Membrane distillation for polishing water originating from moon regolith reduction processes

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Long-distance crewed space missions for exploration of new habitats in outer space might be reality within a few decades. The availability of water is a key element for enabling life in extra-terrestrial environment. The molecule water has unique and versatile properties and can be used as a fluid for thermal management systems, a barrier against high energy radiation, a source of hydrogen and oxygen and as a solvent enabling multiple (bio)chemical reactions and processes. A way of producing water from resources on the Moon is reduction of regolith at high temperature with hydrogen gas as reducing agent. Water is recovered by condensation from the downstream gasses. Trace contaminants among metals, alkali-metals and anions of strong acids are also present in the condensate. The condensate might be a feed for an electrolysis cell to produce oxygen and hydrogen. The water needs to be further purified to prevent interference with the electrochemical process. A sample of water obtained of the reduction of ilmenite was treated in membrane distillation module. Membrane distillation is enabled by a temperature difference between a warm and cold compartment separated by a hydrophobic membrane. This allows water vapour to migrate through the membrane from the hot to the cold site. The contaminants remains as a concentrate in the hot compartment. The operation might be modified towards a direct separation of water vapour from partially cooled downstream gasses of the reduction process.

Utilizing the Moon's most prominent features, the soil and the craters; an Architectural Concept

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Why do we use bricks here on Earth and why would we need a brick on the Moon? We are so used to the specific building standards of our home planet that we mistakenly try to implement them in exotic situations, such as a lunar construction, without ever contemplating the essential reasons that gave rise to these techniques. If we are to build a permanent lunar base in the next decade, instead of coming up with extravagant solutions and conducting research on dwelling scenarios that only refer to the far future, we should turn to pragmatic building methods that have more in common with primitivism rather than futurism. Using the unprocessed lunar regolith as a protective shell of an inflatable module against radiation and micrometeorites, we are reducing the risks of uncontrollable situations, as well as the overall cost; we only need to stabilize it right, an easy task as it turns out. Also, our inability to modify the landscape shows us that it is imperative that we utilize the existing geomorphology; for it to be protected by landing blast effects, be near a peak of eternal light for maximum energy collection and be in an environment of stable temperature without problematic shadows simultaneously, a lunar construction should take place inside a crater. An ideal example is the permanently shadowed crater found inside the highly illuminated zone at 89.7742°S, 203.4952°E of the South Pole[1]. By being completely detached from our conditioned building practices here on Earth and approaching the subject of lunar habitation by reinterpreting architecture anew, this architectural study aims to showcase a pragmatical concept of a first lunar base near Shackleton Crater's rim.

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Space Architecture with Centrifugal Force on the MOON

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The long-term exposure to microgravity environments is known to have adverse effects on mammals, from fertilization through birth to growth. We, therefore, propose various architectural designs of “rotating artificial gravity facilities” to reproduce Earth-like (1G) gravitational environments on the surfaces of the moon, as well as during long spaceflight periods. When the rotation speed of the wine glass is increased on a celestial body whose gravitational acceleration is less than 1G such as the moon, the resultant acceleration, which is the combination of gravitational acceleration G_{moon} (<1G) of a celestial body and acceleration based on centrifugal force, becomes 1G at a point. In the design process, the resultant acceleration is considered as an apparent gravitational acceleration. Figure 1 shows the image of the rotating artificial gravity facility on the moon “Lunar glass”. We propose that these facilities will become indispensable for future human generations to be able to give birth and raise children during the early phases of Solar System colonization. For the transportation system between artificial gravity facilities, we propose the usage of side rails guided tracks because minimal energy would be consumed during operations. Furthermore, using the side rails guided tracks would reduce the exposure to hazardous dust particles on the Moon. When used as international hubs, artificial gravity facilities are expected to promote the unity of humankind.

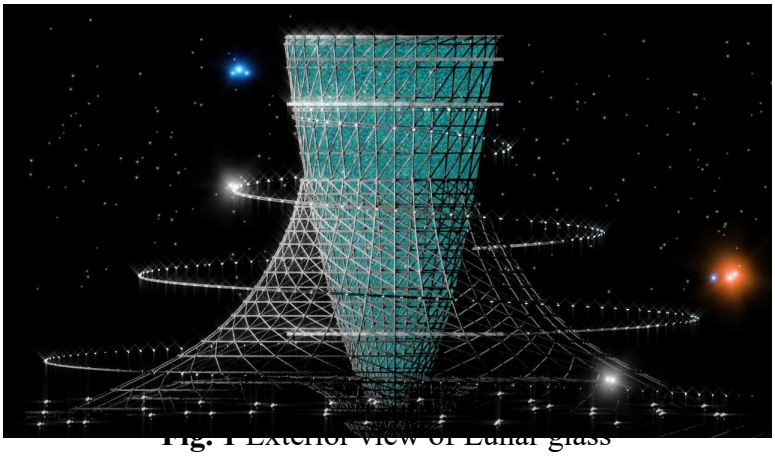

Fig. 1 Exterior view of Lunar glass

Structural Approach in Space Architecture and Social Optimization for Space Habitation Facilities

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The construction of space habitation facilities requires to establish an optimized design method that integrates the multi viewpoints of various experts. We will introduce the front-loading structural method using the international standard data format, 'IFC(Industry Foundation Classes)' for BIM(Building Information Modeling) / CIM(Construction Information Modeling/Management). The structural analysis method enables to optimize the shape of high-strength light-weight material by metal 3D printer. In addition, this presentation shows the historical background of community design by social, economic, and cultural perspectives such as location theory, local currency, and optimization of human relations. They are very important for urban planning and community creation. The perspective of space habitation research and development would provide guidelines for multi-viewpoints discussions and proposals for the ground solutions such as SDGs, regional revitalization, disaster planning, and well-being. Regional currency in space habitation facilities optimizes administrative socialism by entropic theory of economy and ecology based on post-capitalism by balanced economic, social, and environmental capital. This presentation tries to create a momentum to architect ideal society for next generation through discussing and designing space habitation in general.

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