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DESIGN AND EXPERIMENTAL STUDY OF THERMOPHOTOVOLTAIC SYSTEM FOR DEEP-SPACE EXPLORATION

Abstract

With the rapid development of the spaceflight technology,the need for electric power energy becomes more imminently. Due to the special environment of the deep space, radioisotope power system is put forward as the first choice for energy supply. This paper is aimed at establishing a set of thermophotovoltaic(TPV) system, which consists of the heat source, a gray emitter, 1DPMS filters, low bandgap solar cells and the water cooler. Since the isotope heat source is substituted by propane combustor, the recuperator is employed to realize an efficient combustion. The effects of the air flux, excess air ratio, recuperation efficiency and the filter on the emitter temperature, cell output performance and the system efficiency are evaluated. The results indicate that the emitter temperature increases withe the rise of the gas flux; and for a certain gas flux, there is an optimal equivalence ratio at which the highest temperature is gained. The cell short-circuit current density varies with the emitter temperature, and the open-circuit voltage is mainly depend on the cell temperature. In addition, a numerical physical model is constructed to analyze the relation between the radiator and the cells, also a comparison is done between the calculated and the experimental results. A total conversion efficiency of 2.8% is reached with this system design.