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A NUMERICAL OPTIMIZATION OF HIGH-ALTITUDE TEST FACILITY FOR UPPER STAGE ENGINES

Abstract

The Korean Aerospace Research Institute (KARI) successfully launched a three staged space launch vehicle, Nuri-ho, last year. The main engine of the Nuri-ho is an open cycle engine based on a gas-generator. In order to do the hot firing test of engines on the ground, several engine test facilities are built and operating in the Naro space center which is located in a southern place of the South Korea. The upper-staged engine of the Nuri-ho is the 7-ton class engine which has been tested under the vacuum condition in the high-altitude test facility. In order to simulate the vacuum condition, the supersonic diffuser was used to induce the self-pumping by the exhaust gas of the engine. The previous supersonic diffuser was designed with the normal shock method. Following the Korean space launch program, a new upper stage engine is developing to send a satellite into the moon orbit as the next generation engine. The engine has been designed based on the staged combustion cycle engine with a high area ratio nozzle. In this sense, the current ground test facility for the simulation of the high-altitude condition has to be modified to offer the vacuum condition related to the working condition of the new engine. The new engine has the high area ratio nozzle and works with the throttling. In this sense, the ground test facility needs to evacuate the air in the initial condition and the exhaust gas of the engine in the working condition with a high ratio. In other words, the ground test facility has to make the vacuum condition below the 90 mbar before the engine is ignited. This is because the engine has the high area ratio nozzle expansion and the end part of the nozzle uses the radiative cooling method. The combustion power of the engine is controlled by the throttling. The outlet of the supersonic diffuser must be thus a vacuum to keep the engine working while the combustion pressure comes down. An ejector system is designed and simulated to keep the vacuum condition of the test facility. In this paper, we would like to show the previous works of the current high-altitude test facility and CFD results of the next high-altitude test facility design.