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IDENTIFICATION AND MATURATION OF TECHNOLOGIES FOR FUTURE LIQUID PROPELLANT ENGINES

Abstract

While preparing the first launch of the new Ariane 6, ArianeGroup is performing several long-term research and technology projects to continuously prepare the implementation of innovative technologies for future liquid rocket engines. For the German chapter, AGG, the RT programme TARES 2020, which is dedicated to increase the technology readiness level of promising technologies to a level of TRL = 3-5 for later application on launcher engines, is supported by the German Space Agency DLR by a federal grant. Within the four-year programme, which runs from 2017 until 2020, different fields of liquid propulsion systems are addressed, such as cryogenic valves, ignition systems, gas generators and thrust chamber assemblies. This publication gives an overview on the main fields of activities.

For cryogenic valves, a cooperation with the Institute for Applied Mechanics of the Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen has been initiated to perform basic research and numerical model development to be able to predict material behaviour and mechanical properties of polymeric seal materials from room temperature down to cryogenic operating conditions.

In the fields of ignition systems, several potential technologies are being investigated with respect to their applicability for different propellant and injector configurations. For example, the transfer of the already successfully tested laser ignition system to hydrocarbon fuels is being prepared. The results contribute to a comprehensive data base which allows for a sound assessment of the ignition systems for future engines.

For gas generators and thrust chamber assemblies, activities focus on developing tools and competencies required to provide cost-effective solutions for liquid propulsion systems. In the field of manufacturing processes and materials, the know-how on additive manufacturing has been applied to swirl injector configurations. In parallel, extensive process simulation activities are being performed to better understand how the design and manufacturing process affect the material properties and the surface quality of additively manufactured components. A research cooperation with the Institute for Material Sciences of the Friedrich Alexander Universität in Erlangen provides detailed information on the micro structure of different alloys and on damage and fatigue mechanisms of these materials.

CFD tools are being upgraded to master specific requirements of hydrocarbon propulsion systems. Due to the specific fluid properties of e.g. methane and due to the various operating conditions to be considered for future liquid propulsion systems, the so called heat transfer deterioration in the coolant circuit needs to be mastered as well as potential two-phase flow phenomena.