A Promising Energy Storage System for Lunar Rovers

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The moon has a very demanding environment for the energy storage system, mainly caused by eclipse duration and environmental conditions.

Energy to power electrical devices like lunar rovers to guarantee safe hybernation of payload during lunar night can be stored much more efficient in a Regenerative Fuel Cell System (RFCS) than in conventional batteries like Nickel-Cadmium, Nickel-Hydrogen and even Lithium-Ion. A RFCS is comprised of a fuel cell, an electrolyzer and the reactant storage system for hydrogen, oxygen and water. The reactants are stored in reservoirs. These reservoirs contribute to most of the weight of the system, but very recent development of nanofiber structures allow very efficient storage of the hydrogen.

During the lunar day, a photovoltaic reactor provides electrical energy and a part of it is used to split water in the electrolyzer into hydrogen and oxygen. During the lunar night, the fuel cell will provide the electricity generation. Hydrogen and oxygen are fed from the reservoirs and converted in the fuel cell, producing electrical energy, heat and water. The water is stored in a reservoir and is thus available for electrolysis in the following sun phase. The loop of the system is completely closed.

The harsh local lunar environmental conditions (low gravity, vacuum, extreme temperature cycles between day with ~ +120 deg C and night with ~-155 deg C) require a very robust and reliable system, a longer shutdown during lunar night with loss of (waste) heat generation would cause irreversible damage due to freezing.

Mass calculations will be presented for the main components (electrolyzer, storage system, fuel cell) including rough mass assumptions for the secondary components like the cooling loop water pump, leading to a dedicated RFCS system mass. These figures will be compared with conventional battery data.

Keywords: Moon, Lunar rover, fuel cells, regenerative fuel cell systems