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Author: Dr. Binchao Li
Xi'an Aerospace Propulsion Institute, China, lbchmail@126.com

Mr. Huang Daoqiong
China, Huangtrue@126.com
Mrs. Feng Li
China, lfsd11@yahoo.com.cn

TRANSFER PATH ANALYSIS OF DYNAMIC LOADING FOR THE SECOND STAGE LIQUID ROCKET ENGINE

Abstract

Dynamic loading induced during liquid rocket engine working was one of the most important factors to influence the safety of the second stage liquid rocket engine. There were two important cases causing the dynamic loading after rocket launching. "Case I" was that the engine suffered random loading which were transferred from the external working engine, aero-dynamic force of rocket shell and shock loading while base engines were separating. All the three loading transferred to thrust chamber firstly, and then to the other parts such as pipes, turbo-pump, gas generator and so on throughout the connecting sections. In this paper, the vibration experiments for an entire second stage rocket engine had been completed to test the transferring ratios from the thrust chamber to the relative parts. Besides, finite element model of the engine was validated by the experimental measurements. "Case II" was that the engine suffered severe vibration environments while working. The environments were almost caused by three main loading sources which were thrust chamber, gas generator, and turbo-pump respectively. Because of the complex structures, the three loading sources could be transmitted to the objects in various paths. However, both the vibration contribution of the loading sources in frequency domain to the object and the chief path on which the loading was transmitted to the object depending must be found before analyzing dynamic load transferring behaviors for the engine. Thus, experiment system with three shakers was set up for transfer path analysis (TPA) of dynamic loading. The shakers which applied simultaneously with random loading were attached at the loading sources' position so that the acceleration response of the objects could be measured under the multi-sources exciting. In the end, the contribution of each loading source to the object response was investigated using the inverse-matrix method, and based on that, the main transfer path for the object response was discussed.