International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 32 No. 2 May 2022, pp. 343-349

Parallel Series Configuration Influence Analysis on WINDING PMSG 12s8p to Output Performance using FEM-Based Software

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***Abstract*—The 3-phase permanent magnetic synchronous generator used is a type of radial flux. Finite Element Method (FEM) software is used to solve physical problems numerically. The goal is to find the relationship between the configuration of the coil and the performance of the output produced by the generator. The method used in this study is laboratory research. That is, by changing the configuration of the coil (series, 2 parallels, or 4 parallels), the resulting output is then analyzed. Low (0%-30%), medium (31%-60%), and high (61%-100%) content efficiency rates. The result of this study is that for series configurations, 2 parallels and 4 parallels have fairly good output performance, indicated by the increasing voltage, current, and input and output power that are directly proportional to increasing the rotational speed of the rotor. The largest output value is generated by the series configuration, and the smallest is generated by the parallel 4 configuration. Nilai efission in series configurations and 2 parallels is relatively good and stable (>80%), and 4 parallel configurations have efficiency values that are directly proportional to the rotor's rotary speed value. Series configurations result in better *output* performance compared to parallel configurations.**

Keywords—winding; PMSG; FEM.

I. INTRODUCTION

Electrical energy is a primary need that continues to grow rapidly since it was first discovered. Human work is greatly helped by the presence of electrical energy, which can be used as a power source for heating devices, drives, players, and lighting. [1] The power source of the power plant is natural resources. Natural resources are grouped into 2 categories, namely renewable natural resources and non-renewable natural resources. In an effort to maintain electricity, there needs to be a source of power that is cheap, environmentally friendly (safe), and endless. [2]

From the data obtained from the Central Statistics Agency, electricity consumption per capita from year to year increased significantly.

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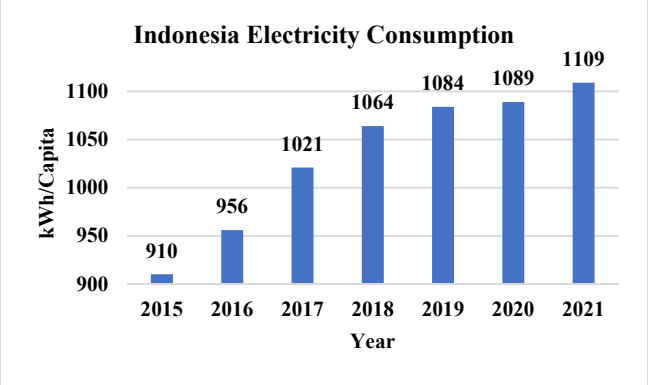

Figure 1. Indonesia Electricity Consumption Graph

Wind is one of the resources that has been provided by nature and exists continuously. Although wind conditions in Indonesia have a changing speed, it does not mean they cannot be utilized. Wind energy in Indonesia has the opportunity to be developed into a power plant. Wind turbines require additional development and research. This alternative energy has the concept of working by converting wind energy into kinetic energy, which is then converted to electrical energy. [3]

According to Arifianto (2018), a generator is a tool that can convert mechanical energy into electricity. A Permanent Magnet Synchronous Generator (PMSG) is a type of magnetic generator that has a high level of efficiency in wind power plants. Permanent magnetic generators are also reliable despite low-speed winds, but the efficiency is quite good. This type is very suitable for areas of Indonesia that are classified as having a fairly low wind speed. Synchronous generators have their rotor speed directly proportional to their frequency. [4]

Analysis of the effect of parallel series configurations on PMSG 12s8p wimding using the Finite Element Method (FEM) is a method that is effectively proven in calculating the distribution of magnetic flux derived from permanent magnets. The generator can produce electrical frequencies that are in sync with the mechanical turning direction. [5]

Coils on generators can be affected by the attraction of magnets that have a great influence on the *output produced* . Performance improvement is done by treating winding the winding on the generator *(winding)*. The configuration of circuits in the electronic world also has an influence on the *output* produced.

II. RESEARCH METHODS

Electrical energy is one of the pre-requisites of human life. The factor that supports human life is growing: the provision of electrical energy. The use of electrical energy is a problem that must be solved for both developed and developing countries. Electrical energy is needed in a very significant way, especially for economic growth. Indonesia has alternative energy from nature that can be used, one of which is wind (bayu). [6]

A generator is an electrical machine that utilizes the encounter between magnets and conductors. The encounter produces electromagnetic induction, which is then converted into electrical energy. The way generators work is by converting motion energy into electrical energy. [7]

The focus of this research is to design generator models by considering the configuration of the circuit to achieve maximum output performance. This study used data collection techniques (literature studies) to add researchers' insights, create PMSG 12s8p designs, configuration variations on circuits, and adjust the rotary speed on the rotor using FEM (Finite Element Methode) based software, which then retrieved data and data inputted and processed using Microsoft Excel.

