Revolutionizing Rocket Propulsion: Development of a 3D-Printed Regeneratively Cooled Aerospike Nozzle for Extended Burn Propulsion

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The aerospike rocket engine, developed in the late 1960s, was designed to address a significant limitation of traditional bell rocket engines: inefficient exhaust gas expansion across varying altitudes. Unlike bell engines, which are only optimally efficient at a specific altitude, the aerospike engine maintains consistent efficiency by utilizing atmospheric pressure to shape its exhaust flow. Despite its theoretical advantages, aerospike engines were historically impractical due to challenges related to weight and cooling. The heavy spike and the complexity of cooling its internal structure negated the engine's efficiency gains and hindered its widespread adoption. Recent advancements in additive manufacturing of high-temperature alloys, like Ti64, have enabled the creation of intricate cooling channels within aerospike engines with laser-based 3d printing techniques. Metal 3D printing minimizes material waste and lowers the cost of innovation compared to traditional CNC milling or casting, making it an attractive solution for manufacturing lightweight, high-performance rocket engines. This project aims to leverage these technological advancements to design and fabricate a small-scale aerospike rocket engine with regenerative cooling channels. The process involves simulating a nozzle design and printing it in a high-temperature and strength resin to validate it with real-world testing. The prototype will be tested at a custom-built rocket bed at TRIPOLI Houston's Rocket Launch Site. The project aims to demonstrate the feasibility of a novel regenerative cooling solution for aerospike engines optimized for extended-duration applications such as deep space propulsion and reusable SSTO (single stage to orbit) satellite-bearing rockets.

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