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PERFORMANCE ANALYSIS OF WIND TURBINE GENERATION SYSTEM AND SIMULATION MODELLING OF WECS WITH PARMANENT MAGNET SYNCHRONOUS GENERATOR

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ABSTRACT

In this paper we described PMSG is a Synchronous Machine, where the circuit of DC excitation is removed by permanent magnets, in the place of brushes. PMSG has a lesser physical size, a lower moment of inertia which means a higher reliability and power density per volume ratio as it has permanent magnets instead of brushes and the slip rings. The electrical losses in the rotor are also eliminated by having permanent magnets in the rotor circuit. The PMSG are becoming an interesting solution for wind turbine applications.

Keyword:-DDPMSG, PWM CONVERTER, WECS

INTRODUCTION

Now a days Wind power has been a fast-growing alternative power source in the world. It is renewable source and widely distributed. It also deducte toxic gas emissions. In the year of 2012, global wind energy capacity grew by 19 percent, with the wind industry installing a record level of 44,711 MW of new clean wind power, and over 150,000 wind turbines operating around the world in over 90 countries . In the year of 2013, the global capacity growth rate has been above 14 percent . Windmills have been utilized for irrigation pumping and milling grain since the 7th century AD .The traditional windmills had typically four blades that provided a lattice framework over which the canvas sails could spread. In light winds, the whole blade area would be covered. In strong winds, the power output could be limited by only covering part of the blades. With a diameter typically of about 25 m, the traditional windmill could deliver a shaft power output of about 30 kW in a wind speed of about 7 m/s . In a well exposed location, it would give an average power output of about 10 kW However, steam engines became progressively more efficient and more economic as the 19th century advanced. Because steam engines could also provide power on demand, the use of windmills went into decline. This decline was accelerated by the later development of internal combustion engines and by the trend in fossil fuels which became more readily available and less costly. Since 1973, the trend of decreasing fuel prices has been sharply reversed, and it is now accepted that the era of very cheap fuel has ended. This trend in addition to the global efforts in reducing greenhouse gas emissions mainly caused by fossil fuels has resulted in investing increasingly in renewable energy sources. Among the various types of renewable energy, wind energy is now emerged as one of the most promising of the renewable energy technologies. It is predicted that by 2020 up to 12% of the worlds electricity will be supplied from wind energy .

COMPONENTS OF WIND ENERGY CONVERSION SYSTEMS

The turbine mainly consists of the blades, the hub, and the connecting components including bearings and pitching actuators. The turbine transforms the kinetic energy of wind into mechanical energy. In multi-megawatt turbines, the blades can be over 60 meters in length [6]. The drive train is formed by the turbine rotating mass, low-speed shaft, gearbox, high- speed shaft, and generator rotating mass. It transfers the turbine mechanical energy to the generator shaft where it can be converted to electrical energy. A gearbox is required between the turbine and the generator, because the angular speed of the turbine is much lower than that of the generator. However, a gearless configuration can also be developed by increasing the number of generator pole pairs. For multi-megawatt turbines the gearbox ratio is about 50-100, because the typical speed range of the turbine is 10-20 rpm, whereas for the generator it is about 1000-2000 rpm [3]. For smaller WECSs, the turbine speed is higher and, therefore, the gearbox ratio may be less than 50. The low-speed shaft contains pipes for the hydraulics system that operate the aerodynamic brake. The high-speed shaft is equipped with an emergency mechanical brake that is used incase of failure of the aerodynamic brake. Other components include the anemometer and vane which respectively measure the speed and direction of wind. Devices such as electric fans and oil coolers are used to cool the gearbox and generator.

DIRECT-DRIVE PMSG-BASED WECSS

In direct drive PMSG based system step-up gearboxes have been utilized in WECSs to provide high angular speeds for the generators. the gearbox brings weight and cost penalties, is subject to wear and mechanical degradation, generates noise ,demands regular maintenance, and incurs loss . Hence the idea of gearless, i.e., direct-drive, WECSs has gained interest in the recent years, especially for offshore applications where a low maintenance solution is an attractive option. Moreover, the higher efficiency of a WECS with gearless drive-train results in achieving about 3 to 5 percent higher energy production compared to a similar WECS with gearbox . To provide high torque at low angular speeds, the direct-drive configuration requires the generator to have a large number of poles and, thus, a large diameter. Permanent magnet excitation for synchronous generators allows for small pole pitch and can yield cost-effective designs.

SIMULATION RESULT

For modelling of WIND ENERGY GENERATION SYSTEM and PMSG system a MATLAB test bench performed different results.

