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Author: Dr. Pengfei Guo
China Academy of Launch Vehicle Technology(CALT), China, gpfmail@gmail.com

Mrs. Qiaoyan Cai
China Academy of Launch Vehicle Technology (CALT), China, caiqy@sina100.com
Mr. Yuan Yuan
China, smthxbar@hotmail.com
Mrs. Haiqiong Yang
China, 79535582@qq.com

CONNECTION STRUCTURE DESIGN OF HANGING CRYOGENIC LIQUID PROPELLANTS TANK OF SPACE VEHICLE

Abstract

With the development of modern space transportation systems all over the world, the design of connection structure between the hanging cryogenic liquid propellants tank and vehicle body has become an significant problem in general layout of space vehicle. As new generation propellants fuel, the liquid hydrogen and oxygen have been widely applied in main propellant system of launch vehicle and space vehicle. However, the liquid hydrogen and oxygen are cryogenic propellant fuel, the liquid propellants tanks will be deformed and strained in the pre-cooling and filling proceeding. In order to conquer this problem, traditional launch vehicles apply entire liquid propellants tanks as the main structure of vehicle body, and they were connected with each other and other parts with transition sections. This kind of connection structure can limit the effects of cryogenic liquid propellants on the vehicle body. But the structure design of new generation of space vehicle demand to optimize general layout of vehicle structure and fully make use of the body space. Recently, the hanging tank has been widely studied and considered as a better general layout of the vehicle body comparing with traditional ways in launch vehicles. However, the cryogenic liquid propellants fuel will cause local stress and strain in connection structure, which can affect the assembling and fixing of fuel tanks. This paper is dedicated to the connection structure design of hanging cryogenic liquid propellants tank of space vehicle. Comparing with different kinds of connection structures, the effects of low temperature, flying load and supercharging pressure on propellant fuel tanks and connection structure are studied. Based on the results of strength analysis and modal analysis, general design principles of connection structure are provided according to the requirement of general layout of space vehicle. The most important innovation of this paper is to change the connection structure of liquid propellants fuel tank in traditional launch vehicle, which can greatly improve the design of general layout of space vehicle. The main research content of this paper focuses on the stress and strain of connection structure induced by cryogenic liquid propellants fuel and reveals the deformation relationship between fuel tanks and connection structure. The main objective is to provide a new connection structure for hanging cryogenic liquid propellants tank in space vehicle.