



TFAWS2025-CRYO-II-01

Computational Fluid Dynamics Analysis of LOX-Methane Mixing within Confined Cylindrical Volume

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Abstract

A computational fluids dynamics (CFD) analysis of liquid Oxygen (LOX) and liquid Methane mixing within a confined volume is discussed. This work is conducted in support of a subscale test series designed to assess the mixture dynamics of these cryogenic fluids within a confined cylindrical space following the removal of a common bulkhead which initially separates the fluids. LOX and Methane are miscible with each other and will combine to form a homogenous liquid solution known as MOX. The analysis is designed to predict the behavior of the fluids as they combine to form MOX. The analyzed configuration includes a constant total mass, a specified proportion of LOX to liquid Methane, specified ullage pressures, and specified initial temperatures.

This topic is relevant considering the increased number of launch vehicles employing LOX-Methane propellants in the near future. While much work is currently being performed in industry to predict the mixture dynamics of LOX-Methane as it pertains to the potential explosive yield, this presentation will not address predicted values of explosive yield. While this analysis can support that effort, the primary outputs of the presented analysis are the mass of MOX formed and the associated mixture ratios as functions of time. This presentation will discuss analysis methodology including mesh topology, physics models employed, challenges encountered, and lessons learned. The analysis is performed using STAR-CCM+.

At present, the results of subscale tests are not available. The test data will be analyzed and utilized to update the simulation for improved predictions. If test data becomes available before the occurrence of TFAWS 2025, comparison to the test data will be included in the presentation.