IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (1) (1)

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DEVELOPING A ROADMAP FOR THE POST-PROCESSING OF ADDITIVELY MANUFACTURED AEROSPIKE ENGINES

Abstract

In this contribution the results of a hot-fire test campaign using a 500 N truncated annular aerospike engine are discussed as well as the planned investigations based on them. The in the test campaign established aerospike serves as a proof of concept for the additive manufacturing of such an engine by the means of laser powder bed fusion (L-BPF). Manufacturing, thermal treatment as well as mechanical post processing was conducted by the Fraunhofer Institute for Material and Beam Technology (IWS). The aspired advantages of this manufacturing method opposed to conventional methods are a reduction of assembly parts leading to fewer machining interfaces and reduced assembly expenditure as well as the functional integration of complex internal cooling channel geometries into both the chamber wall and the central spike to ensure a better heat dissipation. Furthermore, the aerospike engine serves as baseline for the later implementation of a secondary injection located on the surface of the divergent, supersonic nozzle part of the central spike to perform thrust vectoring. This fluidic thrust vector control is an

important field of research at the Institute of Aerospace Engineering (ILR) of the Technische Universität Dresden. The Hot-fire tests using this bi-liquid propelled engine without thrust vector control (TVC) have been conducted at the ILRs own engine test bench. The results show a significant deviation from the designed thrust level of 500 N. Moreover, combustion instabilities have been observed and studied. These instabilities can mainly be traced back to the injector design and the corresponding high pressure losses at the inlets. As a result, a new project called CFDμSAT (funded by the German Federal Ministry for Education and Research) is now initiated, which is focused on the revision of the previous engine design and particularly the injector element orifices with regard to additive manufacturing and finishing of the hydraulically relevant surfaces. To achieve better results during the post-processing of the printed parts, more advanced methods such as abrasive flow machining (AFM) or laser beam drilling will be utilized. The first short-term objective of the project is the examination of test specimens to identify decisive geometric parameters of additive manufactured injectors regarding optimized flow behaviour. Subsequently these findings will then be used for the design and manufacture of a revised aerospike engine, whose performance will be investigated in a further test campaign.