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Author: Mr. Raja Pandi Perumal
University of Luxembourg, Luxembourg , raja.pandiperumal@uni.lu

Dr. Angel Abbud-Madrid
Colorado School of Mines, United States, aabbudma@mines.edu
Prof. Holger Voos
University of Luxembourg, Luxembourg , Holger.Voos@uni.lu

ATMOSPHERIC RE-ENTRY ENERGY STORAGE (ARES)- A NOVEL CONCEPT FOR UTILIZING ATMOSPHERIC RE-ENTRY ENERGY

Abstract

As the aspirational goal of Mars settlement starts to materialize slowly, it is apparent that its viability hinges on the development of Mars based energy sources, preferably utilizing in-situ resources. Although Mars has a thinner atmosphere than Earth, it still exerts large amounts of heat on entry vehicles, generating temperatures around 1500°C. Therefore, the entry vehicle is covered with a thick layer ablative heat shield to protect it from burning up. However, the temperature on the Martian surface is significantly cold. It varies between -140°C and 30°C. One of the critical challenges in developing bases and settlements on Mars is to find heat sources on the surface.

The envisioned heat sources are geothermal energy, greenhouse gases and Radioisotope Thermoelectric Generators (RTG). Although geothermal is the most preferred source for its unlimited supply, it is localized and requires an elaborate infrastructure. Trapping greenhouse gases also requires extensive infrastructure. RTG requires a large amount of radioactive fuel. Due to its hazardous nature, disposal/reprocessing of the fuel will be challenging. Even though heat energy becomes a crucial and a hard to come by resource at the surface, little to no effort is employed to utilize the heat produced inadvertently during entry.

This paper proposes a novel concept to collect, store and utilize the atmospheric entry heat energy using Phase Change Materials (PCM) obtained from the Martian Moons. Mars settlement architectures suggest that the martian moons, Phobos and Deimos, can be used to set up preliminary base camps. These moons are potentially trapped c-type asteroids and have the possibility to contain rich Lithium reserves. Lithium and its alloys have a relatively high latent heat of fusion and low density, making them an ideal PCM for this application. This concept takes advantage of the undesired heat generated during atmospheric entry to melt the PCM. A storage system would store and insulate the melted PCM. As the PCM solidifies, it releases heat energy. The used PCM is reused or industrially consumed.

With current technology limitations, the heat storage system could only store the heat energy obtained using PCM for a few hours. While the results from ongoing research could considerably increase its efficiency, PCM could be used as a temporary energy source in landing sites where no other energy generation infrastructure is available. Alternatively, the heat generated from PCM could be converted to electricity using thermoelectric generators.