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# A NOVEL APPROACH FOR THE DESIGN AND MANUFACTURE OF AN OPTIMIZED CATALYST BED FOR HYDROGEN PEROXIDE

**Abstract**

High-purity hydrogen peroxide (HTP) is a promising monopropellant or oxidizer for rocket engines for small satellites to large thrusters applications. Recently HTP has regained the researcher's attention since it is a green propellant, non-toxic and storable. Materials development has enabled long-term storage of HTP, making it suitable for small satellite manoeuvring systems and planetary landers. The performance of the catalyst bed for the decomposition of HTP is a key factor for the good operation of both monopropellants and bi-propellants systems. Efforts are being conducted to develop more efficient and lighter designs, with the capability to withstand several on/off cycles, good cold-start performance and adequate operating lifetime. Monolithic catalyst beds offer various advantages, such as compact design and, flow stability, when compared to other types of beds, like pellets or metallic meshes. However, the manufacturing process of those monoliths can be complex and time-consuming, involving wash-coat procedures, coating and activation of catalyst phase and thermal treatments. Additive Manufacturing(AM) technology enables design freedom capabilities to project complex monoliths with high specific surface area, controlled flow channels and reduced pressure drop. The laser powder bed fusion (L-PBF) process can produce a metallic catalyst bed with desired surface roughness, eliminating the need for wash-coating procedures and coating. Deploying a combination of AM and recently developed algorithmic engineering software enabled the designing and manufacturing of complex and organically shaped monoliths. A model was developed to create the monolith's geometry according to the system's requirements. Various geometries were printed using L-PBF process and tested using HTP to evaluate the catalyst's performance. This work describes the approaches used in the algorithmic engineering model, the AM process details and the characterization of the produced catalyst beds. The novel designs were also tested to evaluate the decomposition efficiency using high-speed camera monitoring and high-speed infrared thermal imaging. The proposed design approach can allow the production of a catalyst bed with potentially high bed loading, compact and with long operational life.