SPACE POWER SYMPOSIUM (C3)
Space-Based Solar Power Architectures / Space & Energy Concepts (1)

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THERMAL CONTROL DESIGN AND ANALYSIS RESEARCH ON SANDWICH IN SYMMETRICAL CONCENTRATOR MODULE ARCHITECTURE OF SPACE SOLAR POWER SATELLITE

Abstract

Space solar power satellite (SSPS) has been widely defined as the collection of solar energy in space and its wireless transmission for use on earth. As the one of the SSPS architecturesmodule symmetrical concentrator (MSC) has many advantages in avoiding the need for a potentially failure-prone, large, conductive rotating joint and limiting wiring mass. However, the thermal control system has restricted the rapid development of the MSC severely, especially in sandwich module, which is constituted by photovoltaics, DC to RF conversions and antenna elements. Based on the thermal requirement and technology index, the thermal design and numerical analysis of a kilometer and gigawatt level sandwich module in MSC has investigated in this paper. Due to the existence of the 5 times constant solar concentration and natural solar external heat flux simultaneously, the high temperature distribution of the sandwich module has been shown, which can surpass the permissible temperature of the cells all the time . The content has considered three classic thermal control forms of sandwich module: tile, step, and separation, and has also presented an elaborate design and analysis. In tile form, considered different design about absorbance, hot pipe and solar radiation direction, the different work cases have been analyzed. Accompanying with the anodic oxidation disposed on the surface and heat pipes embedded in the structure, the high temperature of thin film solar cells may be 543K. Due to the disadvantage of the heat flux with the outer-heat and inter-heat source together in the tile form, the step form by 100 m dimension can separate the total heat considerably. With the distribution of the outer-heat source on torus and the inter-heat source on cylinder, the heat dissipation area has increased two times approximately. In view of the two forms mentioned above, the separation can separate the heat completely and can reduce the temperature more remarkably. The result that the greatest temperature drop of step and separation to tile can be 138 K and 198 K has also been calculated, respectively. At last, the result has shown the rationality of the three forms. It can be seen that only the separation form can keep the sandwich module in a rational temperature interval well.