Actively Sealed Cryogenic Coupler

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Objective

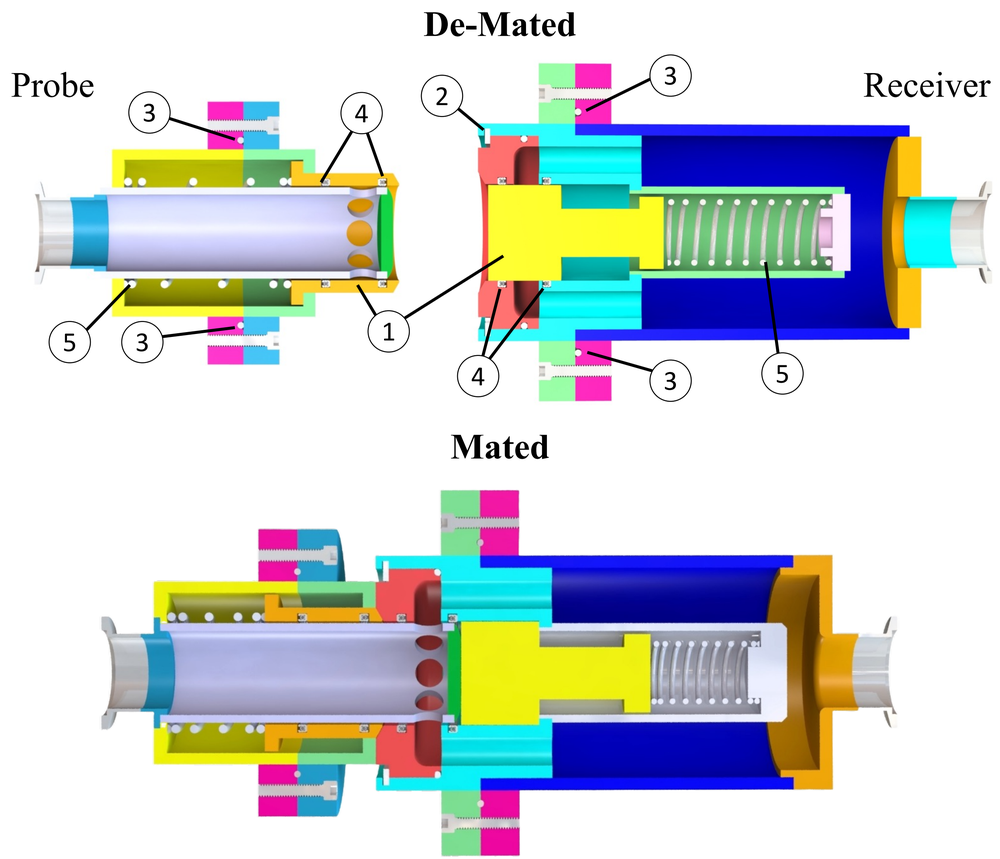
To design, build, and test an actively sealed coupler that prevents the leakage of cryogenic fuel during the transfer from depot to vessel.

Background

Cryogenic fluids (liquid hydrogen/liquid oxygen) are used in deep space missions to fuel space vessels. Fuel transfer between a lunar fuel depot and space vessel is regulated by couplers. A good coupler design limits the fuel leakage and allows for extended duration of deep space missions.

Key Goals

- Protect from contamination and heat
- Survive a 90-day lunar mission
- Minimize leakage



Targets and Testing

Testing was conducted to analyze the thermal properties of the system and the coupler's ability to retain fuel in the desired conditions. The fuel was to be maintained at or below 80 Kelvin. Internal (de-mated) and external leakage were targeted to be maintained at ≤ 500 and ≤ 50 standard cubic inches per minute of LN_2 respectively.

Future Work

- Implementing Spray-On Foam Insulation (SOFI)
- Liquid hydrogen/oxygen flow test
- Reduce overall mass
- Evaluate insulation performance through heat transfer testing

Components

With force-held contact, the probe and receiver springs compress, the flow channels align, and fuel can flow from the depot to the spacecraft. When de-mated, the springs decompress and block the flow channels. Static and spring-energized O-rings prevent internal and external leakage.

Double-Poppet Valve	Force-Held Lock	Sealing	Materials	Springs
(1) Dual spring-loaded actuators (2) Actuator retaining clip	Connection facilitated by the spacecraft pilot	(3) Static O-rings (4) Spring-energized O-rings	304 stainless steel and Teflon (PTFE)	(5) Stainless steel springs for use in low temperatures