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WASTE HEAT RECOVERY OF A RECHARGEABLE ELECTRIC VEHICLE BATTERY PACK USING THERMOELECTRIC GENERATORS

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With the rapid growth of electric vehicles (EVs), enhancing energy efficiency and thermal management of battery packs has become increasingly important. The heat generated during the operation of lithium-ion batteries in EVs is released as waste. The primary objective of this study was to investigate the feasibility of using thermoelectric generators (TEGs) to recover this waste heat from EV battery packs and convert it into electricity, thereby improving the overall energy efficiency of the system without compromising battery thermal management. The use of TEGs on EV battery packs to harvest energy while keeping the cooling rate within a safe range has not been attempted before. Addressing this, the power output of a TEG attached to a sample battery pack was evaluated and time-based efficiency gains were assessed. Experimental measurements were conducted to determine the TEG output power for temperature differences (ΔT) ranging from 1 °C to 20 °C, maintaining the safe range for EV batteries. The maximum output power of 0.0238 W was recorded at ΔT = 20 °C. These experimental measurements were then used to calculate the discharge-time based efficiency gains of the battery pack. The results show that the harvested energy could extend the battery discharge time by over 2.4%, demonstrating a meaningful improvement in efficiency. Our prior findings showed that the heat dissipation rate of the battery pack decreased from 2.8 J s^{-1} to 2.5 J s^{-1} after attaching TEGs. However, this slight decrease in cooling rate still maintains the battery temperature within safe limits. These findings suggest that integrating TEGs into battery packs can enhance overall system efficiency by harvesting waste heat, with minimal impact on cooling effectiveness and battery safety.

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Keywords: Discharge time-based efficiency gain, Rechargeable battery pack, Thermoelectric generator