



24th COBEM - 2017



24th ABCM International Congress of Mechanical Engineering
December 3-8, 2017, Curitiba, PR, Brazil

COBEM-2017-0464

DEVELOPMENT OF A HYBRID ENERGY GENERATION SYSTEM THROUGH ELECTROMAGNETIC INDUCTION

Bruno da Cunha Diniz

Universidade Federal da Bahia, Department of Mechanical Engineering, Salvador, Brazil
bruno.diniz@ufba.br

Leonardo Lima Gusmão

leonardolimagusmao@gmail.com

Abstract. *Due to a increasing global energy demand, the development of sustainability technologies is crucial for a society that is increasingly dependent on electricity for domestic, commercial and industrial purposes. The main purpose of this work is to develop and analyze the feasibility of a system that uses different rotating elements to generate electric energy, through the construction of a prototype. The relative rotation of neodymium magnets, in altered orientation along a disc, over coils of enamelled wire causes electric current to be generated by means of electromagnetic induction. Parameters such as presence of ferromagnetic core in the coils, distance between magnets and coils, and type of connection between the coils were analyzed during the tests. The results obtained, from the analysis of the data collected, were satisfactory, and the system, very promising in what is proposed.*

Keywords: *Hybrid systems, energy generation, energy cogeneration, electromagnetic induction, sustainable energy.*

1. INTRODUCTION

The current society is highly dependent on electric power. According to the Agência Nacional de Petróleo (ANP, 2009), taking into account current reserves and extraction regime, world reserves of oil and natural gas are expected to be exhausted in 150 years and those of coal in just over 200 years. As the global energy consumption is not expected to decrease, new methods of energy generation are increasingly needed.

2. PROTOTYPE

This project consists of analyzing the feasibility of the use of the spinning function of several devices for the generation of electric energy by means of the construction of a prototype.

The prototype consists on a fixed platform containing the enameled copper wire coils and where the motor is fixed. The disc with the neodymium magnets are attached on the motor shaft itself, which are the moving part of the system. The relative rotation of these elements causes the magnetic field inside the coils to be changed and electrical energy is generated. The electric motor is powered by an external power source, and the prototype aims to simulate the turning of a car wheel.

The innovation of the project is in the small size of the system, which enables applications in previously unfeasible locations and devices. It is also worth highlighting the fact that the proposal aims to generate energy through objects that already have the rotation as a function, allowing future tests and adaptations in different systems.

2.1 Experimental procedure

The variables used in the data collection were the presence of ferromagnetic core in the coils, the distance from the magnets to the coils, and data were collected with single and biphasic connection between the coils.

The impossibility of defining the energy efficiency was due to the impossibility of measuring the decrease in the speed of the disk when the current and voltage were measured. Future study's aims to observe the force of resistance imposed by the electric generation with and without the presence of the ferromagnetic core in the coils, thereby defining the system energy efficiency.

2.2 Results and discussion

The power generated is enough to charge a battery, both in voltage and current. In addition, it was observed that the presence of ferromagnetic core in the coils increases the power generation, so the data collected and its subsequent analysis allows us to infer that the system performed satisfactorily, showing itself to be very promising in its application.

2.3 Data collect

The tests were performed with and without the ferromagnetic core on the coils. Another variable was the distance from the magnets to the coils. There were five defined distances. First with the magnets distant of 0.5 cm of the coils, the later stages occurred with variation of 1.0 cm in relation to the previous one. Finally, data were collected with single and biphasic coils.

With each defined distance the system was tested twice, and all the tests lasted for forty-five seconds, in order to allow the stabilization of the engine rotation.

It is noticed that the shorter the distance between the magnet and the coils the greater the electrical power generated. However, the disc fastening mechanism prevents the use of ferromagnetic core in the coils at very short distances.

Therefore, for applications of the system where the magnets can remain very close to the coils, between 0.5cm and 1.5cm, it is indicated that it works without the ferromagnetic cores added to the coils. In places where this distance has to be increased, the addition of the ferromagnetic cores to the system allows a gain in the energy generation.

It is worth mentioning that the system only proves viable when the stator is constructed by means of a biphasic connection between the coils.

