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THE CRYOGENIC REGULATOR DESIGN FOR LIQUID PROPULSION SYSTEM

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ABSTRACT

The regulator that was designed for space use must be operating on the severe circumstance. For example, operating temperature is below 90K and operating pressure is 20.7 MPa. The design of regulator for liquid propulsion system was accomplished and dynamic characteristic was analyzed successfully.

Keywords: cryogenic, regulator, dynamic characteristic, liquid propulsion

1. INTRODUCTION

The pressurization system in a liquid rocket propulsion system provides a controlled gas pressure in the ullage space of the vehicle propellant tank. The ullage pressure is control by regulation system. so The regulator for space application was designed to attain special units designed specifically to meet unique requirements. Accordingly a commercial regulator that could not be accepted for use in the environment of the propulsion system was modified by product improvements or material changes acceptable for space usages

2. DESIGN AND ANALYSIS

Stored-inert-gas pressurization system (Figure 1) has been used widely and successfully, particularly in vehicles with bipropellant propulsion systems. This system is used for propellant tank pressurization. A key parameter in the design is pressurant gas temperature and pressure in both storage and ullage condition (Howard 1975). In general propellant tank using inert-gas pressurization are pressurized through a common pressure regulator to minimize the ullage-pressure difference in the tanks and thereby maintain more consistent engine thrust and mixture ratio.

The Pressure-reducing regulator, the most common type of pressure regulator in airborne systems, is used to reduce pressure.

Both component development and flight experience indicate that the pressure regulator is one of the more unreliable component in ullage pressurization system (Howard 1973). This characteristic stems from the inherent design of the regulator in which a number of moving parts (Table 2) are required to function quickly, continuously, and precisely under widely varying flow, pressure, and temperature (Table 1).

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Table 1. Development Specification.

No.	Item	Requirements
1	Operating Fluid	GHe
2	Operating Pressure	4.4 MPa ~ 20.7 MPa
3	Maximum Pressure	21.4 MPa
4	Operating Temperature	77 K ~ 300 K
5	Mass flow rate	0.14 kg/s
6	Supply Pressure	5.5 MPa ~ 20.7 MPa
7	Regulated Pressure	4.4 MPa
8	Weight	Max 8 kg
9	Regulating Type	Dome-loaded type
10	Dome Pressure	1 : 1 (reference : regulated)
11	Connection Type	1″ (inlet), 1″ (Outlet)
12	Valve Type	Balancing Type
13	Sensing Type	Both Internal and External sensing
14	Actuator Type	Metal Bellows type
15	Bandwidth	±0.04 MPa

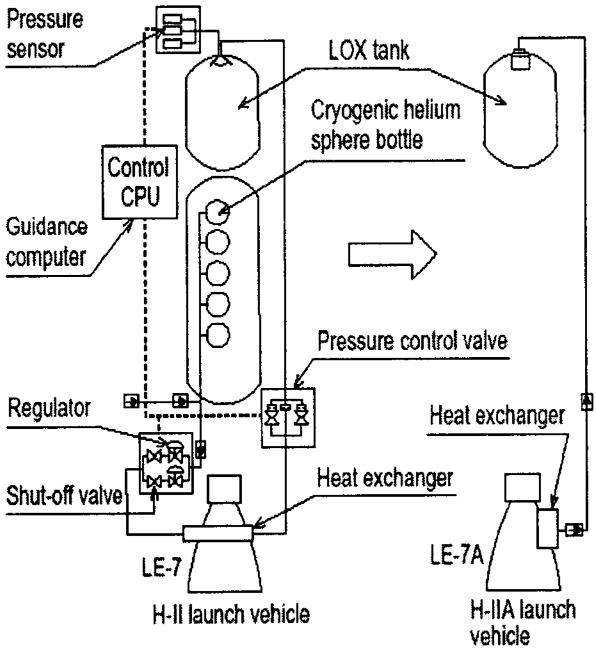

Figure 1. Pressurization System (H-II).

