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EDITORIAL

It is my proud privilege to welcome you all to the ISERD International Conference at Seoul, South Korea in association with The IIER. I am happy to see the papers from all part of the world and some of the best paper published in this proceedings. This proceeding brings out the various Research papers from diverse areas of Science, Engineering, Technology and Management. This platform is intended to provide a platform for researchers, educators and professionals to present their discoveries and innovative practice and to explore future trends and applications in the field Science and Engineering. However, this conference will also provide a forum for dissemination of knowledge on both theoretical and applied research on the above said area with an ultimate aim to bridge the gap between these coherent disciplines of knowledge. Thus the forum accelerates the trend of development of technology for next generation. Our goal is to make the Conference proceedings useful and interesting to audiences involved in research in these areas, as well as to those involved in design, implementation and operation, to achieve the goal.

I once again give thanks to the Institute of Research and Journals, ISERD & TheIIER for organizing this event in Seoul, South Korea. I am sure the contributions by the authors shall add value to the research community. I also thank all the International Advisory members and Reviewers for making this event a Successful one.

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CHARACTERISTICS ANALYSIS OF ELECTROSTATIC GENERATOR

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Abstract—Due to the demand of the modern era, now electricity has become an important factor in every sector in our life. Almost everywhere the electromagnetic induction technique is used to generate the electrical power. Once upon a time, the electrostatic induction technique was used to generate the electrical power. Unfortunately, there is little information about the mathematical modeling and characteristics of static electricity generators. A Wimshurst electrostatic generator of disk diameter 34.0 cm has been designed and experimentally study the characteristics to find the optimized condition for maximum output power. From the results, it has been found that the generator has maximum performance when the conductor segment length about 30% of the diameter of the disk. The machine performance has intensely depended on the total surface area of the conducting material and slightly relied on the number of sectors/segments.

Index Terms—Static electricity, high voltage DC, breakdown voltage, EWICON, Wimshurst electrostatic generator, Van Di Graaff generator.

I. INTRODUCTION

A significant amount of energy is used directly in the form of electric power in every country around the world, due to its easy transmission, distribution and management. Moreover, it is environment-friendly.Nowadays, electromagnetic induction is used to generate the electric power and most of the cases it is in the form of alternating current (AC). However, electrostatic induction can also be used to generate the electric power, but the drawback of this system is, it can generate the power in the form of direct current (DC) and high voltage only. As a result, it uses are limited to some specialized applications and research only. It is possible to overcome this shortcoming of the system by converting the DC into AC supply. Another unruly matter is, the high voltage can easily damage the conducting material due to high voltage electrical arc discharge and break down the insulation materials. As a result, to make a sustainable system it needs special materials and equipment [1]. Now, there is tremendous progress in the material science and electronic devices that make it easy to convert the electric power supply from the DC to AC or vice versa [2]. Once the electric power supply converted into AC from the DC which is generated from an electrostatic generator, the next steps are as usual and it is no longer needed to modify the existing electrical system. However, the challenging task of this research is to find a suitable and sustainable system to transform the high voltage DC into AC supply [3]. The aim of this research is to characterize the electrostatic induction generator and optimize the parameter for the design a Wimshurst electrostatic generator. The history of electricity, especially the static electricity was long, long ago. The fruitful applications of the electricity were started in the last century after the invention of the electromagnetic induction theory and electromagnetic induction type electric generator. Initially, there was a lot of debates between Alternating Current (AC) and Direct Current (DC) supplies. Finally, AC became champion. The AC supply has many benefits such as AC devices are simple, cost efficient and easy to control. Therefore, industries and manufacturers concentrate their focus on production in this direction. Still, the electrostatic induction theory is used to generate the high voltage DC supply for research and special applications. The main barriers of the electrostatic generator are that it can only generate high voltage DC and small current. However, it is the limitation of the existing current technology only. Many countries are using the high voltage DC supply (HVDC) for long distance bulk transmission of electrical power, in contrast with the more common AC systems [4]. The HVDC systems may be less expensive and suffer lower electrical power losses for long-distance transmission. Nowadays, China uses 2,071 km, ±800 kV, 6400 MW HVDC link connecting the Xiangjiaba Dam to Shanghai city [5, 6]. In 2013, the world longest HVDC link was established at the Rio Madeira link in Brazil for 2,375 km, which consists of two bipoles of ±600 kV, 3150 MW each, tie Porto Velho in the state of Rondonia to the Sao Paulo area [6]. It seems that DC supply is again becoming popular due to the HVDC has many advantages compared to regular AC supply and in many future systems will be developed based on the HVDC [7].