2.4 Figures and tables

Below, image of the prototype already assembled and ready for testing.

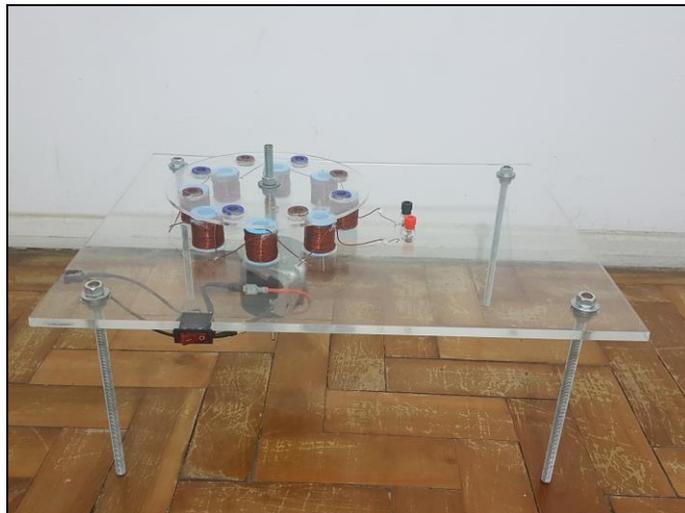


Figure 1. Assembled functional prototype

The figures 2, 3 and 4 show the respective comparisons for voltage, current and power available with the system in single-phase connection.

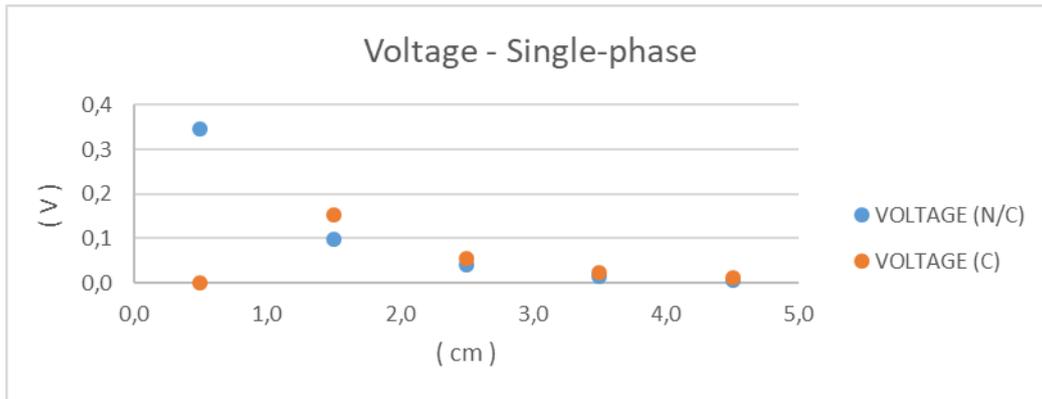


Figure 2. Comparison of voltage generation in the single-phase system with and without ferromagnetic cores

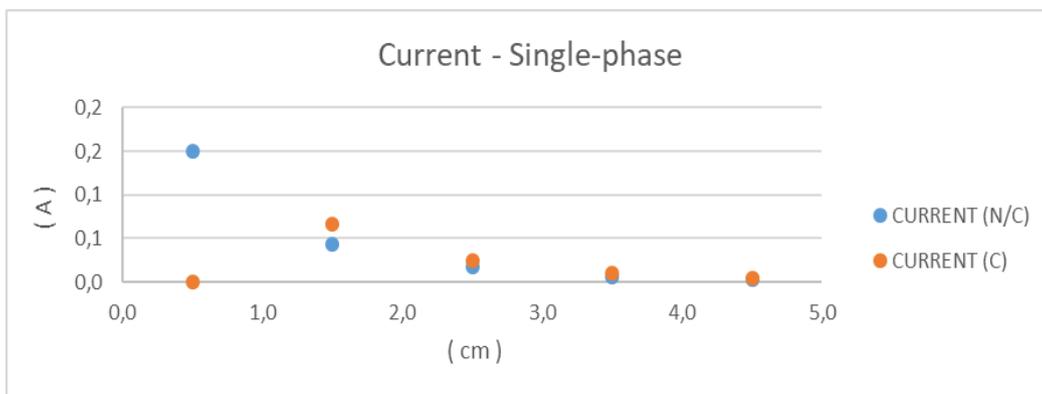


Figure 3. Comparison of current generation in the single-phase system with and without ferromagnetic cores

