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PROJECT HELIOS PHASE I: THE EXTRACTION OF HELIUM-3 IN LUNAR REGOLITH FOR ANEUTRONIC NUCLEAR FUSION

Abstract

Recently, there has been a resurgence of interest in space exploration: At the helm of this modern gold rush are private companies, paving the way for the commercialization of various off-planet activities. Our team was inspired by this trend to design a lunar operation that would be economically and politically feasible within the next twenty years: a reason for the establishment of a permanent human presence on an extraterrestrial body. Helium-3-deuterium fusion was a topic researched towards the end of the Cold War. Three grams of helium-3 could generate up to 1.77 terajoules, or almost 500 thousand kilowatt-hours, of energy. Additionally, the reaction is aneutronic and produces no nuclear waste which makes it easier to contain than traditional neutron rich fusion reactions. Although Earth-wide production generates fewer than fifteen kgs of helium-3 annually, the moon has vast reserves embedded in the regolith, in concentrations measured in parts per billion. Subjected to heat, the regolith releases a mixture of volatile compounds, including helium-3. The project is separated into a three-phase process to retrieve helium-3 from the lunar regolith. The first phase, extraction, involves unmanned haulage vehicles to carry lunar regolith to a processing facility. The second phase, liberation, involves heating the regolith to release the volatiles. The final stage, processing, isolates helium-3 from other volatile compounds and prepares it for shipment to Earth. We will be analyzing the feasibility of this project, focusing specifically on the extraction phase for this conference. While the usage of other volatiles is beyond the scope of our analysis, we will investigate how managing these by-products can affect the economic viability of the project. These volatiles include water, carbon-dioxide, nitrogen, hydrogen and methane, all of which may aid in human colonization of the Moon. Other lunar missions would be able to make use of these by-products, helping establish a lunar economy. Additional considerations associated with this project include space law, politics, and ethics. Our current focus is the evaluation of the project's economic viability and the unmanned lunar excavation vehicles (LEVs) in the extraction phase. The excavation vehicles are assessed on their ability to excavate and transport lunar regolith to a processing facility in a robust and reliable manner. Our plans are to investigate all three phases of the project in an episodic manner at this conference and future conferences.