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Performance of Generator Translation and Rotation Motion on Vertical Direction for Sea Wave Power Plant

Anizar Indriani*[1], Yeni Suhartini[1], Hendra[2], Hernadewita[3] and Rispandi[4]

*[1]Electrical Engineering Department, Faculty of Engineering
University of Bengkulu, Bengkulu, Indonesia
[2]Mechanical Engineering Department, Faculty of Engineering
University of Sultan Ageng Tirtayasa, Banten, Indonesia
[3]Postgraduate Faculty of Industrial Engineering,
Mercu Buana University, Indonesia
[4]Mechanical Engineering Department, Faculty of Engineering
University of Bengkulu, Bengkulu, Indonesia
*aniz_raimin@yahoo.com, h7f1973@yahoo.com

Abstract. The generator has been used in the sea wave power plant to converting mechanical energy into electrical energy. Generator for sea wave power plant depends on the motion as translation and rotation. For position of trust force direction is horizontal and vertical motion. Generator translation and rotation consists of several components such as rotor, stator, frame holder of generator, shaft, piston and etc. In previous study, the generator translation and rotation motion in horizontal direction was used for sea wave power plant [1]. The results show that the performance of generator is depend on the stiffness of frame holder of generator, number of coil (pole) and magnet, material of pole and magnet and etc. The design frame holder of generator translation and rotation motion in horizontal direction is less rigid (stable) and precision, thus affecting the performance of the generator. To overcome problem in the frame holder of generator translation and rotation in horizontal direction, frame holder of generator vertical direction mechanism are used in this research and performance of generator is output like output voltage and power of generator. Input power of generator by using manual process (rotated by hand) and rotation speed of thrust force of generator is 100 rpm to 200 rpm and using load by lamp 16.6 ohm (12 w). Generator holder design made with 90^0 inclination conditions in order to straight or perpendicular to the motion generator components. By applied separate of experimental of generator translation and rotation motion obtained the results of experimental tests voltage generator without the load for generator translation motion is 42.7 volts at 200 rpm and for the generator rotation motion of 77.4 volts. By applied load, the maximum value of output voltage generator becomes decrease is 31.14 volt for generator translation and generator rotation is 36.82 volt.

Keyword: Frame Holder of Generator, FEM, Maximum Stress, Displacement, PL**TGL**

1. Introduction

Electrical energy has been used in many activity and field such as house, industry, hospital, fishing comunity, office and etc. Application of electrical energy can be seen in electricity equipment, thermal, control, lamp and others. The electrical energy derived from natural resources such as renewable and non-renewable energy. Currently non-renewable energy thinning as energy coal, fossil fuels and etc where as is decrease. Renewable energy resources can be obtained from natural resources such as ocean waves, wind, water, solar and etc. But this renewable energy source has not been optimally treated because of limited processing technology equipment such as natural resources. Natural resources such as ocean waves, wind and water are found since the covering a coastline along the Indian Ocean. From the existing potential the ocean waves can be used as one of technological innovation for renewable energy in order to produce electrical energy which is environmentally friendly. Utilizing the up and down motion of the ocean waves as the energy conversion process.

One of the technological innovations for Sea Wave Power Plant (PLTGL) using a pneumatic mechanism [1-4]. In addition to the pneumatic mechanism, PLTGL can also be obtained through the Pelamis, oscilating water column, salter duck and others [1-10]. In previous study, research on pneumatic systems has been carried out electrical energy using generator translation and rotation motion [1-4]. Component of generator translation and rotation consist on the mechanic and electrical component such as shaft, piston, buoy, rotor and stator. Performance of generator translation and rotation depend on magnet variations, the number of coils (pole) and wire dimensions, gap between magnet and coil, trusth force, length of wae length, structure of generator and direction system of generator. In previous study, generator translation and rotation on horizontal direction has been used and get results a voltage and electric current [1-4] but still has disadvantages like unstable due to low stiffness of frame holder of generator. The voltage of the generator can be improved by making a series or arrangement of the components of translational motion generator as stable rotation (rigid) by using frame holder of generator on vertical direction.

Therefore in this research focuses on the performance of generator translation and rotation motion on vertical direction by made the component become rigid (high stiffness). Design a stable frame holder of generator (rigid) as well as translational motion - smooth rotation, can be done with the measuring process order, right angle, perpendicular, alignment and straightness of motion components. Because the motion generator is the main component of the sea wave power plant begins with the manufacture and assembly of the stand, followed by a performance test generator.

2. Method and materials

Experimental method are used in this research. Component of generator translation and rotation motion in vertical direction consist on tube of piston, magnet neodymium (NdFeB magnets shaped beam), frame holder of generator, shaft, piston and etc. PVC material is used for tube of piston, stainless steel for shaft and frame holder of generator, rectangular koker for coil or pole. Dimension of component as PVC tube with diameter 8 in, thickness 8.5 mm and length of 800 mm. For shaft piston is hollow *stainless steel* with diameter 30 x 30 mm, thickness 0.8 mm with a length of 1300 mm. Koker rectangular coil with a size of 45 mm x 45 mm and t = 5 mm. NdFeB magnets shaped beam with dimensions (46 x 21 x 10) mm is used for generator translation motion and permanent magnet generator [11] is used for generator rotation motion. Coil wire size 0.7 mm with the number of windings of the coil 1260. Input power of generator by using manual process (rotated by hand) and rotation speed of thrust force of generator translation and rotation motion on vertical direcation mechanism is 100 rpm to 200 rpm and using load by lamp 16.6 ohm (12 w) Design of generator translation and rotation motion in vertical direction can be seen in Fig. 1.