Usually, the HVDC is generated from an AC supply. An electromagnetic induction type generator is used to generate the AC supply, then step-up the voltage and finally this high voltage AC is converted to HVDC by rectification and filtering process. Since the electrostatic generators inherently generate HVDC, it is possible to generate the HVDC directly for transmission line by using an electrostatic generator without rectification and filtering that is supposed to be more efficient. Since the histories of the electrostatic generators and machines are too old, there are a few current articles on these topics available. In 2013, The School of Electrical Engineering, Mathematics and Computer Science at Delft University of Technology (TU Delft) claimed a new electrostatic wind energy converter or generator named "EWICON." There are no moving parts except wind flowing in it. It is powered by the wind carrying away charged particles from its collector [8] that can be used for household electric power supplies. Usually, the electric power end-users, i.e., household and industry uses low voltage DC or AC supplies. In the early stage, it was not easy to convert the low voltage DC/AC from the HVDC which is generated from the electrostatic generator. Now, the tremendous progress in material science and semiconductor devices, it becomes easy to construct a cost effective long lifetime.

II. DESIGN OF A WIMSHURST ELECTROSTATIC GENERATOR

The acrylic plastic sheet has been chosen in the design for the insulating disk of the generator. It has very good electrical properties which are essential for an electrostatic generator. Aluminum foil has been used for conducting material of the segments. In this design, two identical circular acrylic disks have been placed back to back face with a concentric center. The disks are rotated in opposite directions about a horizontal axis by the electrical motor. Fig. 1(a) and (b) shows one of the disks and the metal sectors of the electrostatic generator respectively. The technical drawing has been performed by using CAD tools.

Assuming that the number of metal sectors in the dielectric disk is N, so the angle θ of the each sector can be represented by (1),

$$\theta=360/N \qquad (1)$$

The length, L between the centers of the outer and the inner arcs of the segment,

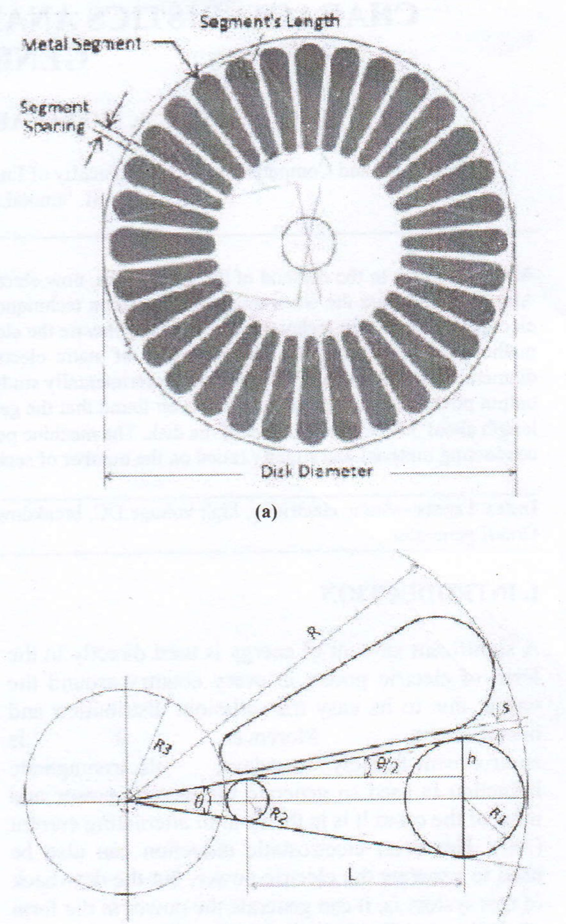
$$L=R-R_1-R_2-R_3 \qquad (2)$$

Where, R_1, R_2 and R_3 are the radius of the outer circle, inner circle and the empty space circle respectively.
The radius of the inner and the outer arcs of the segments can be calculated as follows:

$$R_1/(R-R_1)=\tan(\theta/2)$$
$$\text{Or, } R_1=R\tan(\theta/2)/[1+\tan(\theta/2)] \qquad (3)$$

