LUNAR POLAR ICE
PROPELLANT PRODUCTION PLANT STUDY

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Lunar Prospector (LP) neutron spectrometer data (Feldman et al, 2001), predicted an average ice content of 1.5%, located in permanent shadow craters larger than 10 km. Based on this data, a propellant production plant based on lunar polar ice looks very promising.

This paper discusses an architecture for the production of water, oxygen and hydrogen from lunar polar ice as a first step in the use of indigenous materials from the Moon.

The production plant has been designed using the approach first utilized by Eagle Engineering (Christiansen, 1988; Snaufer, 1991) with some of their assumptions for system efficiencies upgraded with more recent technologies.

The architecture includes mining and processing equipment, a thermal reactor to extract the propellant, a water electrolysis unit, a means of liquefying gaseous propellant, and the power supply (assumed solar cell based) for running the system.

The plant is sized to produce 900 metric tons of water per year. Approximately half of this water is electrolyzed to produce propellant. The remaining water is expected to be stored and transported to other locations in space enabling and/or improving space transportation scenarios for space exploration, satellite servicing and resupply, etc.

Sensitivity analyses based on the plant size and desired production, ice concentration in regolith, reactor size, mining equipment performance and power system have been carried out. These analyses show that the ice concentration is the most important factor related to the total mass of the plant. Therefore, the uncertainties related with the range of concentration, ice form and location would have to be addressed in order to improve future studies.

Second in order of importance are mining equipment size and performance. Improved extraction systems, with higher throughput to excavator mass ratios, will increase productivity and reduce system mass requirements.

The sensitivity analysis does not show the power system to be an important mass factor in the architecture, due to the expected high performance of the solar cells. However, further research should be done in order to enable the proper location and size of the solar power system. Wireless power transmission based on solar energy and the use of nuclear power plants are possibilities for providing energy in the permanent shadow.

Finally, the problems of working in continuous darkness and cold temperatures has not yet been adequately assessed.

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References:

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