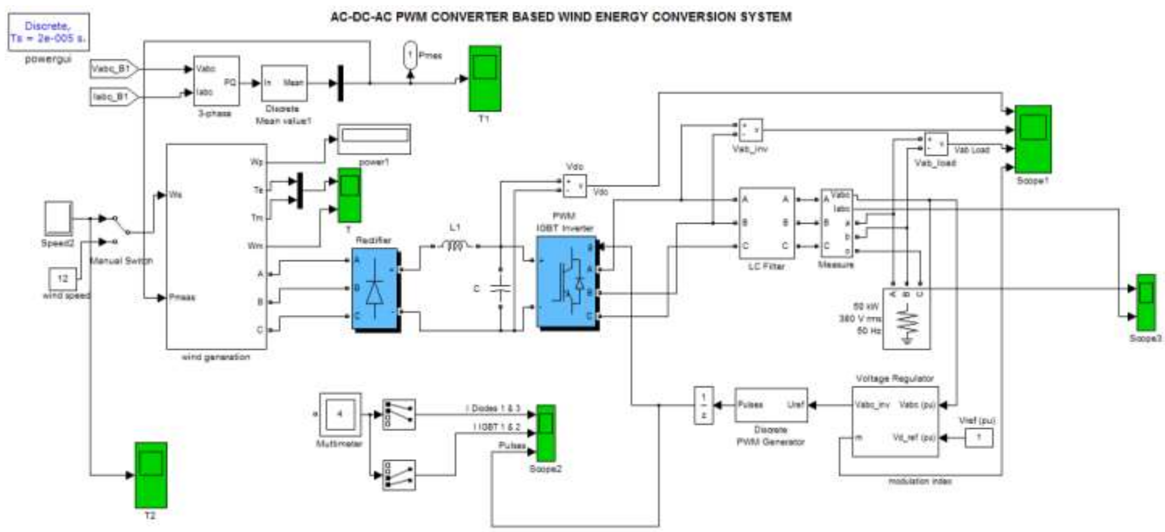

Fig 1. Simulation of AC-DC pwm converter based wind energy conversion system.