The dome-loaded configuration(Figure 2) uses a constant-pressure reference source and actuator rather than the large reference spring to supply and actuation force the inlet valve. A the required flow demand increases, the corresponding inlet valve size increases, and supply-pressure variation and flow demand. An external reference source of constant-pressure gas is not readily available in space application, and a small-capacity direct-acting regulator is used to reduce the supply pressure to the desired reference pressure. Regulator inlet valve design was determined by flow demand, pressure drop, leakage requirements, typer of fluid, and temperature extremes. Pressure-balanced

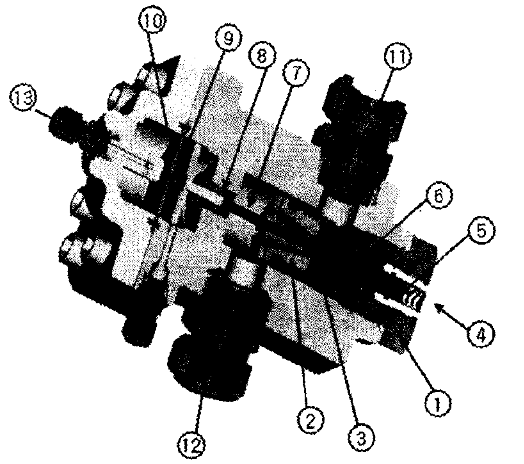

Figure 2. Regulator Configuration.

Table 2. Component list.

No	Component
1	Sleeve
2	Orifice
3	Seat
4	End Gland
5	Orifice Spring
6	Main Spool
7	Cover
8	Guide
9	Spring (Actuator)
10	Bellows (Actuator)
11	Inlet
12	Outlet
13	Dome

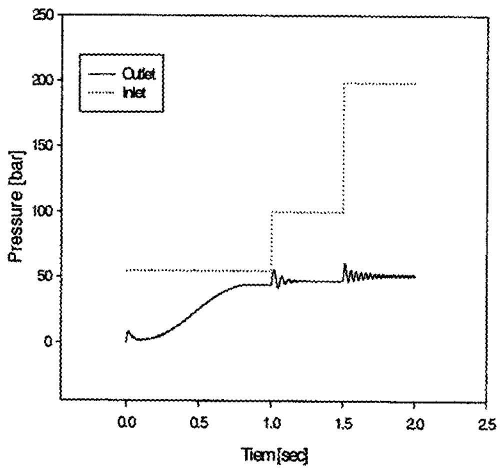

Figure 3. Regulated Pressure.

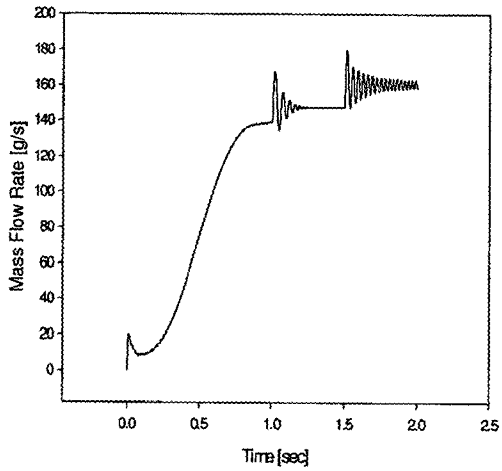

Figure 4. Mass Flow Rate.

inlet valve was employed to decrease regulated-pressure errors and actuator size.

Dynamic characteristic is investigated using AMESIM Module (Figure 3 and Figure 4). This output imply that the analysis of regulated pressure and mass flow rate consist with development specification (Table 1).

3. CONCLUSIONS

The design of regulator for liquid rocket propulsion that was accomplished successfully and dynamic characteristics was investigated. Furthermore, there will be test in real circumstance to verify regulator acceptable for liquid rocket propulsion.

REFERENCES

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