Where, R is the radius of the acrylic plastic disk.
Similarly,

$$R_2/(R_2+R_3)=\tan(\theta/2)$$
$$\text{Or, } R_2=R_3\tan(\theta/2)/[1+\tan(\theta/2)] \qquad (4)$$



(a)

(b)

Fig. 1 Disk design of the Wimshurst electrostatic generator: (a) metal segment arrangement on the disk, (b) geometry of the metal segment

If, s is the spacing between the two successive segments, then the area, A of the each metal segment can be calculated as follows:

$$A=LR_2+LR_2+0.5hL+0.5hL+0.5\pi R_1^2+0.5\pi R_2^2-Ls$$
$$\text{Or, } A=2LR_2+hL+0.5\pi(R_1^2+R_2^2)-Ls \qquad (5)$$

Where, h is the difference between R_1 and R_2

$$h=L\tan(\theta/2) \qquad (6)$$

Putting the value of (6) in (5)

$$A=2LR_2+L^2\tan(\theta/2)+0.5\pi(R_1^2+R_2^2)-Ls \qquad (7)$$

III. RESULT AND DISCUSSION

An electrical motor has been used to derive the electrostatic generator for experiment and collecting the data. Fig. 2, Fig. 3 and Fig. 4 shows the output voltage, current and power with respect to the segment length to diameter ratio of the disk for a fixed number of segments and speed of the disk. It is found that the output power of the machine depends on the segment length to diameter ratio of the disk. However, the output voltage of the machine reduces with increasing the length of the segment. Due to increasing the segment length the corona discharge is increased. As a result, the output voltage reduces as well as the output power. The maximum power has been obtained at the optimum value of the design, segment length to diameter ratio of the disk is 30%.

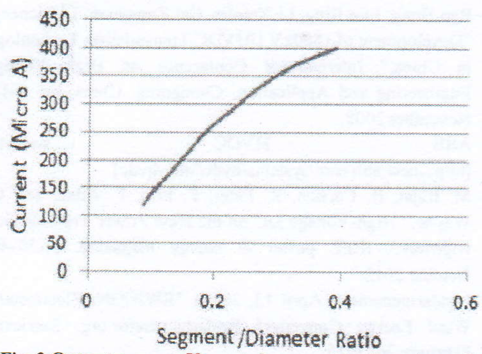


Fig. 2 Output current Vs. metal segment to diameter ratio

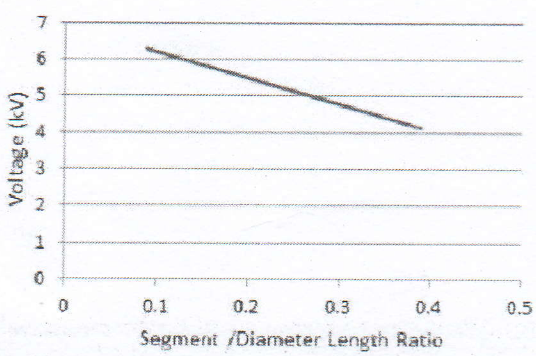


Fig. 3 Output voltage Vs. metal segment to diameter ratio

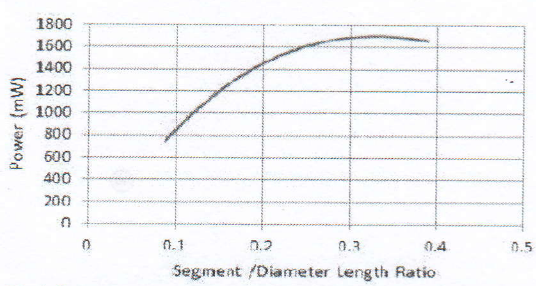


Fig.4 Output power Vs. metal segment to diameter length ratio

Fig. 5(a) and (b) shows the output voltage and current dependency of the machine with respect to the speed of the disk for a fixed metal segment to diameter length ratio and the number of sectors. It is found that the output current is directly proportional to the speed of the disk. Since the voltage discharge length is remaining constant, the output voltage does not depend on the speed. Therefore, there is no optimum value of the operating speed.

