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Experimental Study of a Coupled Stirling Generator-Pulse Tube Cryocooler System Driven by a Stirling Engine

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Cold end temperature of Stirling generator needs to be increased to reduce the heat sink radiator area which is limited due to the payload capacity of rocket in space application. However, the cold end temperature increase leads to the linear alternator's overtemperature and failure consequently. A coupled Stirling Generator-Pulse Tube Cryocooler system driven by a Stirling Engine was proposed in this work to solve the high temperature failure problem of the linear alternator for space usage. In the system, the Stirling Engine converts heat from hot source to PV power first. Then the PV power actuates the linear alternator for electricity generation and the Pulse Tube Cryocooler for refrigeration simultaneously, where the later one pumps heat from the former to cold end of the Stirling generator. The linear alternator temperature can be controlled by the PV power allocation between it and Pulse Tube Cryocooler system, which avoids the high temperature failure problem in the space condition. A prototype was built to validate the feasibility of this proposal, where the Pulse Tube Cryocooler system was connected with the compression space of the Stirling Generator. It shows that, with 300W heat input and 532℃ at hot end temperature, the Stirling Generator system can output 43.9W electricity and Pulse Tube Cooler system can reach 61K without heating load.

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