Paper ID: 52824
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3) (10)

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EVALUATION OF ADDITIVELY MANUFACTURED LIQUID ROCKET ENGINE COOLING CHANNELS

Abstract

Optimal liquid rocket engine cooling channels balance the heat transfer, pressure drop and carbon depositing characteristics, which are all functions of surface roughness. It is known that additive manufacturing increases the surface roughness of the material. The effect of this surface roughness increase has been investigated in cooling channels under representative liquid rocket engine conditions. These characteristics were evaluated in Inconel 718 and GRCop-84 using traditional manufacturing methods and additively manufactured cooling channels. Two fuels were used; a low and high carbon depositing fuel to highlight deposition propensity. Additionally, advanced concept cooling channels were designed, additively manufactured, and tested.

Due to the size of the cooling channels, changes in the surface roughness dramatically effect flow characteristics. Methods in the book Heat Transfer and Fluid Flow in Minichannels and Microchannels by Kandlikar et al. we're employed to calculate surface roughness and friction factor that are analogous to the values used in the moody diagram in classical fluid mechanics. Optical profilometry was employed to obtain surface height data, and a custom script calculated the surface roughness. Surface roughness in terms of flow characteristics were found to be not equivalent to the traditional Ra value of materials, but agreed with the mathematical methods by Kandlikar et al.