THERMOSPRING – Thermal Exchange Reduction Mechanism Using Optimized SPRING

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Introduction

The **THERMOSPRING** system targets the <u>advanced structural support category</u>. It uses the transition from a high gravity environment [Earth] to a low gravity environment [moon] to its advantage.

HOW?
The THERMOSPRING, initially compressed in high gravity environments, is allowed to expand in low gravity environments such as space or on the moon by weight differences on the spring in low vs high g environments..

The **THERMOSPRING** is a multi-spring mechanical system that **allows**:

- **REDUCTION OF HEAT TRANSFER**
  - By forcing heat to travel through a long path that is the wire of the spring.
- **REDUCTION OF CONDUCTIVE HEAT TRANSFER**
  - By separating contacts of inner cylinder surfaces in low gravity/vacuum environments
- **EASY IMPLENTATION**
  - By having a simple mechanism that is not complex and nearly fully mechanical

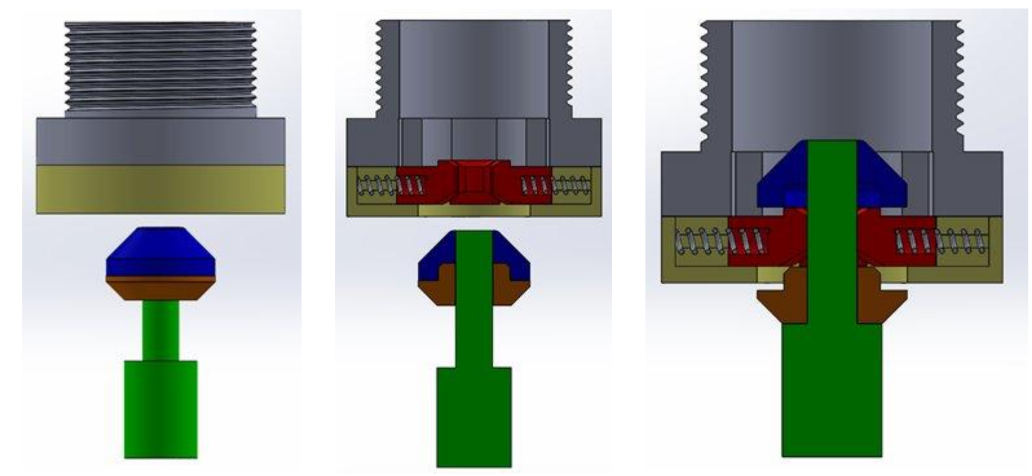
Methodology

The THERMOSPRING system is made of:

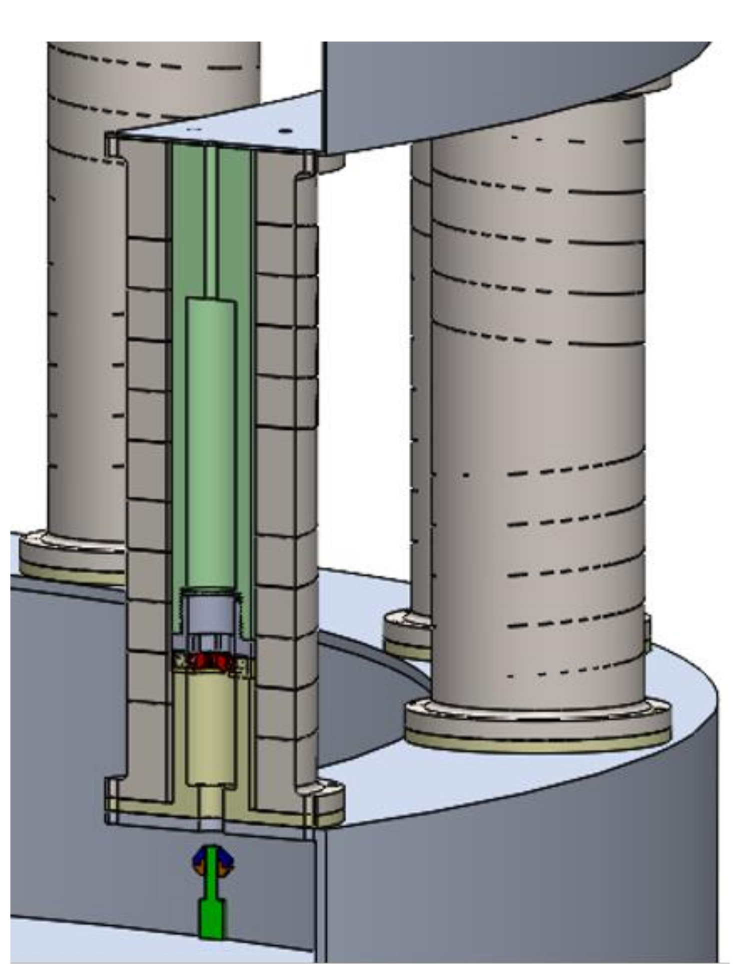
- 14 springs
- 2 concentric cylinders within each spring [28 total]
- 14 Push-Push Lock mechanisms
- 28 screws

