International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

Analysis Of Performance Characteristics Of Wind Turbine Using Permanent Magnet Synchronous Generator

Dinesh Kumar P[1], B Vamsikrishna Reddy[2], K Vamsikrishna[3], E.Vinayak Reddy[4]
[1,2,3,4]*Department of EEE, Annamacharya Institute of Technology & Sciences, Tirupati-517520*

Abstract
The analysis of performance characteristics of wind turbine with permanent magnet synchronous generator (PMSG) consists of simulation of this model. Here wind turbine is operated at variable pace with PMSG. In the past few years using energy has been multiplied swiftly and we try the 'm' quantity of methods to provide the enough and powerful power production , amongst them wind turbine is one of the manner as we visible within the beyond few years the power production by using wind turbine is very huge because its introduction is inexperienced and its generation is relies upon on surroundings, to design one of these big device configuration basically we want to build a version of wind turbine in MATLAB SIMULINK which makes us to understand the operating of wind turbine and to control the variable velocity by way of using a force educate and for generating the efficient electricity output. in this simulation we additionally use the pitch controller for adjusting the blades in wind turbine via rotating them so they use the proper fraction of the to be had wind energy to get the maximum powerful output and we also want to make sure that the turbine does not exceeds its most rotational pace. The supplied model simulation effects are tested in SIMULINK.

INTRODUCTION:

Among differing renewable energies wind era is one of the arrangements to reduce the unsafe carbon emanations. The wind control which is reaching to change over in electric vitality is the leading occasion of alter vitality innovation. everyday exchange quality time is growing exceptionally suddenly. elective power is frequently changed right into a valuable kind of quality, similar to the wind.

turbine may be a tool that changes over mechanical control utilizing wind to electrical power. It offers the comparable things like numerous distinctive alter gasoline resources with the utilize of the renewable sources. The most excellent calculate of the utilization of wind control for wind turbine is it by no implies produces squander. as the time capacity of wind quality is developing significantly.

As India is the fourth greatest in mounted wind vitality capacity within the universal with 38.789 GW by utilizing February 2021. The fetched of wind control is decreasing considerably in India.

Wind power is one of the most rapidly developing technologies for renewables. The usage is growing globally, partially because of decreasing costs. The world's wind capacity on and offshore has increased by nearly 75 times over the last two decades – 7.5 gigawatts (GW) in 1997 – to 564 GW in 2018, according to IRENA's most recent data. Between 2009 and 2013, the output of wind energy tripled more than 16% of all renewable energy generation in 2016. In many parts of the world, wind speeds are high, yet wind power is frequently separated from the largest locations.

There is a lot of potential to offshore wind power. For more than a century, wind turbines have been around. After the invention of the electric generator in the 1830s, engineers started using wind energy to produce electricity. In the UK and the United States in 1887 and 1888, wind power was produced, but the modern wind energy was developed in Denmark where the wind turbines with a horizontal axis were built in 1891 and a wind turbine of 22,8 metres in 1897 in service.

The film energy generated by moving air is used to create wind power. This is converted into electricity by wind turbines or wind power conversion equipment. The turbine blades are first hit by the wind, which causes the turbine to spin and revolve. It is possible to create electric power via electromagnetic by rotating a shaft linked to a generator.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

Energy gathered by wind determines the Turbine's size and blades' length. Size and wind speed are proportional to production. When wind speed is hypothetically doubled, wind power potential doubles by eight.
The capacity of wind turbines has increased in recent years. There were 15-metre-wide blades on the average turbines in 1985, with a maximum power rating of 0.05 MW at the time. (MW). There are onshore and offshore wind power plants now that use 2 to 5 megawatt turbines.
The commercially available wind turbines up to 164 metres in diameter currently have a capacity of 8 MW. The average wind turbine capacity has increased from 1.6 MW in 2009 to 2 MW in 2014 by making the wind power cost-effective reducing risk to developers and users. From past 20 years the total wind capacity is increasing very rapidly in India. In this model wind turbine rotate with the help of wind energy after then wind energy rotates the turbine which drives the generator and converts it into electric power. There are two types of wind turbines: fixed-speed turbines and variable-speed turbines. In comparison to fixed-speed wind turbines, variable-speed wind turbines produce more energy. As a result, the reactive power supply is improved, and power fluctuations are minimised.