SIMULATION MODEL OF PARMANENT MAGNET SYNCHRONOUS GENERATOR

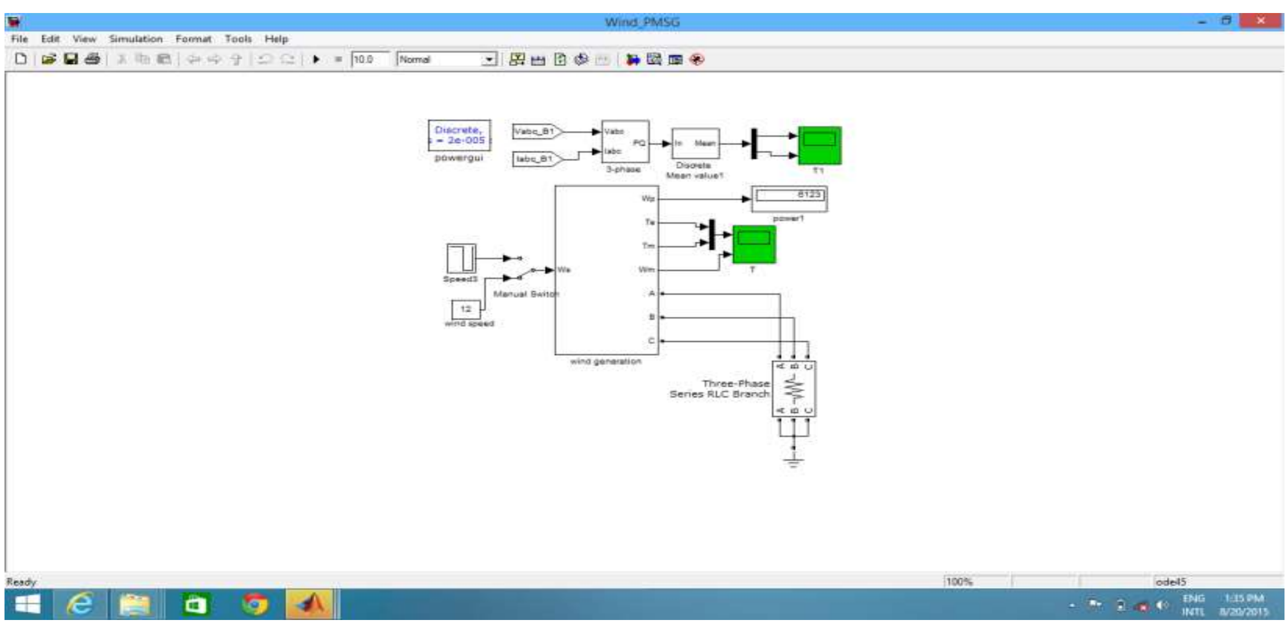

Fig 2. simulation model of permanent magnet synchronous generator

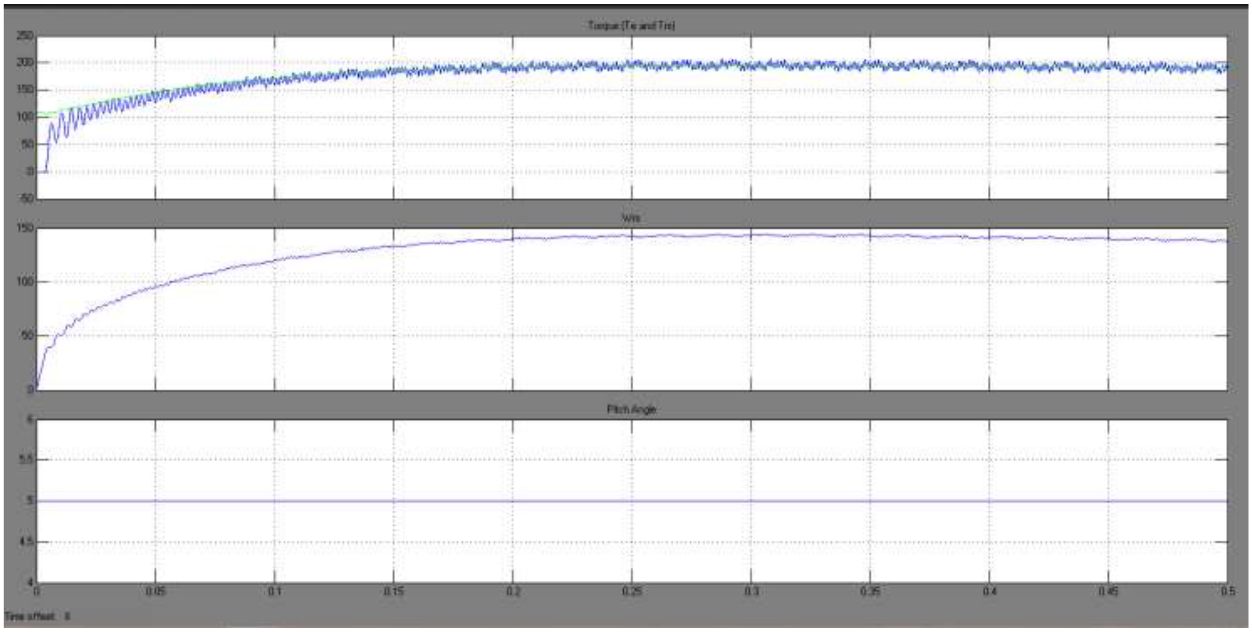

Fig. 3: Torque (Te and Tm), pitch angle and the rotor speed

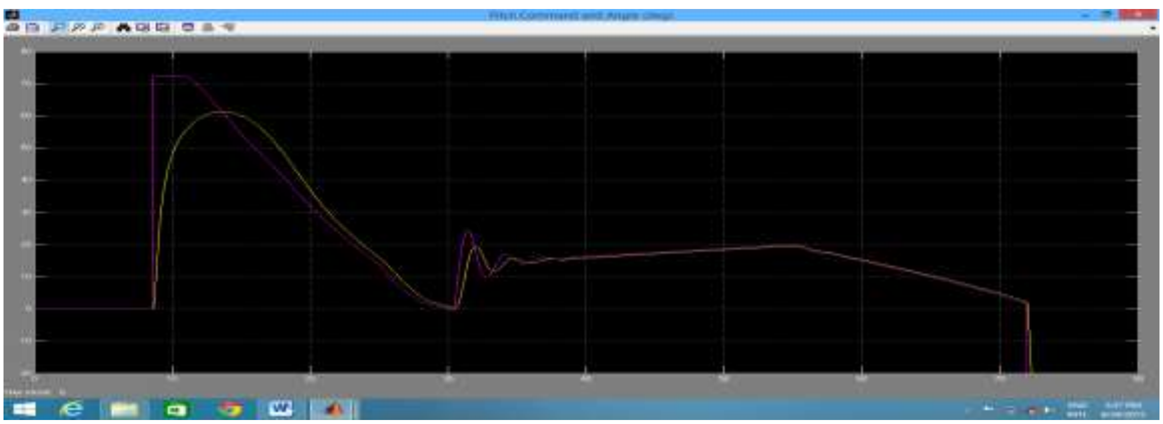

Fig 4. shows that angles of rotor and pitch command.

CONCLUSION

In this paper, there are various important control algorithms for the wind turbine for PMSG systems were studied and analyzed and a variable speed wind energy conversion system (WECS) has been developed using MATLAB/SIMULINK. Mathematical model of various components of the WECS like wind turbine, two mass drive train, PMSG generator, and AC-DC-AC converter along with their controls has been discussed and developed. Also we have studied about the angle of rotor and pitch command.

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