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STUDY ON A NOVEL SELF-ADAPTIVE SPACECRAFT THERMAL CONTROL SYSTEM WITH MOTORIZED THERMAL SHADE AND LOOP HEAT PIPE

Abstract

With the development of modern spacecraft, the mission of the spacecraft becomes complex and multi-purpose, leading to severe external and internal heat flux. How to control the spacecraft self-adaptively becomes a critical issue. In this paper, a self-adaptive spacecraft thermal control system, which combines the technologies of motorized thermal shade and loop heat pipe, has been proposed and investigated. Compared with conventional spacecraft thermal control system, this system is advantageous in variable heat radiation capability and long distance heat dissipation. Specifically, the +Y side and the -Y side plates of the spacecraft are selected as main heat radiating surfaces, with a motorized thermal shade installed on each side. The radiating surface of the spacecraft can be adjusted by deploying the shade to cover the radiator and stowing to expose the radiator. On the other hand, a novel loop heat pipe with multiple evaporators and multiple condensers is used to transport and dissipate the heat load on the +Y side and the -Y side plates. An experimental setup of the system with motorized thermal shade and loop heat pipe has been built. The thermal control characteristics of the system for heating up and cooling down has been tested and verified. On this basis, a mathematical model of the novel system has been developed. The effects of the heat radiation capability of the motorized thermal shade and the heat dissipation capability of the loop heat pipe on the self-adaptability of the spacecraft have been analyzed under various thermal environments. Besides, investigations on the applicability of the self-adaptive spacecraft thermal control system have been performed. It is found that the proposed system preserves favorable self-adaptability and applicability. It can realize self-adaptive thermal control with low resource consumption. Furthermore, the system can effectively solve the problem of being without fixed radiating surfaces, and thus can be a promising technology for the spacecraft on the inclined orbit, geosynchronous orbit, deep space, etc.