The wind energy could be an alternative energy generated from earth by following ways:
- Unevenly heating the atmosphere from sum.
- Because of irregularities of the earth's surface.
- Because of rotation of the planet.

The Wind turbine has many advantages like reducing use of fossil fuels, pollution etc. It does not produce the greenhouse gases or any other harmful pollutants for environment.
There's faster growth during this sector of the energy industries everywhere the planet. This paper gives a brief description about the dynamic behaviour of wind turbine using PMSG as shown in Fig. 1 and also includes power electronics devices.

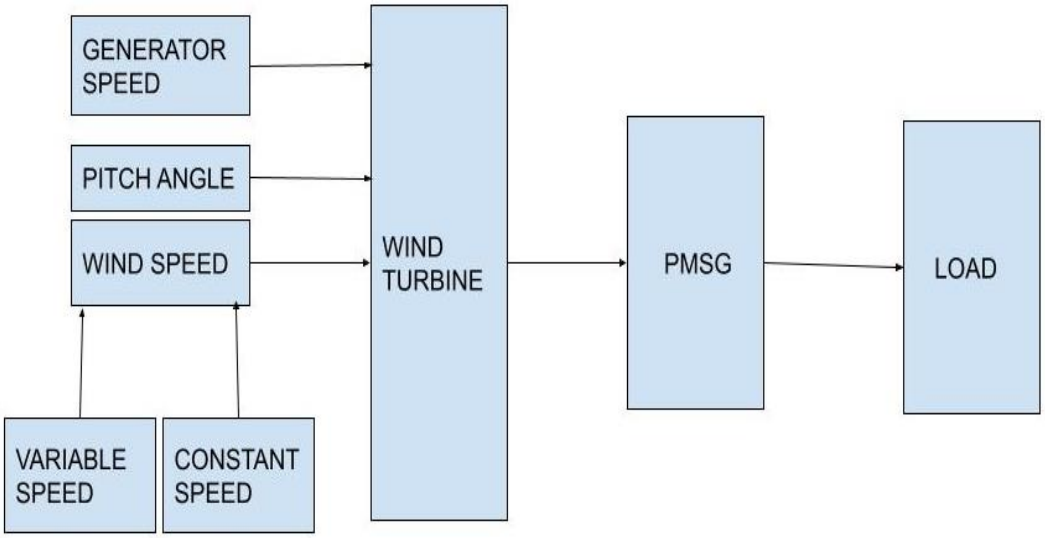


Fig. 1. Block diagram of wind turbine using PMSG

MODEL REVIEW:

1. Permanent Magnet Synchronous Generator (PMSG):

The PMSG have one of a kind of significance within the wind turbine demonstrating SIMULINK. The most masters of the PMSG are for lower upkeep, more productivity, and superior unwavering quality. In this modelling PMSG has an inbuilt show that's appeared in Fig. 2. Within the demonstrate changeless magnet synchronous machine can work in two sorts i.e., engine mode and generator mode.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

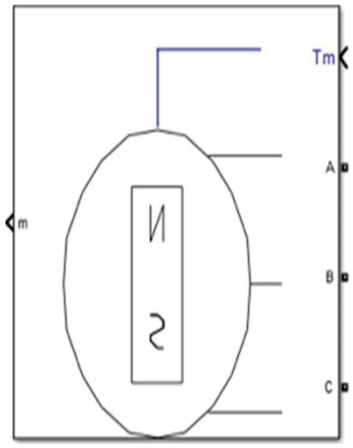


Fig. 2. Simulink block of PMSG

2. Pitch Controller:

This is the technology used to operate and control the blade angle of wind turbine. In SIMULINK pitch controller is designed as shown in Fig. 3. That model is designed to maintain beta angle five. In that design base speed is set 1 and WR (Per unit speed) is set as 1. To minimize error gain is assign value (500), so that angle is maintained. The Fig. 3 represents the angle beta is maintained five throughout the simulation.