<u>Concentric Cylinders:</u>
These cylinders encase one another inside the spring when the spring is compressed. One cylinder is attached to the top of the spring while the other is attached to the bottom. When expanded, the cylinders are separated, and it eliminates conductive heat transfer through the cylinders.

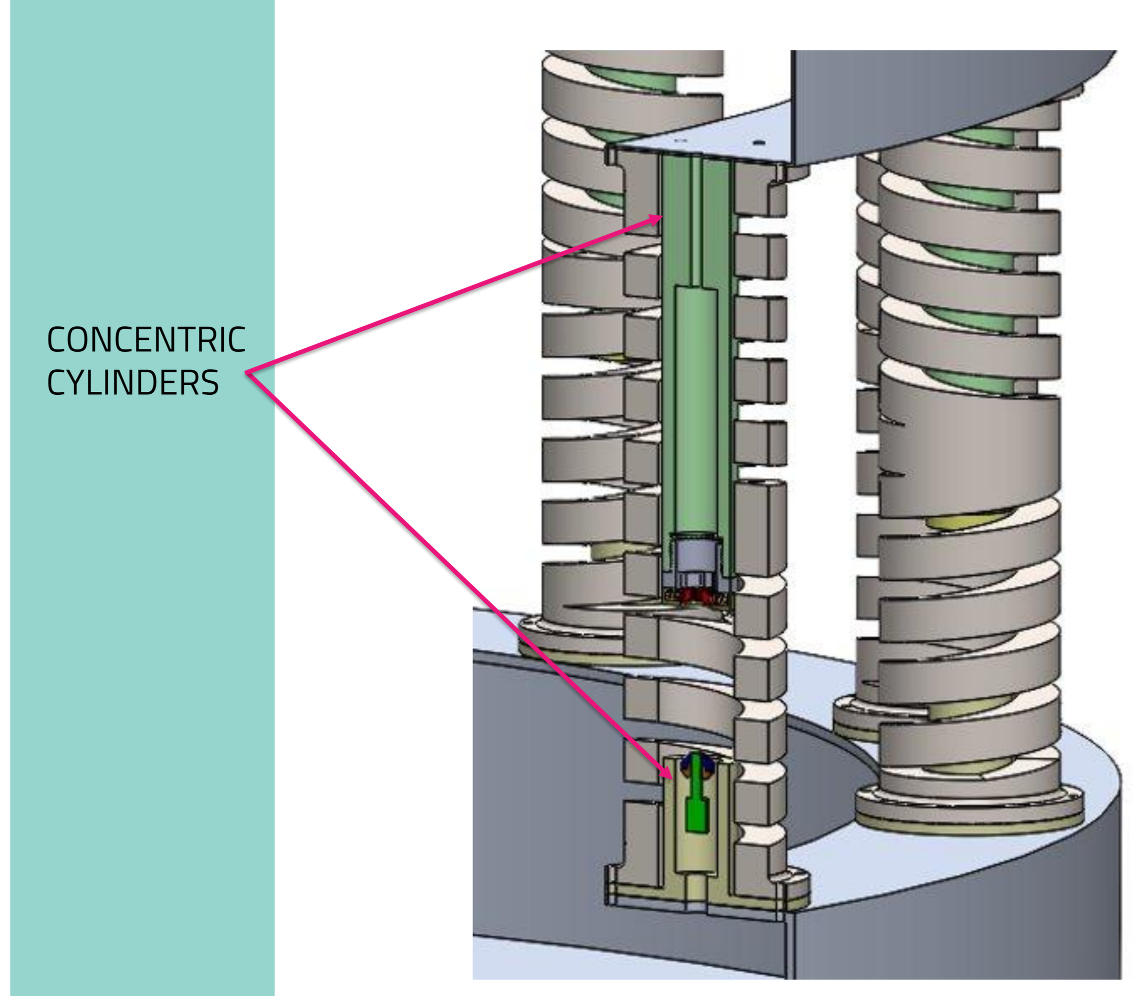
<u>Push-Push Lock</u>
This mechanism was designed to ensure premature expansion, specifically during launch where there are high g's, will not occur. As can be seen below, the mechanism is activated by a jackscrew. This jackscrew will attach to the base of the cryogenic tank and move all 14 cylinders up cohesively via motor control. This will ensure that the system stays locked until it hits orbit.