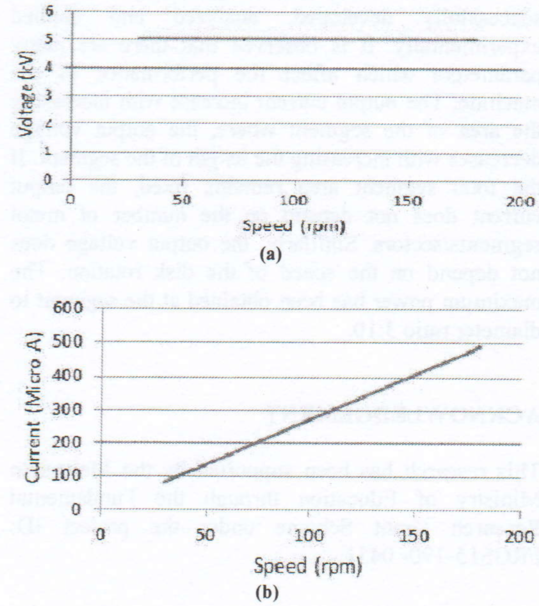


Fig. 5 (a) Output voltage Vs. speed of the disk, (b) Output current Vs. speed of the disk

Fig. 6(a) and (b) shows the output voltage and current dependency with respect to the number of sectors of the disk for a fixed metal segment to diameter length ratio and speed of the disk. It is found that the output voltage and current do not depend on the number of sectors of the disk. Since the voltage discharge length is remaining constant, the output voltage does not depend on the speed. So there is no optimum value of the operating speed.

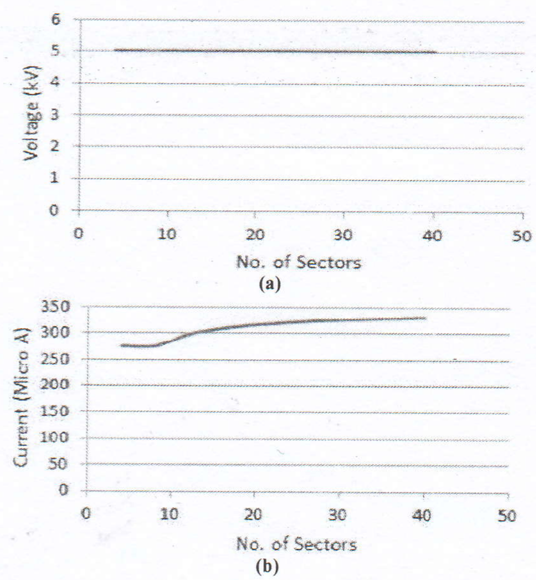


Fig.6(a) Output voltage Vs. number of sectors, (b) Output current Vs. number of sectors

CONCLUSION

A Wimshurst electrostatic generator has been successfully developed, analyzed and studied experimentally. It is observed that there are many parameters which affect the performance of the machine. The output current increase with increasing the area of the segment where, the output voltage decreases with increasing the length of the segment. If the total segment area remains fixed, the output current does not depend on the number of metal segments/sectors. Similarly, the output voltage does not depend on the speed of the disk rotation. The maximum power has been obtained at the segment to diameter ratio 3:10.

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REFERENCES

[1] M. Haeusler, D. Retzmann, "Review on UHVDC Equipment Design Aspects," Southern Power System Technology Research, China, vol.2, No.4, pp.1-7, August. 2008.

[2] L. Peter, C. Magnus, B. Michael, and S. Peter, "High-Voltage DC Converters and Cable Technologies for Offshore Renewable Integration and DC Grid Expansions," IEEE Power &Energy Magazine, pp.31-38, October 2012.

[3] H. Masood, J. Dragan, and W. Bin, "Evaluation of Semiconductor-Based Methods for Fault Isolation on High Voltage DC Grids," IEEE Transactions on Smart Grid, vol. 4, no. 2, pp. 1171-1179, June 2013.

[4] Narain G. Hingorani in IEEE Spectrum magazine, 1996.

[5] Rao Hong, Luo Bing, Li Xiaolin, Cai Zongyuan, Li Licheng, "Development of ±800kV UHVDC Transmission Technology in China," International Conference on High Voltage Engineering and Application, Chongqing, China, pp. 9-13, November 2008.

[6] ABB HVDC website. [http://new.abb.com/systems/hvdc/why-hvdc]

[7] M. Rajat, B. Carsten, K. Peter, F. Eric, F. Allan, and G. Wayne, "High-Voltage DC on the New Power Transmission Highway," IEEE power & energy magazine, pp.39-49, October 2012.

[8] Landartgenerator (April 13, 2013). "EWICON, Electrostatic Wind Energy Converter" landartgenerator.org. Retrieved February 26, 2015.

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