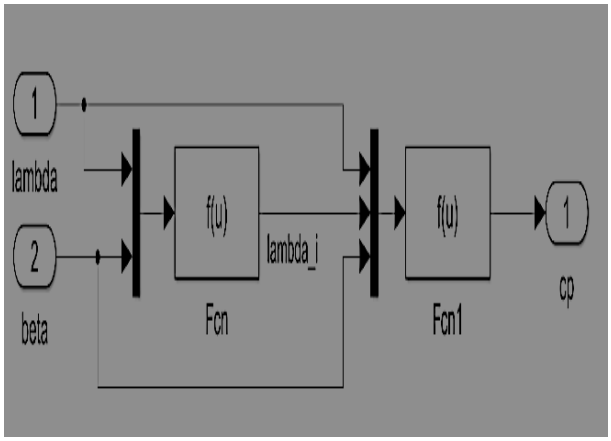


Fig. 3. Internal structure of Pitch controller

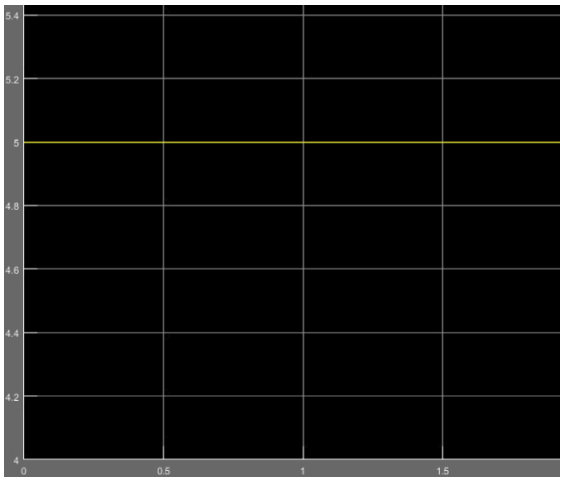


Fig. 4. Output of Pitch controller

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

3. Wind Turbine:

The model of wind turbine is an inbuilt model in SIMULINK. According to requirement there are changes in inbuilt model for this paper and value has been changed. The simple model is shown in Fig. 6. Fig. 7 shows the internal structure of the Fig. 5 block as produced by mathematical expression.

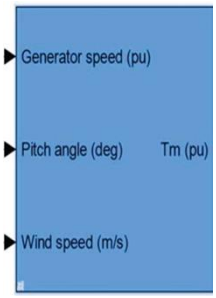


Fig. 5. Simulink Wind Turbine block

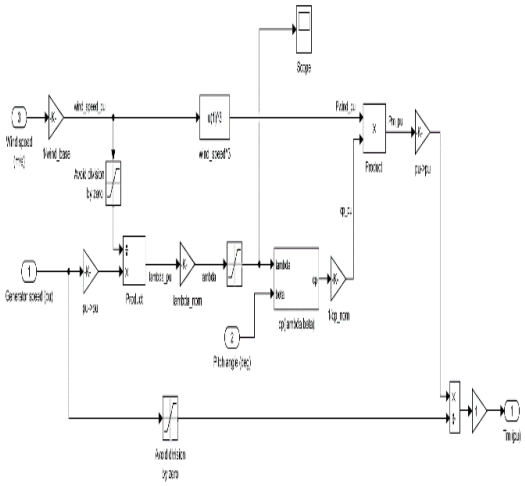


Fig. 6. Internal structure of wind turbine

In this model the base wind speed is kept constant value as 12 meter per second. As on this speed the output power generated is high as shown in Fig. 7.

