Paper ID: 50156
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (1) (3)

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HOT-FIRE TEST OF THE ETID SANDWICH NOZZLE EXTENSION FOR FUTURE UPPER STAGE ENGINE APPLICATIONS

Abstract

The ETID – Expander Technology Integrated Demonstrator – Nozzle Extension builds on GKN's patented manufacturing method for actively cooled nozzle extensions, i.e. the so-called "Sandwich" laser welded channel wall technology. This sandwich wall technology has matured over almost two decades of continuous improvement and it shows clear customer benefit in liquid rocket propulsion applications. The program concluded a successful hot-fire test campaign in the first quarter of 2019 at DLR's P3.2 test facility in close collaboration with Ariane Group, Ottobrunn. The program covered over 20 hot cycles corresponding to 2500 seconds of run-time. Throughout the campaign, the regenerative sandwich part of the nozzle remained unchanged, whereas two different sheet metal skirts were tested. The target was to accumulate as much run-time as possible for the regenerative part in order to build knowledge on life, aging and stability aspects. After successful completion of the test campaign, the ETID NE technology is ready to target future upper stage flight applications. This paper describes overall test objectives for the nozzle extension and findings in test data and post-test inspections. In recent years, the GKN Aerospace Sandwich nozzle technology has featured in a number of demonstrators in collaboration with several customers to demonstrate its technological maturity as well as cost benefits for 1st- and 2nd-stage rocket engine configurations, such as gas generator, expander and staged combustion engine cycles. Together with Ariane Group two demonstration tests were performed in 2010; i.e. the sub-scale SCENE hardware (IAC-11.C4.3.7), and the full-scale test of Vulcain 2+ NE demonstrator (AAAF 2014 SP2014 2968456), which thereby reached TRL5 and TRL6 for those specific materials and applications. These successes formed the foundation to selecting the sandwich technology in today's nozzle designs for the upper stage demonstrator ETID in the ESA FLPP program, as well as for the Vulcan 2.1 engine (AAAF 2018 SP2018 00048) for the Ariane 6 launcher.