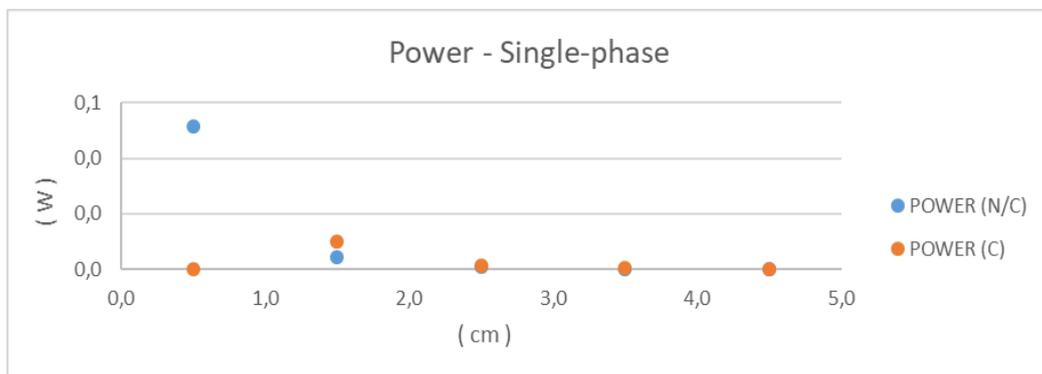


Figure 4. Comparison of power generation in the single-phase system with and without ferromagnetic cores

Figures 5, 6 and 7 show the respective comparisons for voltage, current and power available with the system in biphasic connection.

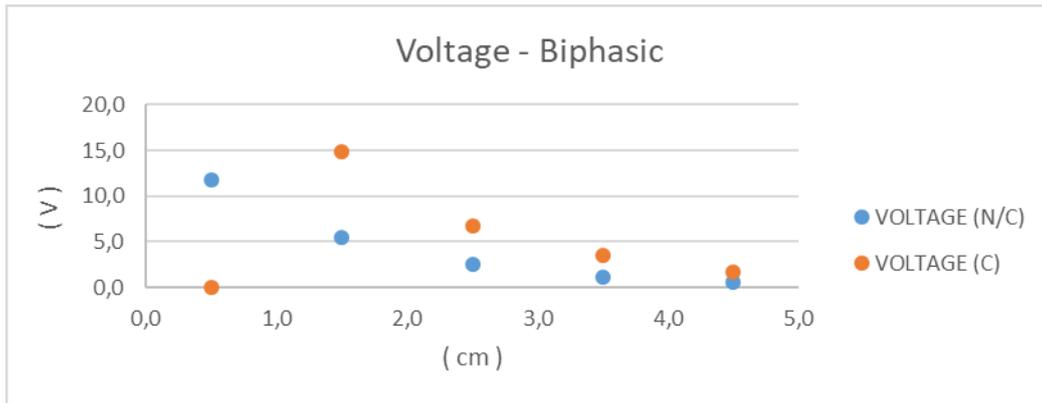


Figure 5. Comparison of voltage generation in the biphasic system with and without ferromagnetic cores