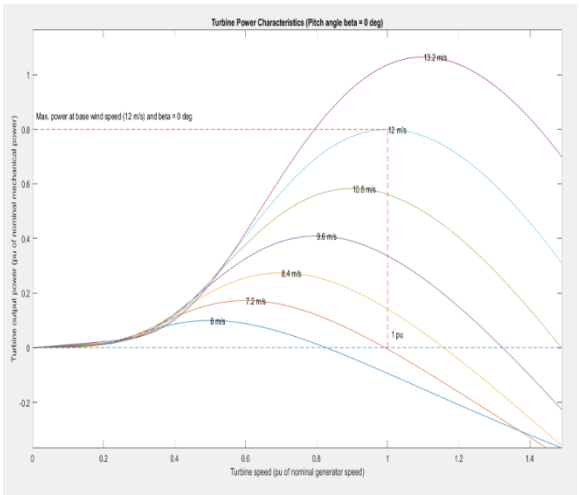


Fig. 7. Turbine output w.r.t pitch angle at different speed

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

WIND TURBINE MODEL USING PMSG:

In Fig. 9 the wind turbine is used with PMSG, pitch controller and drive train are designed in MATLAB/SIMULINK. In this SIMULINK the wind turbine model is connected to PMSG with help of drive train.

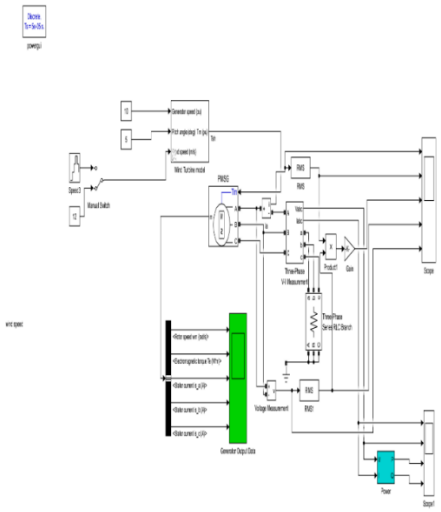


Fig. 8. Wind turbine model using PMSG.

RESULT:

In SIMULINK the wind turbine connected with PMSG with help of drive train. The pitch controller is connected as input to the wind turbine. When the speed of wind is increased to maintain constant output power pitch controller is used. The parameter used in the simulation has been discussed above. The wave form of output power, Torque, 3-phase current and voltage, line- current and voltage as shown in below, we have changed the pitch angle 1 meter per sec to 5 meter per sec for better understanding. When the pitch angle of wind turbine changes then the output power also changes accordingly.

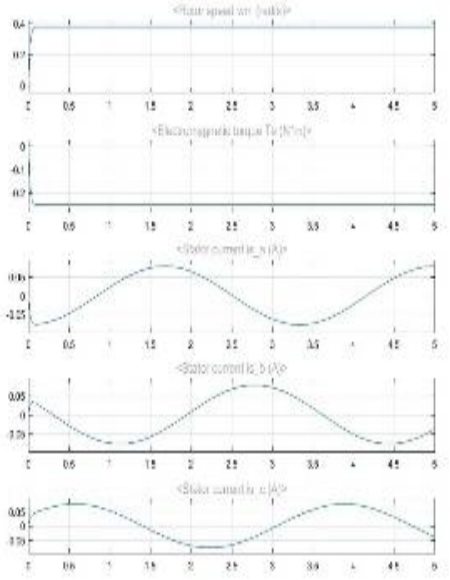
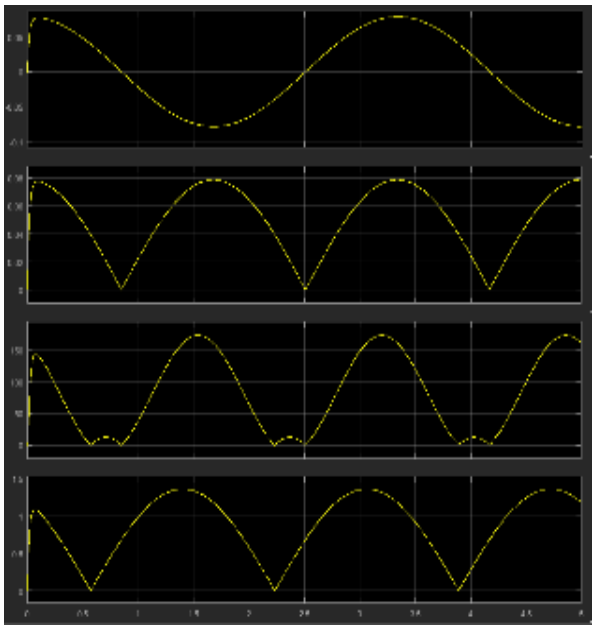


