Design and CFD analysis of the LOX/LCH4 dual regenerative cooling circuit of the DemoP1 Demonstrator

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Abstract:

Aerospike engines have always been of interest because of their altitude adaptation properties leading to higher performances compared to equivalent classical bell nozzles. Regardless, because of their dimensions and configuration, aerospike engines experience a higher integral heat flux, especially at the throat. Cooling this type of engine becomes a real challenge. This is one of the main reasons for the lack of research and industrialization since the aerospike concept first appeared in the 50s. However, because of the recent development of novel manufacturing techniques, such as additive manufacturing, aerospike engines are experiencing a renewed interest. The flexibility of additive manufacturing allows the cooling channels circuit design to reach a new level of freedom. Moreover, the LOX/LCH4 regenerative cooling system is expected to affect positively the engine development improving reusability and reducing toxic substances in the plume.

This study documents the research, design, and CFD analysis of the regenerative cooling system for the DemoP1 demonstrator developed by Pangea Aerospace. DemoP1 is the first aerospike engine fully additively manufactured using copper alloys and including a dual regenerative cooling circuit. The CFD analysis has been performed with the commercial software ANSYS Fluent. Finally, the challenge of numerically simulating both the trans-critical coolant and the high roughness environment will be discussed.