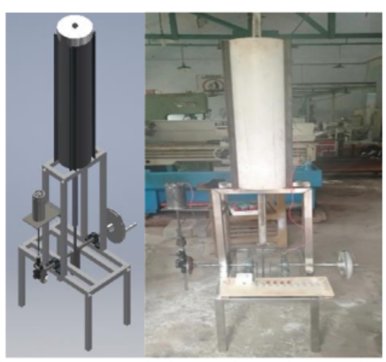

Figure 1. Design of generator translation and rotation motion in vertical direction

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3. Results and discussion

Experimental research in the performance of generator translation and rotation motion on vertical direction get results as shown in Table 1-4. Experimental testing of generator is done by varying speed and load-unload. Table 1 show the result of generator translation and rotation motion on the vertical direction using unload where output voltage is obtained for generator translation motion at 200 rpm of 42.7 volts and output voltage for the generator with rotation motion is 77.4 volts. Also by increasing value of rotation speed for generator translation motion so the output voltages become increase. In other hand for generator rotation motion the output voltage is not much different until rotation speed 170 rpm. When the rotation speed is more than 170 rpm, the value of outout voltage increase significantly.

From this result show that the performance of generator translation motion (output voltage) is smaller than generator rotation motion. This due to the performance of generator depend on the trusth force of generator, number of coil winding/pole, type of coil winding/pole, number of magnet, material magnet, type magnet and gap of magnet and coil winding/pole. For generator translation motion, trusht force is very difficult compare with the generator rotation motion.

Table 1 Experimental testing data of generator translation and rotation without load (unloading).

Number of Coil Winding/Pole	Rotation Speed (rpm)	Result Voltage of Generator Translation Motion (V)	Result Voltage of Generator Rotation Motion (V)
2 x 1260	100	36,12	39,33
	120	37,24	39,32
	140	38,41	39,17
	150	36,70	39,94
	170	39,09	39,88
	190	39,60	63,2
	200	42,7	77,4

By applied the load by lamp 16.6 ohm (12 w) in the generator translation motion the output voltage is higher than generator rotation motion but the value not much different. Where output voltage for generator translation motion is 31.14 volts and current 0.38 A and output voltage for generator rotation motion is 36.82 V and 0.4 A at rotation speed 200 rpm. This results show that after applied load by lamp 16.6 ohm (12 w) in the generator the output voltage is increase by higher of rotation speed but for current is stable.

Table 2 Experimental testing data of generator translation with load by lamp 16.6 ohm (12 w)

Number of Coil Winding/Pole	Rotation Speed (rpm)	Result Voltage of Generator (V)		Result Current of Generator (A)	
		Translation Motion	Rotation Motion	Translation Motion	Rotation Motion
2 x 1260	100	17,41	14,82	0,34	0,38
	120	24,11	17,67	0,39	0,40
	140	27,57	22.19	0,40	0,40
	150	27,26	24,00	0,40	0,40
	170	29,06	28,27	0,40	0,40
	190	27,11	29,44	0,40	0,40
	200	31,14	36,82	0,38	0,40

Table 3 show that the calculation power of generator translation motion. The power of generator depends on the output voltage and current of generator. As shown in Table 3 the minimum value of power of generator appear at the rotation speed 100 rpm is 5.92 Watt. Become increase to 11.83 Watt at 200 rpm. This results show that the value of power become increase when the rotation speed is increase.

As the result in the generator translation motion, the minimum value power of generator rotation motion is 5.63 Watt at rotation speed 100 rpm. At rotation speed 200 rpm, the value power of generator rotation motion is high 14.73 Watt as shown in Table 4.

From Table 3 and 4 the results show that the value power of generator rotation is higher compare with the generator translation motion. This value due to the output voltage of generator rotation is high comparing the generator translation even though the values of current near same.

Table 3 Calculate power of of generator translation motion

Number of Coil Winding/Pole	Rotation Speed (rpm)	Result Voltage of Generator Translation Motion (V)	Result Current of Generator Translation Motion (A)	Result Power of Generator Translation Motion (Watt)
2 x 1260	100	17,41	0,34	5,9194
	120	24,11	0,39	9,4029
	140	27,57	0,4	11,028
	150	27,26	0,4	10,904
	170	29,06	0,4	11,624
	190	27,11	0,4	10,844
	200	31,14	0,38	11,8332

Table 4 Calculate power of of generator rotation motion

Rotation Speed (rpm)	Result Voltage of Generator Rotation Motion (V)	Result Current of Generator Rotation Motion (A)	Result Power of Generator Rotation Motion (Watt)
100	14,82	0,38	5,6316
120	17,67	0,4	7,068
140	22,19	0,4	8,876
150	24	0,4	9,6
170	28,27	0,4	11,308
190	29,44	0,4	11,776
200	36,82	0,4	14,728

4. Conclusion

In this paper, performance of generator translation and rotaion motion in vertical direction with load and unload are presented. The conclusions show that:

1. Output voltage of generator depends on the rotation speed and load of generator. Output voltage generator translation motion has minimum value at rotation speed 100 rpm and maximum at 200 rpm.
2. By applied of load the minimum and maximum value become decrease compare using load for generator translation and rotaion motion. In other hand the current values become same even though the rotation speed is higher (increase).
3. The maximum power produced by the generator translational motion load amounted to 11.83 Watt, the generator rotation motion obtained maximum power load amounted to 14.73 Watts.

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