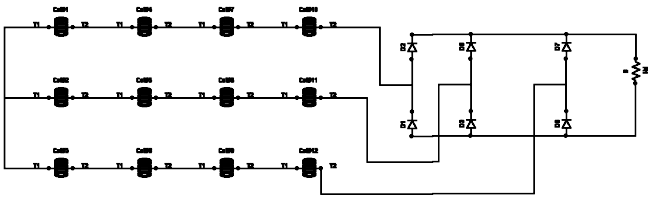

Figure 2. Circuit Series

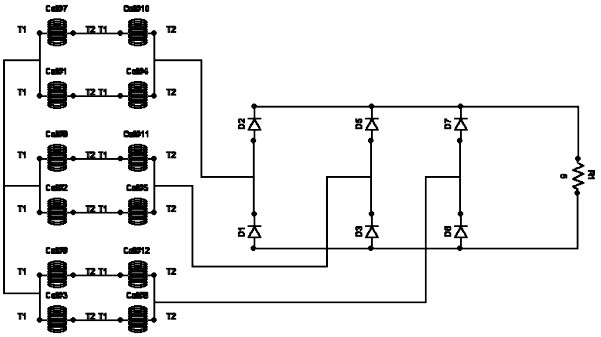

Figure 3. Parallel 2nd Circuit

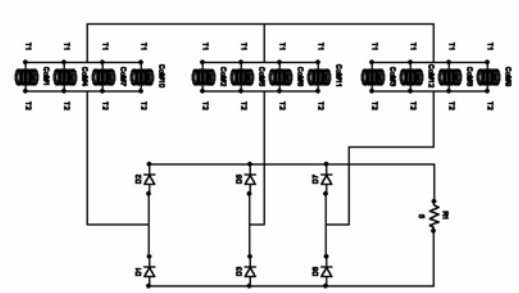

Figure 4. Parallel 4Th Circuit

Table 1. Circuit Configuration on PMSG Winding

Circuit Configuration	**Coil**		
	In the	In	In
Seri	1,4,7,10	2,5,8,11	3,6,9,12
2 parallels	1,4;7,10	2,5;8,11	3,6;9,12
4 parallels	1;4;7;10	2;5;8;11	3;6;9;12

The case of electrical energy is something that must be solved immediately. One of the solutions to this case is the optimization of bayu energy.

III. RESULT AND DISCUSSION

A. Model

The study used FEM-based software to model and retrieve parallel series configuration data on PMSG 12s8p winding.

The circuit used is a rectifier circuit with series configurations, 2 parallels, and 4 parallels at rotor turning speeds of 200rpm, 400rpm, 600rpm, 800rpm, and 1000rpm and is given a load of 5 ohm.

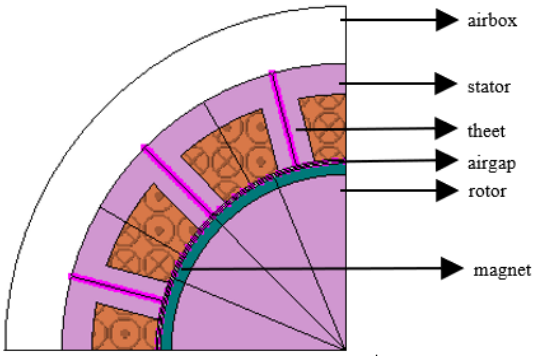

Figure 5. PMSG 12s8p Design

Table 2. PMSG Component Dimensions

Component	**Dimension**
Rotor radius	49 mm
Diameter stator	150 mm
Tebal magnet	3 mm
Magnetic width	20 mm
Gap Thickness	1 mm
Thick stator	8 mm
Theet Height	25 mm
Coil winding	100 twists

Table 3. PMSG Component Materials

Component	**Material**
Stator	TR 52 : USS Trasnformator 52 – 29Gage
Air gap	Air
Rotor	TR 52 : USS Trasnformator 52 – 29Gage
Magnet	PM12: Brem 1.2 wall 1.0
Coil	Copper: 5.77e7 Siemens/Meter

