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PRELIMINARY DESIGN OF A THROTTLEABLE HYBRID ROCKET ENGINE USING THE A-SOFT PRINCIPLE

Abstract

Throttling hybrid rocket engines by changing the oxidizer mass flow is a key advantage of hybrid propulsion compared to solid propulsion. However, changing the oxidizer mass flow usually affects the mixture ratio, which can reduce the engine overall performance.

Therefore, engines with two separate oxidizer mass flow feed systems are used to control the thrust and mixture ratio independently. One approach is to inject an axial and a radial mass flow. This is also referred to as an Altering-Intensity Swirling-Flow-Type (A-SOFT) design. The radial mass flow mainly affects the regression rate and the fuel mass flow due to the introduced swirl, while the axial mass flow mainly adjusts the mixture ratio. It is clear that both mass flows simultaneously influence the thrust and the mixture ratio. To investigate the interactions of the mass flows further studies and experiments are needed.

In this study, an engine suitable for the hybrid rocket test bench at the DLR site Trauen, Germany is designed. Its transient throttling capabilities based on the A-SOFT principle are investigated theoretically. The engine uses hydrogen peroxide as oxidizer and hydroxyl-terminated polybutadiene as fuel. A catalyst chamber is used to decompose the hydrogen peroxide. The chamber is described in detail in a separate study.

The design of the engine and the fluid system is shown. The throttling capabilities are investigated by preliminary design methods. Based on these calculations, throttling experiments are proposed for the upcoming test campaigns.