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GENERATION AND STORAGE OF ELECTRICITY FROM POWERHARVESTINGDEVICES

KEY WORDS:

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ABSTRACT

The idea of capturing the energy that surround an electronic device and transforming it into useful electrical energy that could extend the life of the power source or provide an unlimited supply of energy has caught the interest of many researchers. Utilizing piezoelectric materials to obtain the energy surrounding a system is one technique. The capacity to exchange electrical and mechanical energy is unique to piezoelectric materials. This characteristic enables them to absorb mechanical energy from the environment, such as ambient vibration, and convert it to electricity that can be used to power other devices. The quantity of energy generated by piezoelectric materials, on the other hand, is significantly less than that required by most modern equipment. As a result, techniques for storing and collecting the energy generated until enough power is captured must be devised. The quantity of power generated by a piezoelectric plate is quantified in this research, and two techniques of aggregating the energy produced are investigated. The first use a capacitor, which has long been a popular means storing energy, and the second employs nickel metal batteries. The benefits of each approach are reviewed, and it is discovered that the rechargeable battery has much more desirable properties than the capacitor. The power output of piezoelectric materials is proven to be compatible with that required by a rechargeable battery, and a 40 MAH battery may be charged in under an hour.

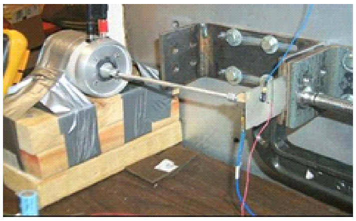
INTRODUCTION

Piezoelectric materials can be used to convert mechanical energy, such as ambient vibration, into electrical energy that can power other devices. Power harvesting is the process of capturing and converting energy around a system into usable power. Portable systems that do not on standard power sources, such as the battery, which has a limited operational life, can be produced using power harvesting devices. The energy generated by the piezoelectric effect, however, is enough to power most electrical devices directly. As a result, a power harvesting system must include a method of collecting and storing captured energy so that it can be used to power portable electronics.

Experimental Setup

The piezoelectric device employed in this part of the study was an AL plate with a Piezoelectric Systems Inc. PSI-5H4E phase change material (PZT) glued to its surface. Superglue was used to bond the piezoelectric material, and the plate and piezoelectric patch had the measurements depicted . The plate and PZT had thicknesses of 0.04 inch and 0.0105 inch, respectively. Because the piezoelectric ceramic material is incredibly brittle and vulnerable to inadvertent breaking, it was glued to a thick substrate to decrease the risk of injuring the piezoelectric.

The vehicle engine is an example of a random vibration environment that is conveniently accessible for analysis. A highway bridge, large skyscrapers, or wing are examples of other possible applications. Each one gives plenty of vibration. However, a vehicle compressor was chosen due to its accessibility and unpredictable nature. As a result, the investigations that follow look into the thought of getting electricity from the vibration of a common mechanical system like an automotive compressor. A PCB voltmeter, model 352C22, was mounted at a random location on the compressor to replicate the vibration of the compressor. Because no effort was made to improve the positioning of the sensors to achieve the largest amplitude of vibration, the phrase "random location" was utilized, nor is the compressor in the engine compartment the best place to get vibration energy. The altimeter was used to measure the compressor's response as the engine was driven at various speeds. From 0 to 1000 Hz, the signal measured from a Mitsubishi Eclipse's compressor suggested random vibration. shows a typical response displaying the magnitude of vibration detected at a random place on the automobile compressor, as well as the input signal employed in the experiment . As indicated in, the AL plate was mounted to a ridged structure with cantilever boundary conditions (fixed-free), and an excitation force was provided by a shaker. By placing the same altimeter on the piezoelectric plate and modifying the signal sent to the shaker until it was comparable to that of the compressor, the excitation signal applied in the experiments was discovered. The disturbance applied in the trials was 9.5 percent smaller than the vibration of an automotive compressor, demonstrating that the excitation signal employed was cautious in portraying the vibration. Two ways were used to store the energy generated by the PZT. The first technique charged a nickel metal battery, whereas the second method charged a capacitor that provides for instant access to the stored energy.



Power Generation

The quantity of power this particular device could create was measured before the previously indicated circuits were utilized to accumulate the generated energy. Because several parameters influence the power generated, such as substrate thickness, material employed, excitation strength, and load resistance, the results are unique to this piezoelectric device. When the impedance of the piezoelectric element and the load resistance are matched, the maximum power production is achieved. However, because the piezoelectric is a capacitive device, the impedance fluctuates with frequency, and thus the ideal load resistance varies, this cannot always be attained during testing. The load resistance was set to the impedance of the PZT at the output for the ensuing power generation results.The power generated by the PZT was obtained using the voltage drop across a 10kW resistor. The power is calculated using the following relation obtained using Ohm's law:

V 2P /R

Based on the possibility power, while V denotes the voltage drop across the load resistance R.shows the generated power (with a chirp input of 0-250Hz) and shows the voltage and current found. The data shown uses a chirp signal rather than the random signal shown previously because a chirp signal makes it easier to understand the voltage produced at various frequencies. The greatest instantaneous power is identified as 2mW in the figure, which occurs at the resonance of the test plate. e PZT plates with the same configuration were tested, and all generated a maximum power of 1.5-2mW and an average power of 0.14-0.2mW. These measurements were taken without the use of a capacitor, implying that this power would be available right away to power additional devices. The efficiency of circuit components like a capacitor, diode, and voltage regulator, on the other hand, are not taken into account in these computations. This predicted power would be sufficient to operate commonly accessible sensors, actuators, or telemetry devices in many field applications, not to mention the time it would take to charge the circuit if a capacitor or battery is used.

Conclusions

Two techniques of storing power generated by piezoelectric materials were examined in this paper. The amount of power that could be generated by the piezoelectric power harvesting plate employed was first determined. This was done in order to identify the maximum output as well as to scale the task to other devices. The usage of a capacitor circuit was the first storage method attempted, followed by a nickel metal rechargeable battery. The capacitor method worked well, but capacitors' high discharge rate prevented them from generating a continuous signal, which is required in many electronic applications. The second power storage technology investigated was ,This paper looked at two methods for storing power generated by piezoelectric materials. First, the amount of power that the piezoelectric energy harvesting plate could generate was calculated. This was done to determine the maximum output and to adapt the task to different devices. The first storage mechanism attempted was a capacitor circuit, which was followed by a nickel metal rechargeable battery. And though the capacitor approach worked well, the high discharge rate of capacitors prevented them from producing a continuous signal, which is required in many electronic applications.

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