Moon to Mars Ice and Prospecting Challenge

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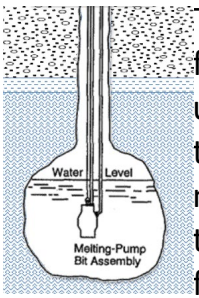
Introduction

- The objective of this NASA-sponsored competition is to design a robot that, once on the surface of the Moon or Mars, can perform the tasks of mining through the different layers of soil, melting and extracting the subsurface ice, and filtering the water *in-situ*.
- This work addresses the development, design and optimization of the extraction system for minimum weight with ability to effectively melt surface ice.

Description

The survival and success of long-term lunar and Martian settlements depends on effective *in situ* resource utilization (ISRU). The Ice and Prospecting Challenge explores ISRU through the design of a robot with 9A, 120V power limit (1080 W), a 60 kg overall mass, and a 12-hour time limit for operation.

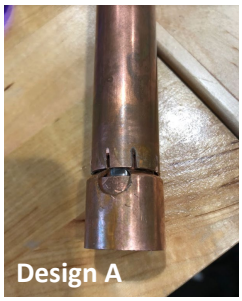


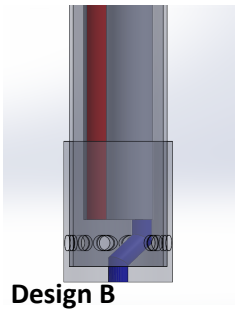
The Rodriguez well shown in the figure causes a cavity with uniform diameter to form throughout the depth of the ice, maximizing the rate of heat transfer and preventing collapse from the layers of soil above.

The NASA prospecting challenge requires that the subsurface ice be modeled to be at -26°C. Thus, the current design envisages the use of cartridge heaters to provide localized heat to melt the ice. Temperature sensors are used to avoid refreezing of the melted ice and facilitate localized mixing for extraction. The ISRU will also include a soil boring system mounted on the robot that can drill through the surface layer followed by the lowering of the ice extraction probe.

Prototype Design and Development

Three different extraction probes (A, B, C) were successfully designed to meet the water extraction challenge.




Design B


Design C

- The first design (A) uses a single 750W cartridge heater mounted in a 3/4-inch copper pipe with slits in the bottom cap for water to be pulled through.
- The second design (B) uses two 500W cartridge heaters in a 5/8-inch tube with holes in the bottom cap to facilitate circulation of the heated water to preheat the entering cold ice melt.
- The third design (C) uses three 250W heaters through holes in the housing and providing dual pathways for fluid flow along the sides of the extractor.

An optimization analysis will be used to fine tune the design and estimate performance in simulated field conditions.

Summary

All three viable ISRU prototypes for water extraction have been designed, developed and fabricated. Performance demonstration and further testing are planned with the mining robot to validate against NASA Moon Mars Ice Prospecting Challenge.

Acknowledgment

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