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RESEARCH PAPER

Renewable energy integration for sustainable cold storage: Designing a solar PV operated thermoelectric cool chamber

Rhutuja N. Palte*, Nitin K. Palte **and** Yashawant P. Khandetod[1]
Department of Renewable Energy Engineering, College of Agricultural Engineering and Technology,
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (M.S.) India (Email: rhutujanpalte@gmail.com)

Abstract : Thermoelectric coolers utilizing peltier effect offer a promising solution for cooling applications. This study elaborates the design and optimization of a TEC-operated cool chamber and evaluation of developed thermoelectric cool chamber. A number of elements need to be carefully considered during the design process, including heat load assessment, TEC module selection and effective heat dissipation techniques. Appropriate TEC modules are chosen based on estimated cooling load, temperature difference achieved, power consumption, maximum cooling capacity of each TEC and heatsink. The solar photovoltaic operated thermoelectric cool chamber comprises essential components such as SPV Panel, solar charger controller, battery, PWM controller, TEC module with heat sink, and insulated box (TCC unit). The design considerations involve estimating total power consumption and determining the number and ratings of solar panels, batteries, and power conditioning devices to ensure reliable electricity supply. The system operates on SPV-generated power, utilizing MPPT charge controllers to maximize power output. Pulsed width modulation (PWM) systems efficiently regulate power distribution to thermoelectric modules, optimizing performance. The thermoelectric cool chamber was developed of 40 L water capacity. It was observed that, the chamber and water temperature in developed thermoelectric cool chamber was reduced from initial temperature by 11.85°C and 11.56°C, respectively after 24 hours. The chamber and water temperature after 24 hours were 13.31°C and 13.49°C, respectively. The performance evaluation showed that the chamber's cooling efficiency was influenced by factors such as cooling load and water volume. This comprehensive approach enables the development of an effective and sustainable thermoelectric cooling system suitable for various applications.

Key Words : Cool chamber, evaluation, heat load, solar photovoltaic operated, TEC

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***Author for correspondence:**
[1]Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (M.S.) India (Email: ypkhandetod@rediffmail.com)