculated from the flow rate.