RedWater: In-Situ Resource Extraction from Sub-Surface Martian Ice Deposits

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Ten Second Summary

Honeybee Robotics is in the process of developing RedWater as a system that will combine a Coiled Tube (CT) Drill and a Rodriguez Well (RodWell) – two proven terrestrial technologies – to be able to drill down through up to 20 meters of overburden and extract tens of tons of water from Mars’ subsurface ice deposits. This system is a cornerstone In Situ Resource Utilization (ISRU) technology that will enable manned exploration of Mars by mining water; the raw material that can be used for everything from life support and agriculture to fuel cells and propellant.

Performance Specifications:
- Maximum Depth: 25 meters
- Power Estimate: ~10-15 kW
- Water Extraction Target: 16 metric tons H₂O

In-Situ Resource Utilization

Significant quantities of subsurface glacial ice formations

Trade Study: One Large Well vs One Deep Well

Larger Heated Auger
- Auger is 4” OD x 36” tall
- Auger surface held at 100°C

Smaller Heated Auger
- Auger is 2.5” OD x 4” tall
- Auger surface held at 80°C

- Initial melt quantity: 5000 L vs 400 L
- Days to 16000 T: 24 vs 280
- Total Depth (exc. Overburden): 2.5 m vs 22 m
- Peak Power: 28.8 kW vs 2.5 kW
- Total Energy: 14 MW-hrs vs 15.7 MW-hrs
- Thermal Efficiency: 14.7% vs 14%

CT Mechanism
- Solid tubing minimizes moving parts, provides anti-torque
- Drill string carries power, pneumatics, signals and returns extracted water
- Drum holds coiled tubing
- 304SS tube (60% elongation at break)

Bottom Hole Assembly
- Pneumatic packer seals borehole
- Pneumatic chip clearing during overburden removal
- Rotary-percussive drill head
- Integrated body heaters
- Drill head enables faster welling via stirring

TRL Development

TR-5 Freezer Test
TR-4 Large Scale Melt Tests
TR-5 TVAC Test

Commercial Applications & Scientific Potential

Propellant Production
Martian Agriculture
Geotechnical Science

Characterization of Ice Resources
Heat Flow Measurements

ConOps & System Architecture

Python OpenCV Image Processing
- Calibration to camera observing well
- Distortion correction of images
- Tracking of well depth and width
- Disc method estimation of well volume

- Order of magnitude estimation
- Depth estimation most accurate
- Width estimation semi-accurate
- Volume est. needs refinement

CT Mechanism
- Drum Assembly
- Tube Straightener
- Inflatable Borehole Seal
- Bottom Hole Assembly

Bottom Hole Assembly
- Inflatable Borehole Seal
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