Compressed – High Gravity



Expanded – Low Gravity / Vacuum



Results

Thermal Desktop, shown on right, was utilized to run stimulations to gather information about the rate of heat transfer into the cryogenic tank on the Moon:

Case 1: Flange to Flange [no THERMOSPRING] – regular space method now

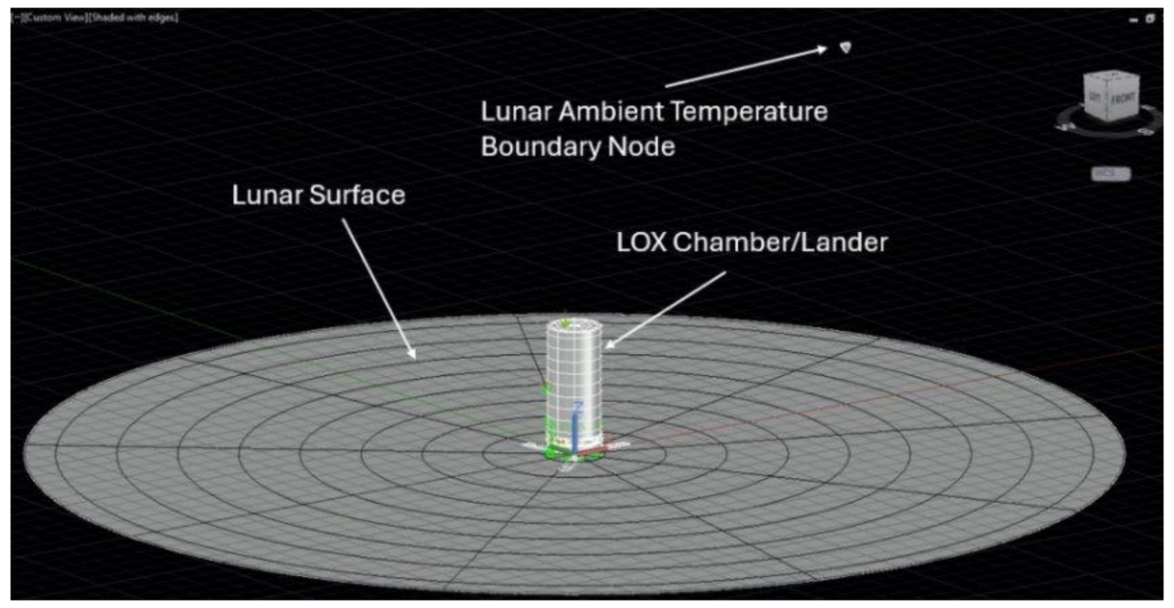
Case 2: THERMOSPRING installation

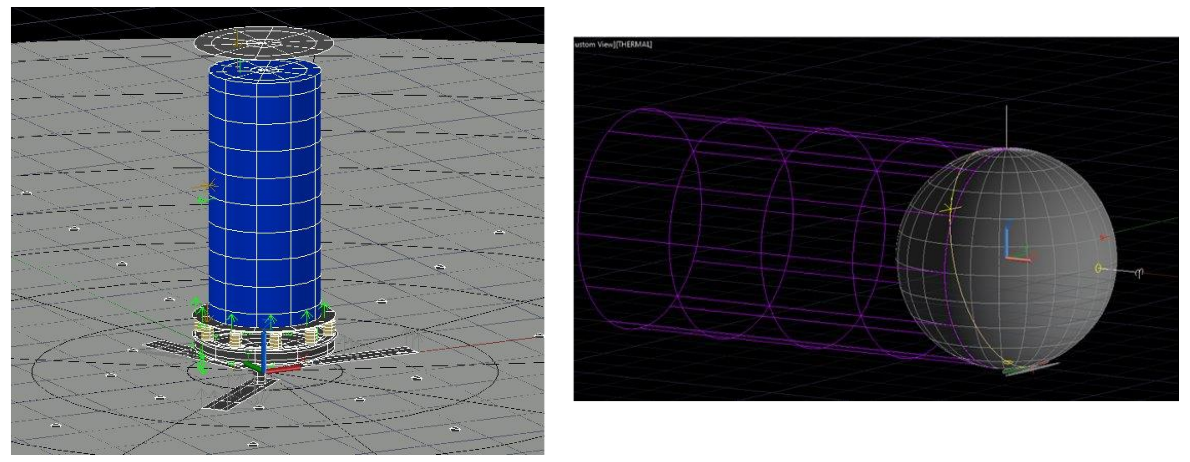
CASE 1 – FLANGE TO FLANGE

WHEN	THERMAL RESISTANCE [K/W]	HEAT RATE [W]
1 – Pre-Launch [1-15g, atmospheric]	0.0396	1930
2 – In Orbit [0g, vacuum]	0.0396	1930
3 – On the Moon [0.17g, low gravity]	0.0396	1930

CASE 2 – THERMOSPRING

WHEN	THERMAL RESISTANCE [K/W]	HEAT RATE [W]
1 – Pre-Launch [1-15g, atmospheric]	1.5443	49.52
2 – In Orbit [0g, vacuum]	16.75	4.57
3 – On the Moon [0.17g, low gravity]	16.75	4.57



