

SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3)

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SCENE SUB-SCALE NOZZLE DEVELOPMENT AND TESTING

Abstract

Volvo Aero is the center of excellence for rocket engine nozzles within the launcher community in Europe. Within the ESA directed FLPP program, a High Trust Engine (HTE) which uses the stage combustion cycle is being developed with a demonstrator engine scheduled for testing in 2015. The HTE demonstrator has a thrust at the 140 ton level and represents a significant technology step beyond the present Vulcain 2 engine. The HTE demonstrator nozzle will be regeneratively cooled at a pressure level which is much higher than the dump cooled Vulcain 2 nozzle. In order to prepare the technologies needed for the HTE demonstrator nozzle, a sub-scale nozzle has been developed. This SCENE nozzle (Stage Combustion Engine Nozzle Extension) will be hot gas tested at the P8 test rig at DLR in Lampoldshausen, Germany, in the spring of 2010. This paper presents an overview of the design, manufacturing and testing of the SCENE nozzle. A specific customer requirement has been the capability to test the SCENE nozzle with either hydrogen or methane as coolant, and this is reflected in the cooling circuit layout. The main test objective has been to provide validation data for the aero/thermal design tools that will be used for the HTE demonstrator nozzle design. The SCENE coolant conditions and the nozzle wall material temperatures on both hot gas side and ambient side will be measured and compared to pre-test predictions. Tuning of the design methods will be performed where necessary. The SCENE nozzle will utilize the same sandwich technology that was recently tested on the Vulcain 2+ demonstrator nozzle on a Vulcain 2 engine with excellent results. The sandwich technology on the SCENE nozzle has been tailored to the needs of the higher coolant pressure, i.e. with material choice and cooling channel sizing. Laser welding of the cooling jacket has been performed by FORCE, Denmark. Also the metal deposition of the structural jacket on the outside of the cooling jacket was made by FORCE. The test plan will be elaborated and main results and conclusions from the SCENE nozzle testing presented. As the nozzle is pressure fed in the P8 rig test times are shorter compared to engine level testing but the rapid thermal response of the hot side wall yields good similarity between a cooling channel on the SCENE sub-scale nozzle and full-scale nozzles at engine level.