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ANALYSIS OF AN ADDITIVE MANUFACTURED LIQUID ROCKET ENGINE

Abstract

This paper highlights the process of designing a 4kN Liquid Oxygen and Isopropyl (LOX/IPA) engine leveraging additive manufacturing. The trade-offs of mechanical and thermal properties, machinability, cost, and performance were compared in the selection of material and engine design. This paper builds on a capstone project to design and print a 2kN engine.

Portland State Aerospace Society (PSAS) has entered into the Base 11 Space Challenge and requires a capable flight-ready engine to achieve the challenge's goal of reaching 100 km. The work completed in this report is a step towards completing that goal.

The current engine being tested, a regeneratively-cooled 2kN, is parametrically designed and is intended as a research engine. Several 2kN sized engines were sintered in AlSi10Mg powder, and the print was verified via CT scanning. Internal wall defects and part tolerances from the CT analysis are presented in this paper. After the engine was verified, the part is machined to remove support material and open up features. The current cleaning and machining steps undertaken are recorded in this paper.

Moving from the 2kN engine onto the 4kN required a re-evaluation of the design and material choices. To improve manufacturing and tolerance, changes were made to the baked-in engine features. Structural models and thermal analysis of the larger engine was compared to the previous design. Scaling the design to a larger engine will thicken the walls, preventing failure in observed defects and improving the engine features.