Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: PROPHY / NEWSPA / REUSYS
Corresponding author: Oh-Sung Kwon
e-mail of corresponding author: oskwon@kari.re.kr
Type: Poster
Status of corresponding author: Regular
For student corresponding author:

Title
LOX recirculation characteristics of propellant feeding system with a filter installed at tank outlet

Authors
Oh-Sung Kwon [1], Joong-Youp Lee [2]*

** Corresponding author*
[1] Korea Aerospace Research Institute, 34133 DAEJEON, Korea, oskwon@kari.re.kr
[2] Korea Aerospace Research Institute, 34133 DAEJEON, Korea, leejy@kari.re.kr

Abstract
The propellant feeding system of the liquid propulsion rocket should maintain the temperature of the cryogenic propellant supplied to the engine within the engine requirements. The temperature of the cryogenic propellant rises due to heat input from the outside during standby after completion of filling. This can cause turbopump cavitation problems. If the temperature keeps rising, the propellant reaches saturation state and begins to evaporate and in severe cases, geysering may occur.

Methods for controlling the temperature of the cryogenic propellant include direct cooling the propellant by helium injection, draining the temperature increased propellant, and recirculating the propellant. The recirculation method prevents propellant temperature rise at the engine inlet by installing a recirculation pipe to form a loop composed of a propellant tank, a feeding pipe, and a recirculation pipe, and allowing the propellant to continuously flow through the loop. Helium could be injected at the bottom of the recirculation pipe to promote propellant recirculation.

This paper describes the results of the recirculation test conducted in a sub scale propellant feeding system test facility using liquid oxygen. The tank diameter is 1 m and a filter is installed at the tank outlet. The test was conducted in four phases: standby after filling with liquid oxygen, recirculation test under atmospheric pressure, propellant refilling, and recirculation test under pressurized condition. The evaporation of liquid oxygen in the feeding pipe during standby, liquid oxygen recirculation flowrate according to the amount of helium injection, and the effect of the propellant filling rate and pressurization of the tank on recirculation were examined.

Due to the filter installed at the tank outlet, gaseous oxygen evaporated during standby could not flow up into the tank and accumulated in the feeding pipe. The accumulated gaseous oxygen reduced the hydrostatic pressure in the feeding pipe, so natural recirculation did not occur. A large amount of helium injection was required to generate forced recirculation when the feeding pipe was filled with a lot of gaseous oxygen. When the propellant was rapidly filled, the liquid oxygen in the feeding pipe maintained a subcooled state due to the high tank ullage pressure, and recirculation naturally occurred. Even if there was a lot of gaseous oxygen in the feeding pipe, when the tank was pressurized, liquid oxygen rushed into the feeding pipe through the filter and gaseous oxygen condensed. Then, natural recirculation began by itself.