B. Simulation Research

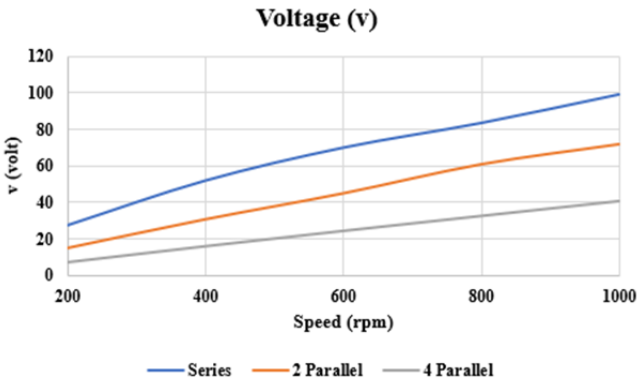

Figure 6. Voltage Graph

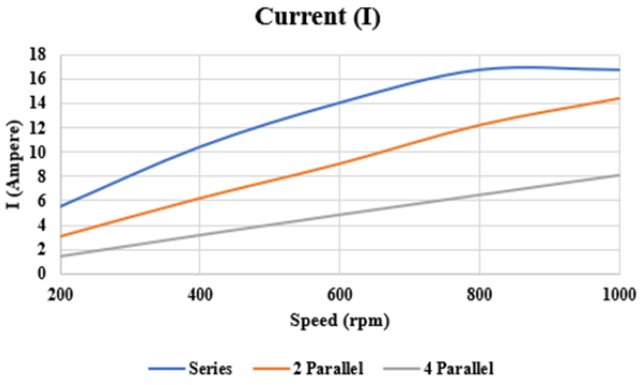

Figure 7. Current Graph

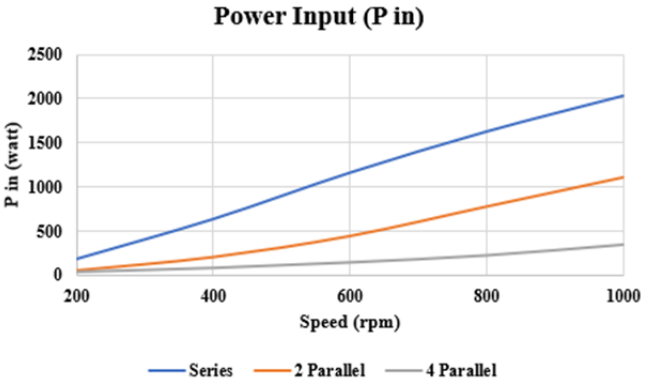

Figure 8. Power Input Graph

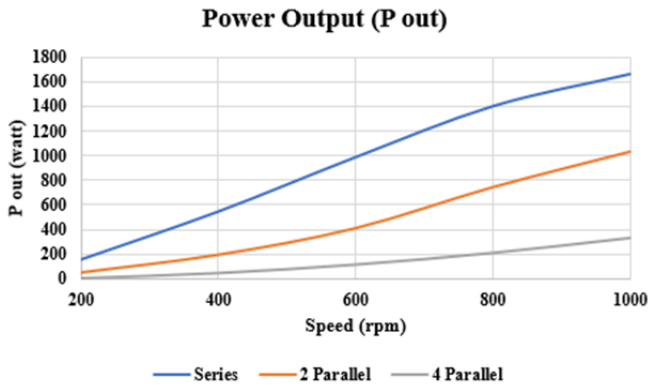

Figure 9. Power Output Graph

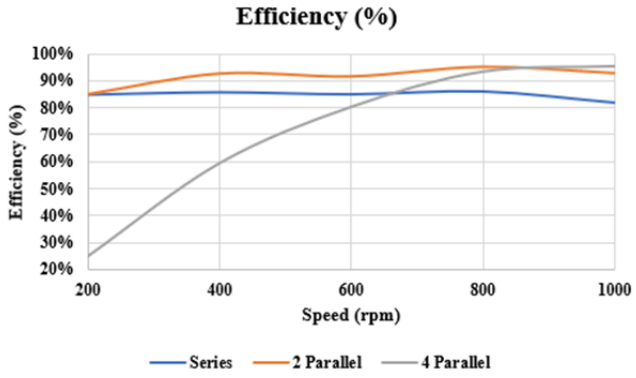

Figure 10. Efficiency Graph

C. Analysis and Discussion

From the obtained data, it is then analyzed using Faraday's law and Ohm's law. Winding is closely related to Faraday's law, which states that the Electric Force of Motion (GGL) will be formed when the electrical transmitting wire is in a changing magnetic field. The law indicates that the amount of winding on the coil affects the voltage produced. [8]

The simulation results revealed that the series configuration produced the highest voltage and the parallel 4 configuration produced the lowest voltage. The voltage on the series circuit has the same value as the total voltage of the voltage source. In parallel circuits, the voltage value is equal to the voltage of each component. [9]

The electric current that has the greatest value is in the series configuration, and the smallest current is generated by the four-parallel configuration. This is in accordance with the theory of Ohm's law, which states, "The strength of the current flowing in a conductor is proportional to the potential difference between the ends of the conductor." [10]

The series configuration has power with a high value compared to 2 parallels and 4 parallels. This is because power is affected by currents and potential differences. [11] One of the most important parameters for determining whether or not an electrical system is powered.[12]