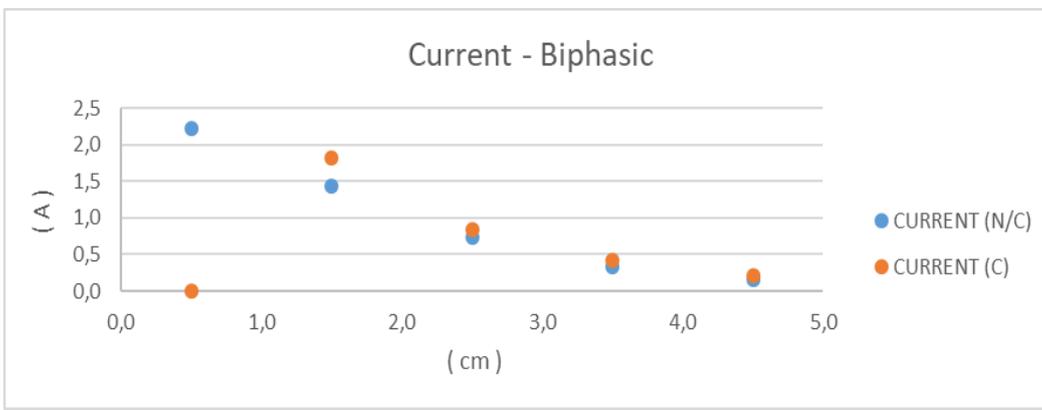


Figure 6. Comparison of voltage generation in the biphasic system with and without ferromagnetic cores

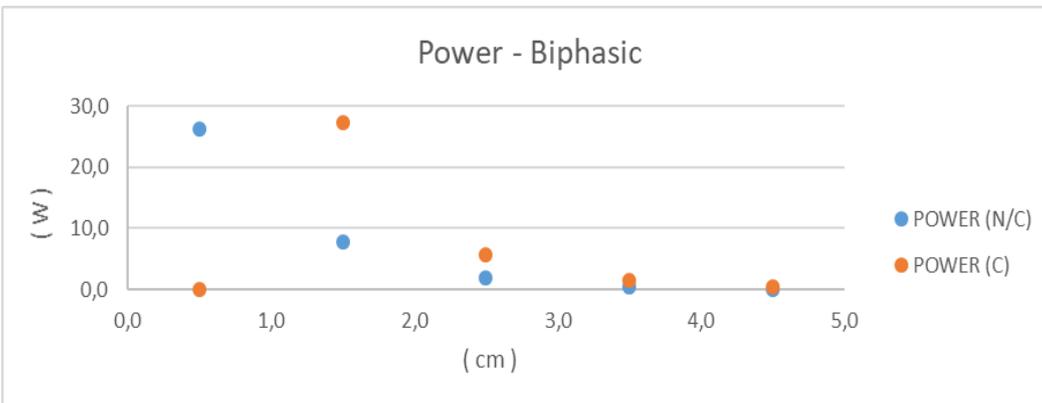


Figure 7. Comparison of voltage generation in the biphasic system with and without ferromagnetic cores

Tables 1 and 2 present all the data collected on the system in single-phase and biphasic connection, respectively, for better visualization purposes.

Table 1. Listing of the data collected for single-phase system connection, highlighting the highest values collected.

Distance (cm)	0,5		1,5		2,5		3,5		4,5	
	C	N/C								
Voltage (V)	0,000	0,345	0,152	0,099	0,055	0,040	0,024	0,015	0,010	0,006
Current (A)	0,000	0,150	0,066	0,043	0,024	0,017	0,010	0,007	0,004	0,002
Power (W)	0,000	0,052	0,010	0,004	0,001	0,001	0,000	0,000	0,000	0,000

Table 2. Listing of the data collected for biphasic system connection, highlighting the highest values collected.

Distance (cm)	0,5		1,5		2,5		3,5		4,5	
	C	N/C	C	N/C	C	N/C	C	N/C	C	N/C
Voltage (V)	0,000	11,840	14,720	5,410	6,780	2,530	3,480	1,080	1,680	0,520
Current (A)	0,000	2,220	1,830	1,440	0,840	0,740	0,420	0,330	0,210	0,160
Power (W)	0,000	26,285	26,938	7,790	5,695	1,872	1,462	0,356	0,353	0,083

3. CONCLUSIONS

The initial hypothesis that it would be possible to generate a significant amount of energy through electromagnetic induction using reduced size coils of enameled wire and small neodymium magnets was confirmed.

The energy generated is sufficient to charge batteries, both in voltage and current, proving the viability of the usage of the system. This does not indicate that the proposed application for the system will have the same performance as the prototype since the system was built almost artisanal. The use of more refined design and construction techniques can make the results even more significant.

