IAC-05-C3.P.05

A 25 KW SOLAR-STIRLING CONCEPT FOR LUNAR SURFACE EXPLORATION

Henry W. Brandhorst, Jr.
Space Research Institute, Auburn University, USA
e-mail: brandhh@auburn.edu

Julie Anna Rodiek
Space Research Institute, Auburn University, USA
e-mail: rodieja@auburn.edu

ABSTRACT

In the 1990's, NASA successfully developed and tested a 25 kW free piston Stirling convertor under the SP-100 space nuclear power program. This program demonstrated the feasibility of the free piston Stirling convertor system for space power systems. Mass estimates based on known technology advances at that time projected a convertor specific mass of 4.9 kg/kWe. Since that time, new developments in free piston Stirling convertors have produced smaller and lighter versions. The purpose of this paper is to propose a new lightweight solar-powered system concept that uses an updated 25 kW convertor, an inflatable Fresnel lens solar concentrator and a liquid sheet radiator. This liquid sheet radiator is adapted for planetary surfaces and is enclosed in a transparent envelope. The liquid that flows down the inside of this envelope is only 300 µm and has an optical emissivity of 0.85 at a temperature of 373 K. This system is lightweight, efficient, and affordable with a system specific power projected at 100 W/kg. This system can also accept other forms of energy for night time use. With the use of lightweight Fresnel lens concentrators, advanced Stirling convertor technology, and an enclosed liquid sheet radiator, a new lunar power system may emerge.

SYSTEM OVERVIEW

The purpose of this paper is to describe a lightweight solar-powered system concept for the lunar surface that uses an inflatable Fresnel lens solar concentrator, an updated 25 kW free piston Stirling convertor, and a new look at the liquid sheet radiator. A conceptual drawing of the system is shown in figure 1. Each component has been selected due to its operating performance, efficiency, durability, and weight, which coincide with payload delivery costs. Limiting characteristics of this system are described along with potential solutions and areas of future research.

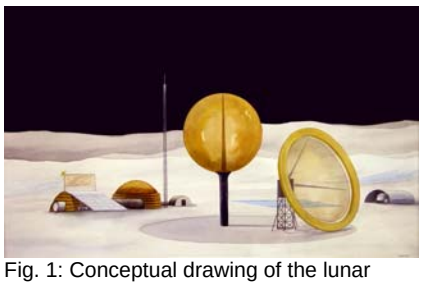

Fig. 1: Conceptual drawing of the lunar solar Stirling system at a polar site

Inflatable Fresnel lens concentrators have been produced in 5 m diameters with a specific mass of 0.5 kg/m^2 that can concentrate sunlight about 1000x. This level can produce enough heat to power a 25 kW free piston Stirling engine.

The SP-100 effort projected a specific mass for a 25 kW free piston Stirling engine at 4.9 kg/kWe. Free piston Stirling systems