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BLOCKAGE REMOVAL AND REQUALIFICATION OF A REGENERATIVELY COOLED, ADDITIVELY MANUFACTURED ROCKET ENGINE

Abstract

Regenerative cooling channels are prominent features in the design of liquid rocket engines due to their ability to improve efficiency and thrust. These small, complex features benefit from the recent advancements in additive manufacturing technology, allowing for more intricate and precise designs. However, as the cooling channels geometry increases in complexity and decreases in dimension, they become more susceptible to obstructions, especially in additive manufacturing technologies that are prone to residual particles. Concerns of blockage are compounded by the fact that inspecting numerous miniscule channels is a difficult process requiring tools that are out of the scope of many collegiate rocket teams. The inspection and removal of residual particles is a project that the Liquid Propulsion Laboratory (LPL) at the University of Southern California (USC) has researched in the past in order to determine the best way to prevent blockages forming from remaining Inconel particles in an additively manufactured rocket engine. Now, LPL at USC is furthering this research by attempting to remove Inconel particles that have already caused blockages in one or more cooling channels. This research was initially prompted by the inability to flow deionized water through the regenerative cooling channels of the Balerion engine during fuel flow path qualifications. Preliminary investigations led to the hypotheses that a build up of Inconel particles has caused an obstruction inside the regenerative cooling channels of the narrowest section of the engine nozzle. It is also believed that improper storage after previous qualification tests of the engine exacerbated the blockage. The testing process consists of heating the engine to dry trapped moisture and break up coagulated particles, dry sonication of the engine to dislodge the particles from sections of dead geometry, and pulse purging using gaseous nitrogen in the reverse flow direction. This test will be validated by flowing deionized water and recording the pressure drop through the channels after removing the blockage and comparing to the pressure drop recorded during the problematic qualification tests. Detailed here is the investigation, procedure design, testing campaign and evaluation of the blockage removal campaign.