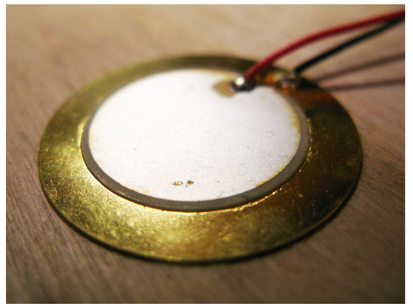
INNOVATIVE APPLICATIONS OF PIEZOELECTRIC GENERATORS: ANALYZING EFFICACY AND FEASIBILITY



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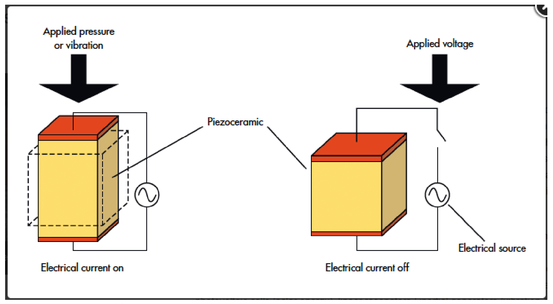
Introduction

The objective of the study was to test and collect data on novel application areas of piezoelectric materials to determine their overall efficacy and efficiency for the transfer from mechanical to electrical energy. Efficacy was determined by the magnitude of the voltage as well as the electrical current being produced, in relation to the magnitude and frequency of the vibrations being applied. Analysis of quantitative data enabled calculation of the efficacy of the conversion and ultimately showed whether the piezoelectric materials can be an effective way to recycle energy lost to vibrations in modern machinery and infrastructure, and an alternative energy generation practice.



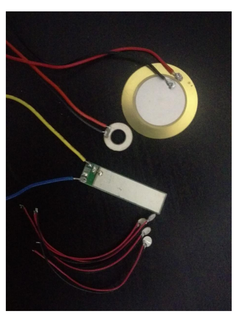
http://shm.ucsd.edu/Site/research/energyharvesting.html

Method

Test the voltage output of each piezoelectric crystal and ceramic design by testing for both vibrations and pressure. The ceramics were attached to the external surfaces of the machinery used for testing, which include single-room AC unit, building AC unit, washing machine and dryer. Based on the qualitative observations of the machinery and the data collected, the potential and direction of further testing was determined.

Materials

- Piezoelectric Ceramic disks, plate and Ring
- Piezoelectric Film
- National Instruments MYDaq
- Multimeter



Data and Tables

Table 1. AC Voltage Output from Vibrations for the Various Applications Tested

Single-Room AC Unit				
Disk	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	0.17	0.00	-0.81	0.98
	0.30	-2.6	-5.3	5.6
	0.34	-1.7	-4.0	4.4
Ring	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	1.3	1.0	0.71	0.55
	1.1	-3.2	-5.9	7.1
	2.5	0.74	-1.1	3.6
	2.5	-0.07	-2.8	5.2
	2.6	-0.32	-3.4	6.0
Plate	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	1.9	-0.46	-4.8	6.8
Building AC Unit				
Ring	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	3.9	0.13	-2.7	6.5
	3.5	0.18	-3.5	7.0
	9.8	-0.14	-3.6	14
Washing Machine				
Ring	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	0.1	0.02	-0.43	0.53
Dryer				
Ring	Max(V)	Average(V)	Min(V)	Pk-Pk(V)
	0.93	0.02	-0.74	1.7

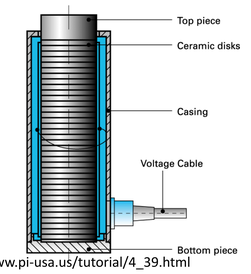
Results

Based on the data collected piezoelectric materials tested produced higher voltage outputs when tested on larger machinery and when placed closer to the motor or source of the vibrations. On the other hand, the voltages recorded together with the current produced from the experiments was found to be lower than initially expected, thus rendering the use of crystals inefficient in terms of passively harvesting energy from vibrations.

Conclusion

Due to lack of testing equipment the frequencies of the vibrations produced by the machinery used for the testing are not available. Without those numbers it is hard to make concrete statements. The data collected also only includes single ceramic applications. The ceramics tested can produce voltage from vibrations. The voltages produced are low, but it can be increased connecting large numbers of ceramics in stacks or in series. Piezoelectric ceramics have the potential to be applied in modern machinery that produces large enough vibrations. Further testing will be required to find the efficiency and confirm if this application is cost effective

Figure 1. Diagram showing a design setup to increase voltage output by stacking crystals



http://www.pi-usa.us/tutorial/4_39.html

Future Plans

- Design and test generators that use piezoelectric materials
- Compare the efficiency and cost of piezoelectric materials to currently used sustainable energy sources
- Further testing to seek optimal application areas
- Project successes and failures are intended to be reported as a conference paper in the Fall semester

References

- Energy harvesting from low frequency applications using piezoelectric materials Huidong Li-Chuan Tian-Z. Deng - http://aip.scitation.org/doi/full/10.1063/1.4900845
- Daniel Motter-Jairo Lavarda-Felipe Dias-Samuel Silva - http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-58782012000500006

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