Notes from ISRU Monthly Meeting

September 2020

Notes from Discussion

Synopsis from ISRU Supply / Demand Workshop ::REFER TO SLIDES::

- Over 200 attendees
- Over half were LSIC attendees
- Also have seen an uptick in LSIC memberships
- An out brief report and presentation is in the works for NASA (will also be shared with the group)

- Gary Barnhard pointed out that determining the most manageable phases for water / hydrogen (on demand vs. production) for different customers should be more than a secondary concern.
  - Michael Nord responded that Firehawk and OrbitLab want water, not liquid hydrogen

- Dallas Bienhoff suggested taking water and breaking it into how much oxygen and how much hydrogen a customer needs
  - Jerry Sanders responded that just stating the product need was important, without necessarily knowing where it specifically comes from at this point
  - Karl Hibbitts pointed out that another variable is different mixtures used by different customers
  - Ron Jones added that producing hydrogen without knowing the demand could lead to issues with storage
  - Clive Neal pointed out that establishing an evolution plan for demand is a major outstanding issue, and should be listed as its own ‘bullet point’ as a question to address
  - Karl Hibbitts and Jerry Sanders added that anchor tenants would likely be a factor

- Jerry Sanders added that another bullet point should be added for understanding the lunar water resources better

ISRU Water Ice Open Discussion ::REFER TO SLIDES::

- John Gruener raised a concern about a lack of knowledge about what surrounds water ice, and how expensive it might be to extricate

- Dennis Wingo pointed out via chat that perfect is the enemy of good, so what is good enough?
  - He followed up that his opinion is that the amount of power needed to operate on the lunar surface is being vastly underestimated

- Karl Hibbitts pointed out that he didn’t expect a relationship between surface abundance of frost and subsurface abundance of ice
  - Dennis Wingo argued that the Apollo missions proved the existence of ice and we just have to get there and measure what’s actually present
• Dennis Wingo also pointed out that determining whether there’s a high enough concentration of water depends upon the established systems engineering, just like it does terrestrially

• Gary Barnhard pointed out another consideration was what transformation would be necessary to transport for further processing

• Kirby pointed out the discussion between Leslie and Dennis (in chat) about how drilling dry wells was not necessarily bad, that drilling them to ‘practice’ was still a win
  o Clive Neal agreed and said this wasn’t about mining wells, but extracting minerals
  o Michael Poston added that a discussion at LEAG said sampling would necessitate drilling to check controls
  o Dennis Wingo pointed out that the drills that have already been used extraterrestrially have been science implements and not true mining tools

• Kirby Runyon synthesized the point that there’s a need to understand subsurface ice abundance at the relevant scale, so what should the relevant scale be?
  o Kirby further extrapolated that the community was on board with a CLPS lander dedicated to handling ISRU and related geotechnical issues (all agreed)

• Kirby Runyon asked what the group’s thoughts were on wheeled versus walking robots
  o Clive Neal responded that walking robots were too risky, and that the initial mining would not be done on an incline anyway
  o Gary Barnhard pointed out the value of Occam’s Razor and setting up an engineering system to succeed

• Bonnie Dunbar pointed out that if water is in a liquid phase during processing, you may have to worry about whether 1G models and heat mass transfer apply to the environment

Discussion about Year One Goal ::REFER TO SLIDES & CONFLUENCE::

• Gary Barnhard said his initial reaction was a need to mature the end to end process
• Leslie Gertsch suggested replacing technology approach with capabilities approach
• Dallas Bienhoff pointed out that both water and regolith should be listed as sources of oxygen
• Dennis Wingo suggested that an actual numerical scale should be identified
Notes from Chat

- **Other Materials for ISRU**
  - Aluminum for rocket fuel
  - Silicon / aluminum for solar panels
  - Methane seen in LCROSS data (low concentrations)
  - LCROSS also found carbon bearing compounds
  - Hydrogen is also in demand, along with O2

- **OVERALL: Need for ground truth on all volatiles**
  - Concentration data important

- **Water Storage / Usage**
  - ALICE fuel would be water even at launch
  - Main storage as water with days of O2 and H2 storage

- **Defense Innovation Unit is about to award activities under Multiple Orbit Logistics opportunity (inc. lunar landers) - should be contacted about propellants being considered**

- **Location of post Supply / Demand Workshop discussion on Confluence: https://lsic-wiki.jhuapl.edu/x/B4A9**

- **CSDC provided range of values for water that ISRU must beat to be salable**

- **Demonstrations of water ice extractability needed, info about abundance and quantities**

- **Extraction system demonstrations needed, including mining, transport, processing, refining / purifying, and more transport to manufacturing / placement**

- **How to measure how much H2O / OH vapor is lost in extraction process**
  - Measure or estimate from research on Earth and in situ

- **Viability of 100 to 1000ppm of OH extraction for reserve of H2o depends on cost and efficiency of extraction system (not well defined)**

- **Power is a big driver for lower concentrations b/c of need to process more material**

- **Julie Kleinhenz’s work simulates water vapor extraction from simulant regolith**

- **Need to stop calling resource extraction digging wells**

- **VIPER Trident has been tested at Glenn Research Center drilling into ice-bearing simulant in thermal vacuum chamber (refer to Kris’ presentation)**

- **Relevant scale for technology requirements depends on extraction technologies to be used (bucketwheel excavator vs. RASSOR-sized excavator) and safety factors in the system**