In series and 2 parallel series, the efficiency value obtained is quite stable at 80% and above. Parallel 4 circuits have efficiency values that are directly proportional to the given rotary speed. Efficiency is usually used as a benchmark and is used for various purposes. Because this study is motivated by the use of energy, a generator is needed that has sufficient efficiency at both high and low speeds. [11]

IV. COVER

Based on the results of the analysis of the effect of parallel series configurations on PMSG 12s8p winding, obtained:

V. CONCLUSION

1. Generators are closely related to Faraday's laws that produce a voltage source or electric force of motion (GGL). The greater the voltage, the greater the power. The larger the current can produce a large power output as well, but it has a small voltage value. Good efficiency is one that has stable efficiency values at high and low speeds. The highest voltage value is generated by the series configuration at a speed of 1000rpm, which is 99.378 volts. The strongest current is found in the series configuration with a speed of 1000 rpm, which has a value of 16,739 A. The largest input and output power are obtained at a speed of 1000rpm in the series configuration with a value of 2039,164 watts and 1665,703 watts. The highest efficiency is obtained in parallel 4 configurations with a speed of 1000rpm, which is 95%. The lowest efficiency is also found in the parallel 4 configuration at a speed of 200rpm. The efficiency is 25%. Fairly stable efficiency at speeds of 200 rpm, 600 rpm, 800 rpm, and 1000 rpm is obtained on parallel series and 2 configurations that have an efficiency value of > 80%.
2. Series configurations have better output performance than 2 and 4 parallel configurations.

REFERENCES

[1] S. Anwar, T. Artono, Nasrul, Dasrul, and A. Fadli, "PZEM-004T-Based Electric Energy Measurement," *Pros. Semin. Nas. Politek. Lhokseumawe State*, vol. 3, no. 1, pp. 272–276, 2019.

[2] B.C. Wibowo, I.B. Winardi, M. Kom, and L. Rear, "Simulation of SYNCHRONOUS MAGNET SYNCHRONOUS GENERATOR (PMSG) 12S8P Output Voltage Change AGAINST ROTOR ROTARY SPEED VARIATION WITH FINITE ELEMENT METHOD (FEM) BASED SOFTWARE , *"J. Tek. Electro*, vol. 2, no. 1, pp. 1–9, 2020.

[3] I. Arifianto and M. R. HS, "Efficiency Analysis and Design of Permanent Magnet Generator 12 Slot 8 Pole Using Magnet Software 7. 5," *Semin. Nas. Microwave, Antenna and Propagation*, pp. 43–48, 2018.

[4] H. Piggott, T. Kirby, and H. Piggott, *Windpower Workshop Windpower Workshop BUilding Your Own Wind Turbine*. 2001.

[5] Y. Prasetyo, "Comparative Analysis of Magnetic Material Materials in Permanent Modeling of Synchronous Magnet Generator (Pmsg) 12 8 Pole Slots Using Finite Element Method (Fem) Software," 2019.

[6] A. A. Syarif *et al.* , "Design of small-scale power plants," *Thesis*, pp. 1–64, 2015.

[7] H.M. Zuhdi, *Analysis Back EMF Permanent Magnet Synchronous Generator 12 Slot Pole 1/4 Model Using Infolytica 7.5 Magnet Software*. 2021.

[8] Agus Nur Hidayat, Suyitno, and Daryanto, "The Effect of the Number of Coils Stator Coils on the Performance of the Permanent Magnte Generator of One-Phase Axial Flux," *J. Electr. Vocat. Educ. Technol.* , vol. 2, no. 2, pp. 28–31, 2020, doi: 10.21009/jevet.0022.06.

[9] M. Siregar, N. Evalina, Cholish, Abdullah, and M. Zainul Haq, "Analysis of Series And Parallel Relationships To Solar Cell Characteristics In Medan City," *Tech. Electro*, vol. 3, no. 2, pp. 94–100, 2021, [Online]. Available: http://jurnal.umsu.ac.id/index.php/RELE/article/view/v3i2.6492/5248.

[10] A. Rosman, Risdayana, E. Yuliani, and Vovi, "Characteristics of Current and Voltage in Series And Parallel Circuits Using Resistors," *J. Ilm. d'Computare*, vol. 9, no. 2, pp. 40–43, 2019.

[11] A. Yahya, "Optimization of PMSG 12S8P Design," *J. Elektro*, vol. 4, no. 3, pp. 148–162, 2019.

[12] P. Mangera and D. Hardiantono, "Analysis of Distribution Network Voltage Loss of 20 kV at PT. PLN (Persero) Merauke Branch," *Musamus J. Electro Machanical Eng.* , vol. 1, no. 2, pp. 61–69, 2019, doi: https://doi.org/10.5281/zenodo.3516283.