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DEVELOPMENT OF SUBCOOLED LIQUID OXYGEN SYSTEM FOR LIQUID ROCKET ENGINE

Abstract

After the successful launch of the Second Korea Space Launch Vehicle-II(KSLV-II, NURI), the development of a next-generation launch vehicle(KSLV-III) is being discussed. The KSLV-III is a launch vehicle with higher performance than the KSLV-II. The new launch vehicle will feature a first stage clustered of five 100-ton engines, and the second stage will be composed of two 10-ton engines. As propellants, kerosene and liquid oxygen are used as before. However, the KSLV-III will use densified propellant to improve launch vehicle performance.

In particular, Liquid oxygen (LOX) is a critical component in liquid rocket engines, offering high performance and efficiency. Subcooled liquid oxygen provides additional benefits by increasing its density and improving engine performance. This paper introduces the cryogenic liquid oxygen subcooled system designed for liquid rocket engines.

The primary objective of this study is to design and implement a reliable and efficient subcooled system capable of producing subcooled liquid oxygen suitable for use in liquid rocket engines on laboratory scale. Various methods for producing subcooled liquid oxygen were considered, and a pressure reduction method was selected as the most suitable approach for implementation in small-scale test facilities.

The developed subcooled system consists of several key components, including a circulation pump, heat exchanger, and vacuum pump system. In the operating sequence, liquid nitrogen is introduced into the heat exchanger, and the vacuum pump is operated to reduce the pressure in the ullage space. Liquid oxygen is then circulated through the coil inside the heat exchanger until the desired temperature is reached. When the liquid oxygen reaches the desired temperature, the supply pump and vacuum pump stop operating.

In the future, several experimental tests will be performed to evaluate the performance and efficiency of the subcooled system. By analyzing parameters such as cooling efficiency, pressure drop, and temperature control, system performance will be evaluated under various operating conditions, and a subcooled system will be developed to continuously produce subcooled liquid oxygen with high efficiency and reliability.

Additionally, we plan to conduct research on engine performance by conducting combustion tests using subcooled liquid oxygen. In conclusion, we built a laboratory-scale subcooled liquid oxygen test facility and performed several tests to confirm that the desired temperature was reached. In the future, we plan to secure high efficiency and reliability through additional tests, and determine the effect on engine performance through liquid rocket engine combustion tests.