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Dry Ice Freezing-Sublimation Energy Conversion for Space Stations, the Moon, and with Particular Reference to Mars

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Consideration is given to the use of CO_2 freezing-sublimation process for energy conversion for spacecrafts, and lunar and Mars human outpost. The idea is conceptually simple: for a space stations, spacecrafts or outpost located at the moon, the drastic changes of temperature between the shadow and isolation time can be harnessed to freeze (during the shadow) and sublimate (during isolation) CO_2 which is properly stored in suitable tank or vessel. Because the huge difference in density between dry-ice and gas, the sublimations could be translate into a strong build up of pressure in the tank when sublimation occurs limited only by the critical point of CO_2 at environmental conditions. Therefore, the depressurization of the tank can generate electricity by sudden adiabatic expansion of CO_2 using, say, a simple turbine and the avoiding loss of efficiency by Carnot considerations when thermal conversion systems are used . Because in outer space (spacecrafts, space stations, etc...) as well as in the Moon there is not available CO_2 and then it must be brought from the Earth, the system must operate in a closed cycle, in which the expansion of CO_2 must be from a pressurized tank to a non-pressurized tank in order to avoid exhaust the CO_2 into environment. This technique, however, reduce the maximum efficiency attainable in the conversion of energy during expansion. However, for Mars, where the atmosphere is nothing but CO_2, the CO_2 can be extracted from the atmosphere and be exhausted which increase the efficiency in the mechanical conversion of energy. Nevertheless, for Mars, the freezing of the CO_2 although could be performed during cold nights, it is possible that a supplementary source of energy will be needed (e.g., Peltier batteries) to help drop temperatures around an additional $\Delta T \approx 20 - 30$ K. Utilizing a simplified geometrical model, the proposed energy conversion method was investigated and theoretical calculations derived and compared with traditional proposed methods. One of the most interesting applications of the proposed technique is in the production of intensive electrical pulses on Mars which can be used in the Sample Fetching Rover (SFR) for Mars Sample return Missions. In fact, the technique could be employed to generate short but powerful electromagnetic pulses for communication between the SFR and the return vehicle (which according with current reference mission could be as far as 150 km each other) and the compensating the strong loss of power of the electromagnetic signal due to the high opacity of the terrain because dust.

Keywords. *Energy systems, Energy conversion,Moon and Mars human settlements,Sample Fetching Rover (SFR).*

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