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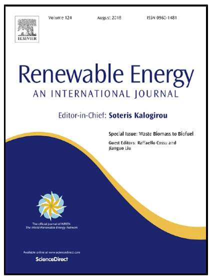

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DEVELOPMENT OF AN AUTOMATIC SOLAR-POWERED DOMESTIC WATER COOLING SYSTEM WITH MULTI-STAGE PELTIER DEVICES

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Abstract

One of the major problem that comes with summer season in the arid countries is rise in the temperature of water for both domestic and commercial building usage. At a persistent high temperature up to 55 degree Celsius for almost half of the year, people have to face challenging and sometimes unbearable hot water for drinking, bathing, and other general use. Cooling this water using conventional cyclic refrigeration is usually met with huge energy consumption that leads to upsurge in electricity tariff, and indirect rise in environmental pollution associated with all processes involved. By leveraging on the abundant solar energy during this period with a cooling technique based on thermoelectric device approach, an effective solution approach is proposed in this study. The proposed method is based on the philosophy of, "cooling the water by the heat of the sun", annexes the environmental friendly solar energy source and cooling technique to provide comfortable water. Design and implementation strategy towards practical deployment of the proposed solution is presented. The real-time results and analysis with a developed laboratory scale prototype show the effectiveness of the system in providing solution to this perennial water problem, and in addition serves as platform for further study.

Key words: water cooling, thermoelectric, Peltier Devices, Solar energy, Renewable energy

Nomenclature

Q: heat absorption or emission
Q_{max}: maximum heat absorption or emission
Q_C: absorbed heat at the Peltier cold side
Q_H: absorbed heat at the Peltier hot side
Q_L: heat load
COP: coefficient of performance
Φ: Figure of merit
α: Seebeck coefficient, V/^{o}C
$\Delta\theta$: temperature gradient
θ_C: Peltier device cold side temperature
θ_H: Peltier device hot side temperature
K: Peltier device thermal conductance
φ: COP
R: net resistance of the Peltier device
ρ: resistivity of the Peltier device
κ: conductivity of the Peltier device
W: net input work done
$I_{opt}^{Q_{max}}$: optimum current at the maximum heat
q: heat flow rate
ΔT: water temperature gradient
T_{inlet}: inlet water temperature
T_{outlet}: outlet water temperature
A: cross sectional area of water tank
Δx: spacing distance between water tank and Peltier device