Fig.9 Mechanical internal responses

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621



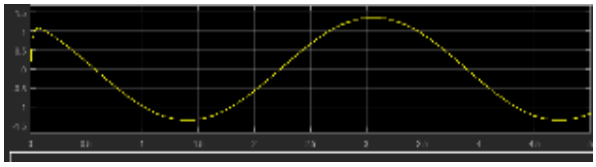


Fig.10 Generator Output Response

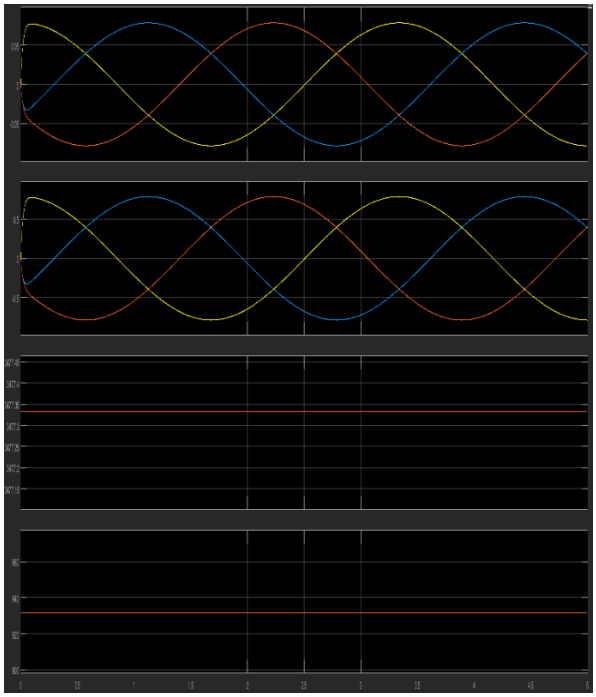


Fig.11 Three phase voltage and current, Active and Reactive power output of WECS.

CONCLUSION:

This paper has introduced the displaying of fixed-pitch point wind turbine system by utilizing a MATLAB/Simulink program. The reason for the demonstrating wind turbine system is:

DOI:10.46647/ijetms.2023.v07si01.058 ISSN: 2581-4621

1) to recognize the mechanical force and force when a fixed wind speed.
2) in this manner distinguish the force stream of an acceptance generator into the load. This paper features significance of complete wind turbine displaying that joins electrical and mechanical parts.

REFERENCES:

1. Chen, H. B. Wu, M. Sun, W. N. Jiang, L. Cai, and C. Y. Guo, (The modelling and simulation of directly driven wind turbine with permanent magnet synchronous generator) in Proceedings of the 2012 IEEE Innovative Smart Grid Technologies, Asia (ISGT '12).
2. S. Li, T. A. Haskew, and L. Xu, "Conventional and novel control designs for direct driven PMSG wind turbines," Electric Power Systems Research, vol. 80, no. 3, pp. 328–338, 2010.
3. Tiwari, R.K. and Sharma, K.K., 2014. "Simulation and modelling of wind turbine using PMSG". International Journal of Recent Research and Review, 7(2), pp.46-50.
4. VERGAUWE, J. MARTINEZ, A. and RIBAS, A., 2006. Optimization of a wind turbine using permanent magnet synchronous generator (PMSG). Proc. ICREPQ, 6, pp.5-6.
5. Samaria, A., Sharma, H.K. and GIDWANI, L., 2015. Modelling and simulation of wind turbine using permanent magnet synchronous generator. Wind energy, p.2.