UTILIZATION OF NUCLEAR POWER FOR MOON MISSIONS: NUCLEAR POWER GENERATION USING HELIUM COOLED REACTOR FOR MOON HABITATS

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Introduction: As the closest space based natural satellite in space, the moon has been one of the main interests of mankind since the dawn of the civilization. To overcome certain difficulties with power requirements, nuclear power sources will be more advantageous in long term point of view. On the moon, it is essential to have extensive support to create power for the various logistical requirements such as life support, communications, lights, waste removal, etc. as well as for the scientific experiments and for the facilities that will process materials. Thus, functional power sources are needed which can function reliably in long term. Due to its basic properties, chemical or thermal means of generating electricity would be quite difficult under reduced gravity conditions. Moreover, it would create several control and stability issues as well and furthermore they would require excessive amounts of fuel to be either mined or transported from Earth in a continuous manner.

However, with the availability of a nuclear reactor, all of the power requirements in a moon based station (with reduced gravity conditions) can be met for several years without any difficulty. Nuclear reactor power systems can support human exploration at surface outposts and space stations. A nuclear reactor on the surface of the Moon can be a source of reliable power to provide life support, and to supply the large power demands of facilities processing materials.

Naturally, there are different options for utilization of nuclear power for moon based missions. Unfortunately, the standard types of reactors found on Earth such as the Heavy Water Pressurized Reactor or the Light Water Pressurized Reactor systems will not be feasible on the moon. Since the moon has the $1/6^{th}$ gravity of the Earth, the fission kinetics would be harder to control and using water as a coolant will not be practical as having thousands of tons of water on the moon will not be logistically feasible. In addition, the circulation of waste water will be extremely difficult due to subzero temperatures as well as the vacuum outside of the Moon Habitat

Since the operation of normal water cooled nuclear reactors would be a challenge due to limited availability of water and due to behavior of water under reduced gravity and vacuum conditions in the Moon, it will be necessary to utilize more advanced types of nuclear reactors. One such example would be the utilization of a ***Helium Cooled Nuclear Reactor*** where Helium will be used both as a neutron moderator and as a coolant. Since helium is a noble gas, it will not be chemically reactive and also several studies suggest that Helium circulation would function well under reduced gravity conditions and even under microgravity conditions. In addition, the pumping and the cycling of Helium would be easier and the logistics of wastewater will not be a problem as well.

Thus, by using a helium cooled reactor, the challenges of using a water cooled reactor can be overcome and the necessary long term power supply can be provided to a Moon Habitat. The paper will discuss the issues while addressing moon based criteria such as the reduced gravity, lack of atmosphere, availability of large amounts of moon dust and lack of natural resources necessary for operation of such a system.

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