Sensitivity Analyses of Propulsion Components for LEO Spacecraft

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ABSTRACT

The LEO observation satellite suffers from disturbances on its orbit, which make its altitude decrease gradually due to gravitational force and atmospheric friction near the earth. To compensate this, thrusters on the propulsion system must be operated periodically. In addition the thrusters should be actuated when performing main mission of satellite as well as attitude control to aim at sun for electrical power production. Such reasons emphasise the importance of a propulsion system on LEO observation satellite.

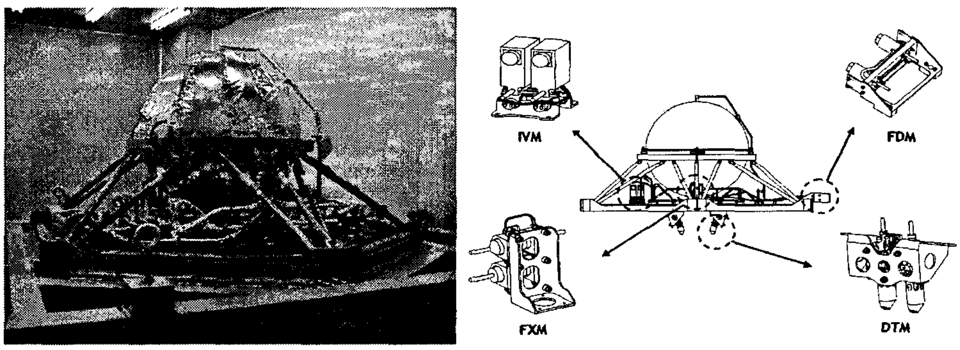

Fig. 1 LEO satellite propulsion system and its configuration

In the mean time, the environment of space where the satellite performs its mission is 3K absolute, which is an extremely low temperature that could hardly be experienced on earth. A common main fuel for the propulsion system of LEO satellite is the hydrazine. A thruster using it can deliver impulses required for specific mission through catalytic decomposition. Hydrazine, the propellant of the satellite, has very similar property to that of water; it freezes around 2°C. To secure performance and safety of the propulsion system at an extreme environment in space where the satellite operates, the involvement of thermal control system to prevent from propellant freezing is substantial.

Performing the sensitivity analyses of contact conduction and the position of thermostat on the basis of the thermal model established, the study of thermal design is accomplished for the preparation of the future changes of mechanical interface design of LEO satellite propulsion system. A relatively simple thermal model is taken into consideration for the convenience of the analysis. A variety of the spacecraft bus voltages and the contact resistances are tried as well as the position of thermostat on propulsion components. As a consequence, when the mechanical interface condition is changed at the same module, the successful thermal design could be achieved if we design the heater to have sufficiently large power with reference to the legacy of contact resistance. Besides the reasonable performance on the thermal control is believed with possible human errors if the uncertainty in the position of thermostat is not quite large when assembling tank module.

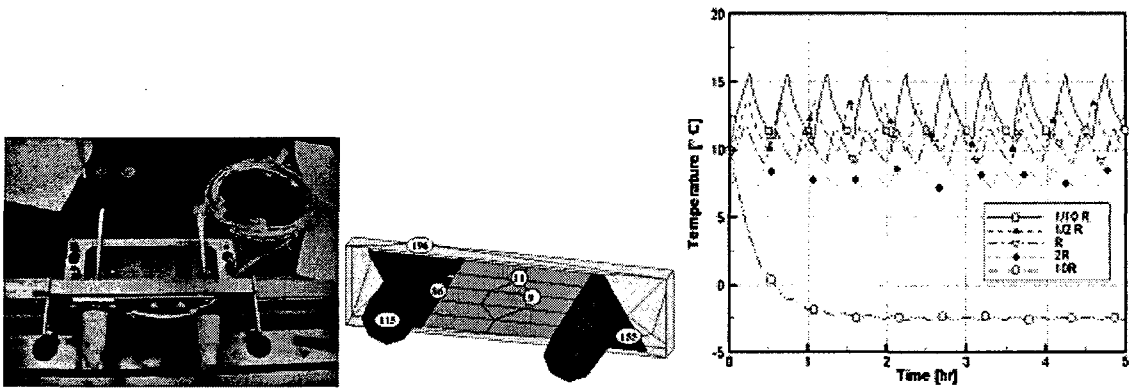

Fig. 2 Fill and drain valve module, its thermal model, and transient thermal response

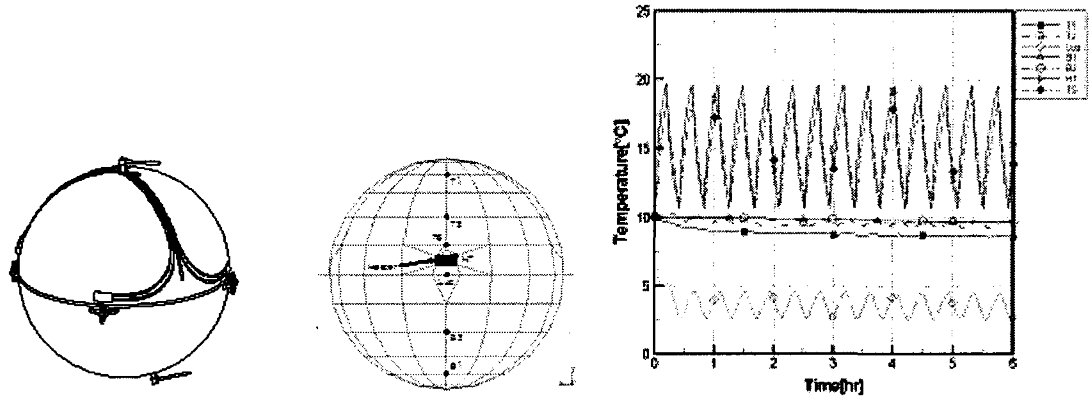

Fig. 2 Propellant tank module, its thermal model, and transient thermal response

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