NASA SBIR/STTR Technologies

H2.02-8607 - Low-Cost Manufacturing Technique for Advanced Regenerative Cooling for In-Space Cryogenic Engines

PI: Thomas Haymond

Analytical Services, Inc. (ASI) - Huntsville, AL

Identification and Significance of Innovation

The goal of the proposed effort is to use selective laser melting (SLM, an additive manufacturing technique) to manufacture a hot fire-capable, water-cooled spool piece that features an advanced regenerative cooling technique that combines high heat flux performance with low pressure drop. SLM enables us to "print" the spool piece in days, despite the complexity of the regenerative liner's inherent flow passage complexity. This reduction in manufacturing lead time, combined with the fact that SLM manufacturing costs are driven in large part by the amount of raw powder used during fabrication, results in a substantial cost reduction for future regeneratively-cooled rocket engines. Additionally, the proposed advanced regenerative cooling approach features a heat-pickup efficiency that is at least two orders of magnitude higher than traditional milled channel liners and/or brazed tube bundle chambers.



Estimated TRL at beginning and end of contract: (Begin: 3 End: 6)

Technical Objectives and Work Plan

The primary objective of our Phase II project is to analyze, design, and fabricate a water-cooled throat spool piece sized for the GRC 2,000-lbf thrust stand. The intent is to deliver that spool piece to our Phase II technical point of contact (TPOC) during the final month of our project, so that it can undergo hot fire testing using funding from a related, but non-SBIR, effort. To insure our objective has low technical risk, Aerojet Rocketdyne will fabricate the spool piece (of our design) in their SLM machine using C18200, a Cu-Cr alloy that they have abundant experience using. We have identified two interim objectives that reduce technical risk even further and to aid our commercialization goal: 1) develop and demonstrate the SLM processing parameters for a relevant copper-based alloy, and 2) to determine the optimum approach for our advanced cooling scheme using a combined experimental and numerical analysis effort.
Task 1: SLM Manufacturing Trials
Task 2: Labscale Testing and CFD Modeling of Cooling Scheme
Task 3: Liner Simulator Design, Fabrication, and Test
Task 4: Design and Manufacture Hot Fire-Capable Spool Piece
Task 5: Full Scale Combustion Chamber Design

NASA Applications

Affordable Upper Stage Engine Program
Altair Ascent and Descent Engines
RL-25

Non-NASA Applications

Long Range Missile Defense Target Engine
Tactical Nano-Sat Lanuch Vehicle

Firm Contacts

Joseph D. Sims, Ph.D.
Analytical Services, Inc. (ASI)
350 Voyager Way
Huntsville, AL, 35806-3200
PHONE: (256) 562-2100
FAX: (256) 562-2000

NON-PROPRIETARY DATA