STYX & STONES

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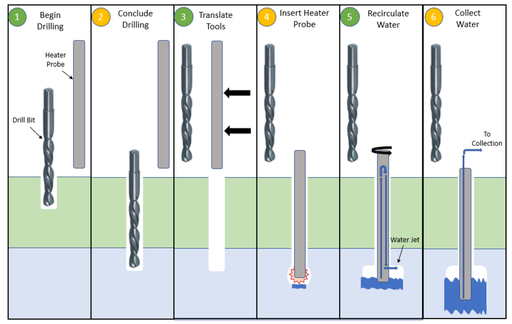
On Earth

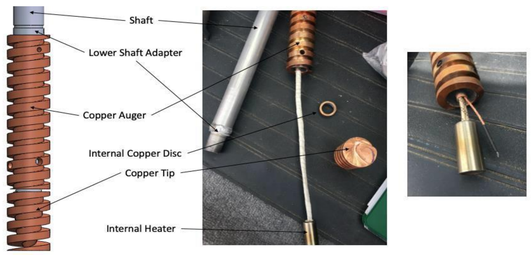
Concept of Operation

The STYX & STONES prototype cuts through regolith and collects liquid water using a two-tool, multi-step process. This process includes drilling through overburden with a rotary hammer and then using a separate heated auger to melt and collect water. To maximize water collection, the heated auger recirculates melted water and discharges it into the hole to expand the well before collecting. The general plan of operation is detailed in the diagram below.



Completed Prototype Performance

During testing on Earth, the prototype was successful at extracting water using the prescribed process. STYX & STONES is built primarily of square aluminum tubing and uses a rotary hammer with a 1.5” masonry drill bit to cut through regolith. The heated auger is custom made and has a cartridge heater, thermocouple, spout and suction ports in the head of the tool.



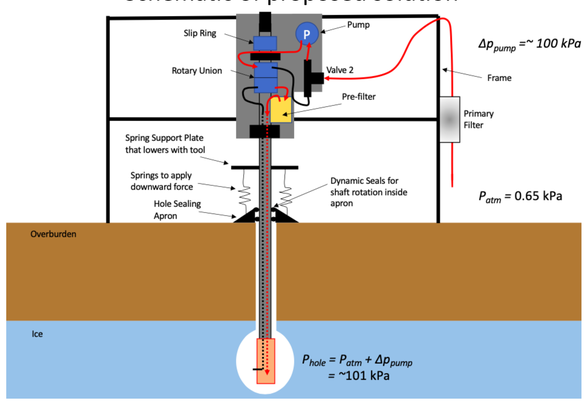
Heated auger head

On Mars

The Pressure Problem

The Martian atmosphere is significantly less dense than Earth’s which lends to the planet having an atmospheric pressure of approximately 650 Pa. At this pressure, adding heat to solid water (ice) would cause sublimation rather than melting. Currently, STYX & STONES is incapable of collecting water vapor and would be unable to utilize its waterjet.

Schematic of proposed solution



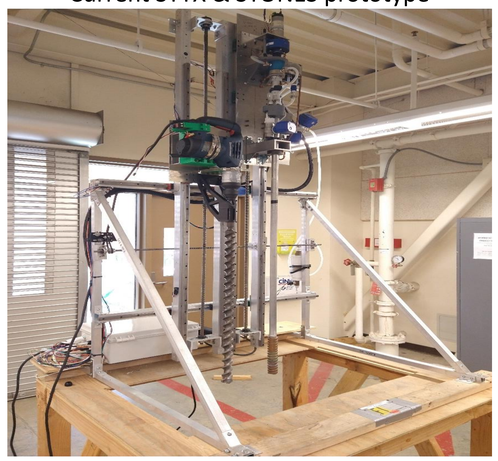
The Dust Problem

Every year, large scale dust storms rage on Mars lasting weeks at a time. These storms threaten to deposit dust on many critical components decreasing the life and efficiency of the machine.

Proposed Solution

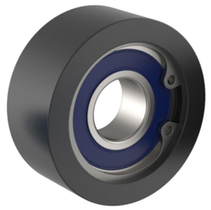
To combat issues of dust deposits, a gasketed bearing solution could be implemented to prevent dust ingress for motors and bearings. Similarly, a flexible bag or CVCM approved fabric cover could be fitted over the lead screws, linear bearings, and rails to prevent dust from coating these surfaces.

Current STYX & STONES prototype



Proposed Solution

To circumvent the sublimation issue, STYX & STONES can be modified to pressurize the hole and guarantee the ice melts. The proposed method involves utilizing a separate pump to pull in and compress Martian air and pump it into the hole via the spout of the heater probe. As the heater probe descends, seals will be pressed around the mouth of the hole to prevent leakage.



Protected bearing

Exposed motor and leadscrew

Flexible bag example

On Moon

Thermal Expansion

The ambient temperature on the surface of the Moon varies from -280 to 260 ° F. Thermal expansion of metal components will induce thermal stressing and decrease the life of major components. Additionally, expansion will alter the calibration of the load cells mounted on the prototype.

To negate these issues, the material for the frame and other components could be changed to a metal with a lower coefficient of thermal expansion. To calibrate the load cells, a thermocouple can be placed on the frame to read ambient air temperature. Depending on the reading, the load cell calibration can be altered.

Overheating Motors

With temperatures as high as 260°F and no air to allow convection, it is difficult to cool electronics on the Moon. Important components such as stepper motors, and the drill motor are all at risk of overheating.

An easy way to minimize this risk is to limit, or prevent, operation during the hottest times. Similarly, the drill can be run at a lower RPM to reduce heat generation, and it can be removed from the hole more frequently to increase heat rejection.

Load cell assembly

X axis motor

Acknowledgements

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