JJMIE

Volume 16, Number 3, June. 2022
ISSN 1995-6665
Pages 439 – 448

Jordan Journal of Mechanical and Industrial Engineering

Harvesting Human Being Energy to Charge Smartphone

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Received 21 Nov 2021 Accepted 17 Apr 2022

Abstract

Rapid development has occurred recently in the use of thermoelectric generators (TEGs), as they have been applied in numerous fields. Although TEGs can harvest the body's energy, the output voltages they yield are extremely small (a few hundred mV). Accordingly, the objective of this paper is to study the possibility of enlarging a voltage generated by the TEG to a level where it can be used.

In this paper, we provide a comprehensive simulation of the performance of TEGs system that harvests human energy by using one topology of the conversion circuit, the DC/DC step-up converter, that raises the external voltage so that portable mobile devices can be charged. In the proposed system ten pieces of the TEGs have been used, every system contains 35 TEG couples connected serially by legs. The methodology of the current study focuses on using the finite element method (FEM) to simulate the TEG system, where we used ANSYS Workbench software platform (Professional Version 18.1). Moreover, MATLAB and PSPICE Simulink have been used to simulate the energy conversion circuit. The outcomes of this study can be summarized in the following points: 1) the total voltage obtained from the ten pieces of the TEG system is about (2.165V). 2) Using the boost DC/DC converter system help to enlarge the total voltage of TEG to 5 Volt. 3) There is no signifying effect for the different shapes of TEG legs, where a comparison was made between two different shapes of TEG legs, one is rectangular and the other is equivalent cylindrical. 4) The results of TEG were also compared with the results of previous work, and a good agreement has been attained. 5) MATLAB - PSPICE simulation programs were used to design and implement the DC-to-DC boost converter circuit, and the results showed the output response of the overall system being in line with the study objectives.

Keywords: Thermoelectric generator, Human body temperature, DC/DC boost converter, Seebeck effect.

Nomenclature

A	Area [m^2]
c	Heat capacity [J kg^{-1} K^{-1}]
C	Filter capacitance [F]
D	The duty cycle [-]
E	Electric field [V m^{-1}]
F_s	Switching frequency [Hz]
I_L	Inductor current [A]
J	Electric current flux [A m^{-2}]
k	Heat transfer coefficient [W m^{-2} K^{-1}]
L	Inductance [Henry]
P	Electric power [W]
P'	Peltier coefficient [-]
Q	Heat power [W]
Q'	Density of Joule heating energy [W m^{-3}]
q''	Heat flux [W m^{-2}]
R	Electrical resistance [Ω]
R_{DS}	Drain source ON-state resistance [Ω]
R_L	Inductor resistance [Ω]
S	Seebeck coefficient [V K^{-1}]
T	Absolute temperature [K]
T_s	Switching cycle [s]
T_{ON}	ON state time [s]
T_{OFF}	OFF state time [s]
t	Time [s]
V	Voltage [V]
V_d	Forward voltage drop [V]
V_L	Inductor voltage [V]

Greek letters

Δ	Difference
η	Conversion efficiency
κ	Thermal conductivity [W m^{-1} K^{-1}]
ρ	Density [kg m^{-3}]
ρ_c	Charge density [C m^{-3}]
ρ_e	Electrical resistivity [Ω m]
σ	Electrical conductivity [S m]
τ	Time period [s]

Abbreviations

TEG	Thermoelectric generator
DC	Direct current
CCM	Continuous current mode

1. Introduction

Globally, electric power generation is shifting to more environment-friendly methods, since the use of conventional sources of energy causes more environmental issues, including global warming, greenhouse gases, and air pollution. This makes the use of renewable energy resources crucial. Solar energy has been used in many applications, incling electric power generation and in water

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