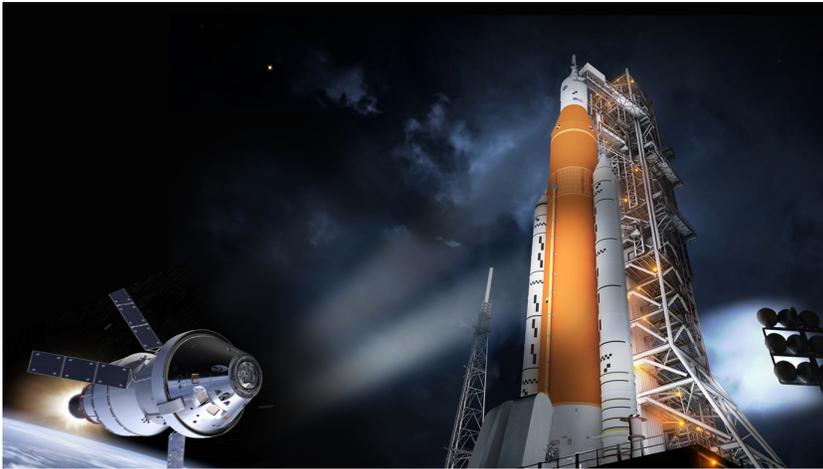




TECHNOLOGY SOLUTION

Mechanical and Fluid Systems



Self-aligning Poppet

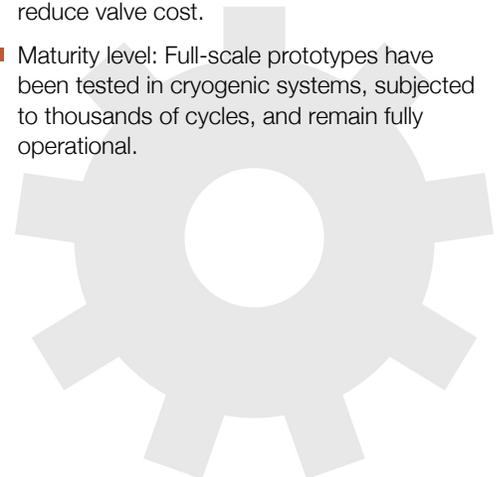
Reduce valve leakage by three orders of magnitude

As NASA plans for manned missions to Mars, efforts are being made to identify technologies that must be improved to make such trips feasible. Valves have been identified as one technology in need of improvement – on the voyage to Mars, propellants and other stored materials will leak through seals in the lines, tanks, and valves. For example, traditional valve technologies are projected to result in a loss of 17 tons of hydrogen during a 6-year manned trip to Mars. Thus, to make a Mars mission (or other long duration manned space missions) feasible, cryogenic valve leakage rates must be reduced by several orders of magnitude.

After identifying this need, engineers at NASA's Marshall Space Flight Center set out to develop a solution. The result is NASA's self-aligning poppet for low leakage valves – a seat alignment technology that eliminates the need to precisely control interfaces between poppet sealing surfaces and the valve seat seal. Instead, the seat and poppet self-align, ensuring the poppet is always centered, parallel to the seat, and perpendicular to the actuator line of action. Testing has shown that NASA's self-aligning poppet reduces leakage in aerospace cryogenic valves by three orders of magnitude.

BENEFITS

- **Low leakage:** Testing has shown that NASA's self-aligning poppet reduces valve leakage rates by ~3 orders of magnitude relative to conventional aerospace cryogenic valves, resulting in near-zero (~1 SCIM) leakage.
- **Reduced size, weight, and power:** The self-aligning poppet greatly reduces the energy required to make a tight seal, which decreases actuator size, weight, and power.
- **Scalable:** NASA's poppet has been incorporated into valves with 1" to 8" line sizes. However, the invention could be scaled down to line sizes under 1" for applications requiring smaller valves.
- **Potentially reduces valve cost:** While NASA's self-aligning poppet is slightly more complex than conventional poppets, the self-aligning feature greatly relaxes required tolerances for the valve system, which may significantly reduce valve cost.
- **Maturity level:** Full-scale prototypes have been tested in cryogenic systems, subjected to thousands of cycles, and remain fully operational.

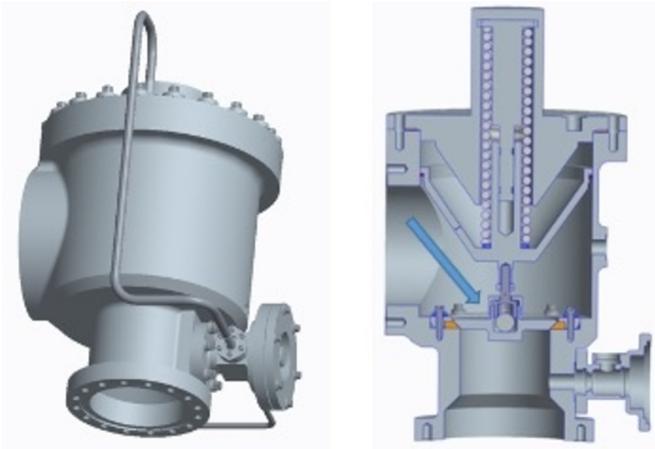


THE TECHNOLOGY

Without improvements in valve technologies, propellant and commodity losses will likely make long-duration space missions (e.g., to Mars) infeasible. Cryogenic valve leakage is often a result of misalignment and the seat seal not being perpendicular relative to the poppet. Conventional valve designs attempt to control alignment through tight tolerances across several mechanical interfaces, bolted or welded joints, machined part surfaces, etc. However, because such tight tolerances are difficult to maintain, leakage remains an issue.

Traditional poppets are not self-aligning, and thus require large forces to “crush” the poppet and seat together in order to overcome misalignment and create a tight seal. In contrast, NASA’s poppet valve self-aligns the poppet to the valve seat to minimize leakage. Once the poppet and seat are precisely self-aligned, careful seat crush is provided. Owing to this unique design, the invention substantially reduces the energy required to make a tight seal – reducing size, weight, and power requirements relative to traditional valves. Testing at MSFC showed that NASA’s poppet reduces leakage rates of traditional aerospace cryogenic valves (~1000 SCIM) by three orders of magnitude, resulting in leakage rates suitable for long-duration space missions (~1 SCIM).

NASA’s self-aligning poppet was originally targeted for aerospace cryogenic valve systems, especially for long-duration manned space missions – making the invention an attractive solution for aerospace valve vendors. The invention may also find use in the petrochemical or other industries that require sealing to prevent critical or hazardous chemicals from leaking into the environment. Generally, the invention may be suitable for any application requiring low-leak and/or long duration storage of expensive or limited resource commodities (e.g., cryogenic gases, natural gas, nuclear engines, etc).



Renderings of a 3" low leakage relief valve using NASA's self-aligning poppet technology. The arrow in the cross-sectional view (right) marks the poppet head.

More Information

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APPLICATIONS

The technology has several potential applications:

- Aerospace cryogenic valves
- Cryogenic valves
- Petrochemical valves
- Plug-type valves (e.g., globe valves)

PUBLICATIONS

Patent No: 11,873,915

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