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C3Or2A-04: Benchmark performance metrics of a vane propellant management device for a 0.15 m3 liquid hydrogen tank

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The use of cryogenic propellants has and will continue to play an integral role in manned-space exploration due to the high specific impulses offered and its ubiquity in space through in-situ resource utilization. But guaranteeing vapor-free transfer of such low-surface tension liquids is difficult for traditional capillary-action propellant management devices (PMDs). Screen-channel liquid acquisition devices and compliant origami bladders are potential solutions, but to quantify the benefits these technologies offer, this study presents a cast study analyzing the performance metrics of an orthodox vane PMD as a benchmark for comparison. A 0.15 m3 liquid hydrogen tank at 20.3 K and 103 kPa was selected for study. Then assuming no body forces and no heat transfer (for simplicity), a steady-state 1-D differential equation was numerically solved in tandem with two possible wetted area configurations to yield an expulsion efficiency for a given inputted expulsion flow rate. Additional inputs, including vane height and vane number, were parametrically varied between 1 – 10 cm and 4 –8 vanes, respectively. Future work will determine expulsion efficiencies achieved from maximum expulsion flow rates constrained by choked flow.

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