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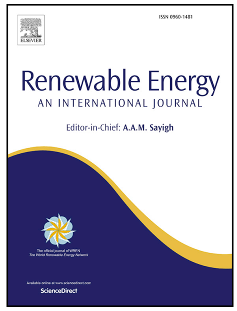

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Conversion of Atmospheric Variations into Electric Power – Design and Analysis of an Electric Power Generator System

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Abstract

Given its abundant availability, ambient thermal energy harvesting has the potential to power standalone microelectronic systems. The challenge in efficiently harvesting temperature and pressure variations is the low thermal to electric conversion ability of current harvesters. Most thermal harvesters require high temperature gradients. This paper presents the design, analysis, and implementation of an energy harvesting system that effectively harnesses naturally occurring temperature variations using ethyl chloride filled mechanical bellows. A mechanical drivetrain scales the bellows displacement and a coil spring stores the potential energy. This energy is periodically released and converted into useable electric power by a DC generator. A series of mathematical models are developed and accompanying numerical analyses completed on the harvester system. For a low frequency sinusoidal temperature cycle of ±1°C about 22°C, 9.6 mW of electrical power was produced using a 1.5V micro DC generator for a 24 hour harvesting period. The power generation capacity of the proposed harvester is sufficient to indefinitely operate low power sensors and microelectronics in environments with small temperature gradients.

Keywords: atmospheric variations; thermal energy harvesting; energy storage.

1. Introduction

The process of harnessing or "capturing" energy from ambient sources that are natural or artificial, and converting it to useable electric power is referred to as energy harvesting. Strict environmental regulations and rising interest in power capability of electronic devices, wireless sensor networks and autonomous devices have created a rising market for energy harvesting technologies. Currently, mass manufactured energy harvesting devices are targeted to run a range of low-power and mid-power electronic equipment. Energy harvesting allows implementation of self-sustaining, portable smart devices that have increased life and minimal maintenance requirements [1]. These energy harvesters can facilitate the use of smart computers, low power sensors [2] and LED lighting systems in remote regions throughout the world with minimal battery storage requirements. Ideally energy harvesters are compact, miniature systems that can be integrated into devices without significant structure or space requirements. Advanced material technologies, micro-manufacturing and three dimensional (3D) printing have enabled the development of micro components that satisfy functional requirements, at lower costs. Energy storage techniques have also received considerable attention in offering dense power capacities for uninterrupted power when coupled with energy harvesting systems.