Space Laboratory, Space Station and Space Exploration (2)
Space Laboratory, Space Station and Space Exploration (1)

Author: Dr. Wei Sun
Institute of Manned Space System Engineering, CAST, China, victs@163.com

Mr. Chuanfeng Wei
China, yangbiao228@gmail.com

MODELING AND SIMULATION ON KEY POCESSES OF PROPELLANT REFUELING FOR A SPACE STATION

Abstract

Propellant refueling is necessary for long-term operation of a Space Station. Although many kinds of propellant refueling methods for on-orbit spacecraft were put forward and tested, a method based on pressurized-gas pumping-back mechanism which both used in MIR and ISS Space Station is the most successful. In this method, the pressurized gas in a propellant tank is firstly pumped back to the gas-bottle to generate a low back-pressure in the propellant tank, then the tank is linked to another tank in the propellant-resupply craft and liquid propellant is refilled to the tank with the differential pressure between two propellant tanks. Finally, pressurized gas is released back to the propellant tank to resume its function from gas-bottle. In order to investigate the characteristic of the propellant refueling process, numerical models for a pumping-back course of pressurized gas and a refilling course of propellant tank is built, simulation results of which are compared with experimental data obtained in ground tests using pure water. It is found that pressure variation of propellant tank in the pumping-back course and the refilling course is similar to the isothermal process, and pressure variation of gas-bottle in the pumping-back course is similar to the polytropic process with a polytropic exponent of 1.1. Further simulation analysis is carried out with the developed model to investigate a typical propellant refueling process of a Space Station, result of which shows pressure-rising rate of a gas-bottle in pumping-back course is significantly influenced by heat dissipation of the gas-bottle, and propellant-refilling rate of a propellant-tank is influenced by the back pressure of the propellant-tank. It indicates that pressure parameter needs be well designed in the propellant refueling system of a Space Station.