4. REFERENCES

Listed below are all the essential references to corroborate and complement the understanding of the proposed work:

- Ametic. Estudio de viabilidad previo al diseño de un esquema de logística, tratamiento y reciclado de baterías de vehículo eléctrico y vehículo híbrido. Available at: <[http://ametic.es/sites/default/files/media/Anexo1_Estudio_bat_estado_arte%20\(1\).pdf](http://ametic.es/sites/default/files/media/Anexo1_Estudio_bat_estado_arte%20(1).pdf)>. Accessed at 13th Mar. 2017
- Brasil, 2005. Ministério de Minas e Energia. Empresa de Pesquisa Energética. Balanço Energético Nacional 2006: Ano base. Relatório final. Rio de Janeiro: EPE, 2006. Available at: <https://ben.epe.gov.br/downloads/BEN2006_Versao_Completa.pdf>. Accessed at 24th Jan. 2017.
- Casimir, H. B. G.; UBBNIK, J., 1976. The skin effect. Phillips Technical Review, Toronto, v. 28, n. 9, p. 271-283. Available at: <http://www.extra.research.philips.com/hera/people/aarts/_Philips%20Bound%20Archive/PTechReview/PTechReview-28-1967-300.pdf>. Accessed at 10th Feb. 2017.
- Chan, C. C., 1993. "An overview of electric vehicle technology", Proc. IEEE, vol. 81, pp. 1202-1213. Available at: <<http://ieeexplore.ieee.org/abstract/document/989873/references>>. Accessed at 10th Feb. de 2017.
- Euder, Francisco, 2011. KERS. Available at: <<http://umpontovirtual.blogspot.com.br/2011/04/kers.html>>. Accessed at 13th Mar. 2017.
- Halliday, Resnick, Walker, 2009. Fundamentos de Física. Vol. 3. 8 ed. Editora LTC.
- Investtienergy. Sistemas de generación de energía en una sola instalación. Available at: <<http://www.investtienergy.com/sistemas-hibridos-2/>>. Accessed at 14th Mar. 2017.
- Koimas. Neodímio. Available at: <<http://www.koimas.com.br/produtos-imas-neodimio.php>>. Accessed at 21th Feb. 2017.
- Nussenzveig, H. M., 2002. Curso de Física Básica: Mecânica. Vol1. 4 ed. Edgard Blücher.
- Porsche. Prof. Ferdinand Porsche Created the First Functional Hybrid Car. Available at: <<http://press.porsche.com/news/release.php?id=642>>. Accessed at 13th Mar. 2017.
- Rajashkara, K., 2002. "Power electronics for the future of automotive industry", Proc. PCIM Eur.. Available at: <<http://ieeexplore.ieee.org/document/4493430/references>>. Accessed em 10th Feb. 2017.
- Robert, R. Efeito Peculiar. Revista Brasileira de Ensino de Física, São Paulo, v.22, n.2, p. 285-289, 2000. Available at: <http://www.sbfisica.org.br/rbef/pdf/v22_285.pdf>. Accessed in 10th Feb. 2017.
- Teixeira, Mariane. Indução eletromagnética. Available at: <<http://mundoeducacao.bol.uol.com.br/fisica/inducaoeletromagnetica.htm>>. Accessed in 13th Mar. 2017.
- Tolmasquim, Mauricio T.; GUERREIRO, Amilcar; GORINI, Ricardo, 2007. Matriz energética brasileira: uma prospectiva. Novos estud. - CEBRAP, São Paulo, n. 79, p. 47-69. Available at: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S010133002007000300003&lng=en&nrm=iso>. Accessed at 24th Jan. 2017.
- UFRGS. Tabela de características dos fios esmaltados AWG. Available at: <http://www.if.ufrgs.br/~mittmann/tabela_de_fios.pdf>. Ac http://www.if.ufrgs.br/~mittmann/tabela_de_fios.pdf. Accessed at 17th Feb. 2017.

5. RESPONSIBILITY NOTICE

The authors are the only responsible for the printed material included in this paper.