THE MOVABLE ROCKET ENGINE TEST FACILITY FOR THE NEW SPACE METHALOX INITIATIVE OF KARI

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Abstract: Privately owned companies including SpaceX, Blue Origin, Virgin Orbit, Relativity Space, Firefly, Landspace, AVIO, PLD Space, Isar Space, RFA, Orbex, and many more across the world, as well as government funded institutes such as DLR, CALT, ISRO, and JAXA are trying to reinvent the liquid rocket technology as a game-changing enabler that would ultimately make access to space a common thing that is flexible and responsive with varieties of launch demand from fast-growing small satellites industry in the new space era[1]. In response to this global trend, Korea Aerospace Research Institute (hereinafter, KARI) initiated a preceding research project to secure key technologies for a methalox second stage of a small launch vehicle (hereinafter, KSLV-s) that is capable of lifting around 500 kg to 500 km Sun Synchronous Orbit. As the first stage can be reliably built with flight proven technology of the NURI, the preceding research is focused on developing a 3 tonf-class methalox rocket engine with a specific impulse (Isp) greater than or equal to 360 seconds in accordance with the engine performance requirement of the small launch vehicle.[2]

In this paper, an overview will be given of the engine development activity that uses liquid methane and liquid oxygen as propellants. Subsequently, a detailed description of a test facility capable of testing 1 tonf-class liquid methalox engine and thrust chamber will be presented, including specification, component and operational procedures of the movable test bed. The test facility was designed as a modular type that can be lifted and moved by general-purpose forklift and truck for the easy move and re-installation. The movable test bed was our solution to support the preceding research on the methane fueled liquid rocket engine and additively manufactured thrust chamber because methane supply system was unavailable in 2020 on KARI campus and future installation was undecided.

The test bed is only operable when it is connected to the existing firing test facility(model rocket engine test facility, mRETF), which has been used for various rocket engine thrust chambers' elementary research, for developing and qualifying the gas generator of the 7 tonf-class kerosene engine for the NURI launch vehicle, has a heritage of performing more than 1,000 hot firing tests using kerosene and liquid oxygen for nearly twenty years after large changes in supplying pressure and capacity in 2003. From the existing test facility, our test bed is supplied with high pressure nitrogen gas, electric power, fire protection water for ambient cooling, and test site monitoring system. The test bed itself is composed of two high-pressure propellant tanks, solenoid valves, various sensors (mainly pressure, temperature, and flowrate), and pipes. And it also has the data acquisition system and facility control system which are composed with the National Instrument's Compact RIO platform and its individual module. The movable test bed was built in six months and connected to the mRETF in September of 2020. Upon its installation, commissioning tests of the bed itself were conducted until February of 2021, including flushing, wiring, leak proof, sensor calibration, and liquid flow tests. Starting in April of 2021, more than 50 tests including cold flow and hot-firing ones have been conducted on three different types of additively manufactured, methalox thrust chambers. While more tests are still in que, a relocation plan to move our test facility for future use is being discussed.

References:
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