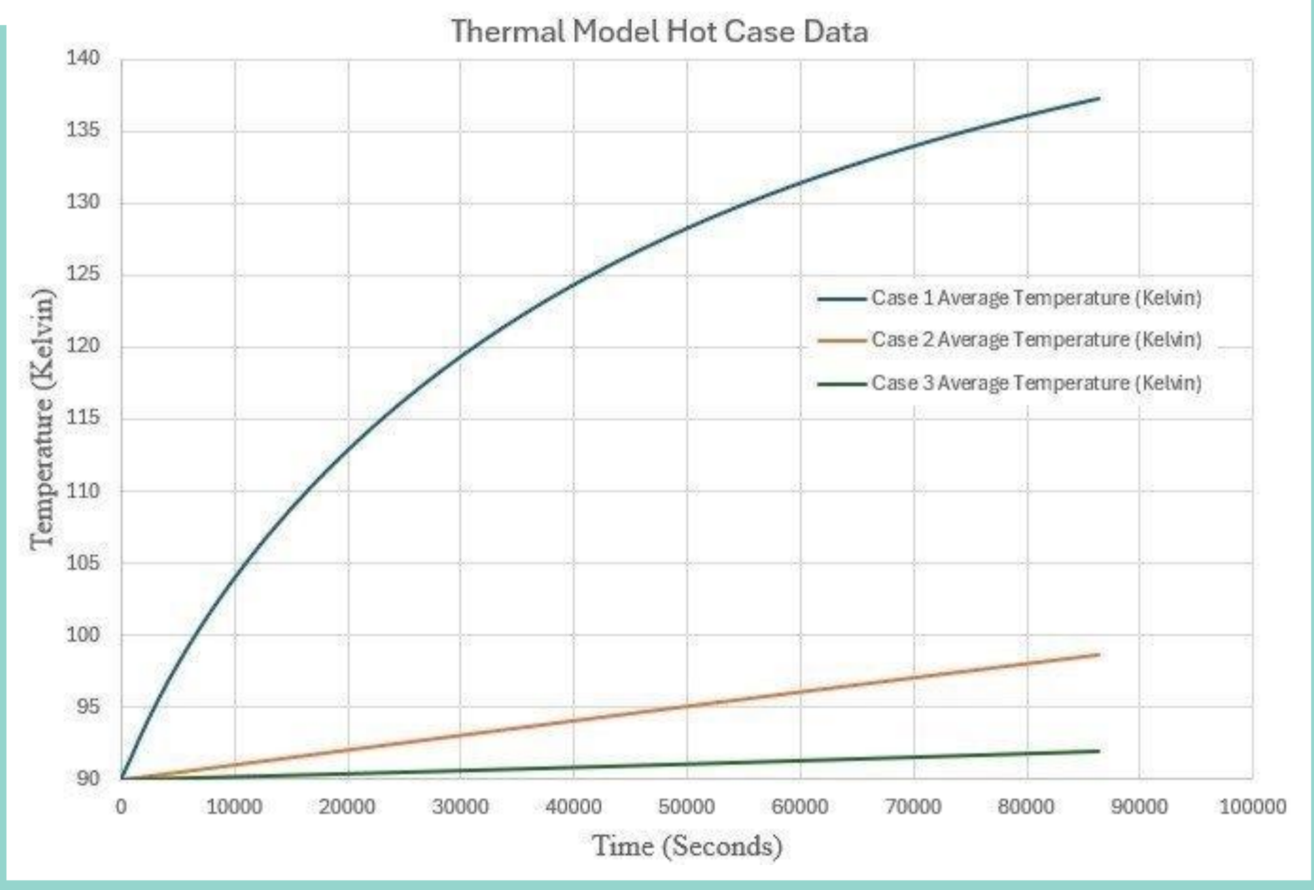


As can be seen, the heat rate for Case 2, the addition of the THERMOSPRING, is *significantly* lower than the traditional flange to flange connection. Thus, a clear demonstration of reduction of heat transfer has been show cased.

A 24-hourt thermal study was conducted, shown below, and the following results are found:

- Flange to Flange shows rapid heating and boils to original temperature of roughly 137K in about 3.5 hours.
- THERMOSPRING compressed showed slower heating and reached about 98K after 24 hours
- THERMOSPRING expanded had the lowest heating time of all and reached about 92K after 24 hours

This result showcases the effectiveness of the THERMOSPRING



Conclusion

The THERMOSPRING successfully demonstrates the reduction of heat transfer to increase the lifespan of cryogenic fluids.

It reaches a total value of $133,297 which is **below** the $150,000 budget.

The THERMOSPRING is thought to be **completely attainable following the NASA path to flight timeline in 4 years**, indicating that implementation is quite simple.

Acknowledgements

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