HG-11

Magnetic Analysis of Electromagnetic Microgenerator via Finite Element Analysis.

W. Chin Chye, Z. Dahari
School of Electrical and Electronic Engineering, Universiti Sains Malaysia, Nibong Tebal, Malaysia

Introduction

In future, micro sensor system will be deployed throughout our environment for monitoring purpose. Powering system is becoming important factor for independent and long period deployment sensors in our environment (deploy and forgot). Micro systems that are able to convert energy present in environment to electrical energy are one of the key components to have self-sustained system for critical environment such deep sea, space and human body where replacement of energy system is nearly impossible or too costly. This paper presents a design and modeling of a vibration based micro power generator using Finite Element Analysis (FEA) software which uses permanent magnet to convert mechanical energy into useful electrical power by Faraday's law of induction. [1, 2].

Design and modeling

The micro generator consists of a cantilever, neodymium iron boron (NdFeB), coil and permalloy. The design used two high flux density NdFeB magnets bonded to the top and bottom surface of the end of cantilever while other end of cantilever was fixed. Figure 1 shows the magnets arrangement. The magnets sizes are 10 X 10 X 10 cubic millimeter each while the cantilever used in this design is 50 X 10 X 0.5 cubic millimeter. In order to study the magnetic behaviors of the design, it is modeled in the FEA as shown in figure 2. The simulation results of the magnetic flux plot and densities of the magnets are demonstrated in figure 3 and 4, respectively. Paths were set along the modeled copper coils in order to extract the flux density values across the coils. Figure 5 and 6 shown the Bx and By component for the left and right-hand side of the structure respectively. According to the Faraday's law of induction, the induced electromotive force (emf) in any closed circuit is equal to the time rate of change of magnetic flux through the circuit. Thus, the flux component Bx becomes main flux density component to pass through the coil perpendicularly and induces emf in the coil. Hence, the Bx component in this analysis will play a significant role in the emf output. By comparing both figure 5 and 6, it can be seen that the magnetic flux density can be increased by including the permalloy material besides the planar coil. The result showed that with a permalloy it is able to achieve 0.23 T compared to .0148 T in the case of without the core.

[1]Cian O Mathuna, Terence O'Donnell, Rafael V. Martinez-Catala, James Rohan, and B. O'Flynn, "Energy scavenging for long-term deployable wireless sensor networks.," Talanta, vol. 75, pp. 613–623, 2008.

[2]T. v. Buren, P. Lukowicz, and G. Troster, "Kinetic energy powered computing – an experimental feasibility study," in Proceedings of Seventh IEEE International Symposium on Wearable Computers, 2003.

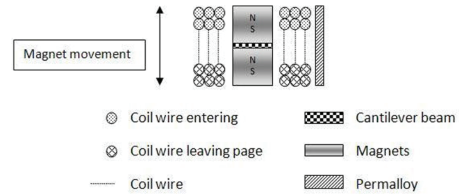

Figure 1. Cross section of the magnet arrangement.

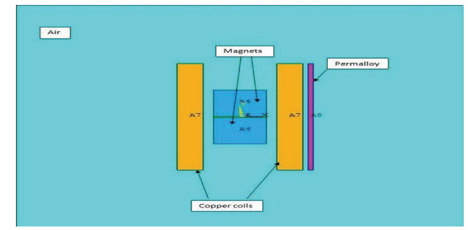

Figure 2. The modeling of cross sectional magnets arrangement in ANSY.

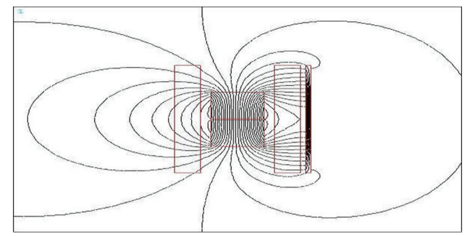

Figure 3. The flux density of the magnets. The right hand side shows the flux linkage under permalloy effect while left side shows the ordinary flux linkage over the coils.

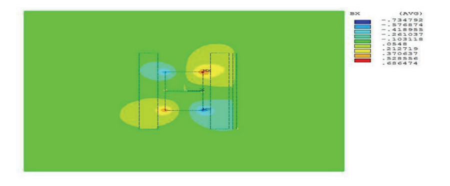

Figure 4. The above graph shows the Bx component of the flux density.

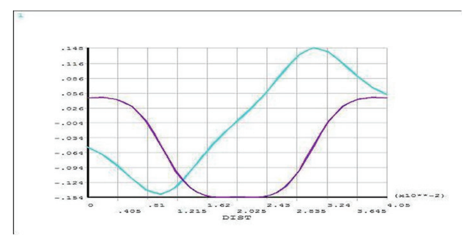

Figure 5. The flux density along the left side coil.

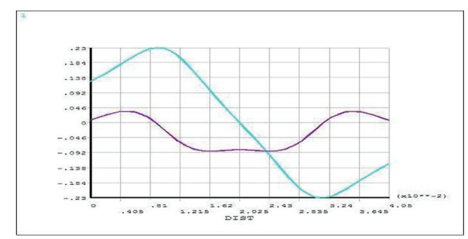

Figure 6. The flux density along the right side coil under permalloy effect.