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Analysis Report of Excitation Synchronous Wind Power Generators with Maximum Power Tracking Scheme

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Abstract – *The global electricity consumption is rising and there's a steady increase of the demand on the ability capacity, efficient production, distribution and utilization of energy. A unique excitation synchronous wind generation generator (ESWPG) method with a most power tracking scheme. Power electronic, the technology of with efficiency processing electrical power, plays an important half within the integration of the distributed generation units for good efficiency and high performance of the power systems.*

Keywords*: PMSG, Wind Power, Wind Energy, Wind turbine.*

I. Introduction

Power electronic, being the technology of with efficiency converting electrical power, plays a very important role within the field of modern electrical engineering, it's a necessary part for the combination of dispersed generation unit to achieve high efficiency and performance in power systems. the utilization of permanent-magnet synchronous machines (PMSMs) for wind power generation. The PMSMs will offer high-efficiency and high-reliability power generation, since there's no need for external excitation and no copper losses within the rotor circuits. Additionally, the high-power-density PMSMs are little in size that reduces the price and weight of wind turbines.

The wind power system equipped with a PMSM and power-electronic converters, the wind turbine may be operated to extract the maximum power from the wind at numerous wind speeds by adjusting the shaft speed optimally. Therefore, the PMSMs are usually used for little variable-speed wind turbines to provide high-efficiency, high-reliability, and low-cost wind generation generation.. A Variable-Speed wind-turbine configuration as well as an induction generator and a matrix convertor (MC). The system consists of a turbine, a gearbox, a squirrel-cage induction generator (SCIG), and an MC, A wind generation generator in grid connection applications, aside from doubly fed induction generators, achieves these features using variable speed constant frequency technology. However, most excitation synchronous wind generators can't be connected on to the grid, due to instabilities in wind generation dynamics and unpredictable properties that influence the generator synchronous speed.

The wind and servo motor powers are integrated with one another and transmitted to the excitation synchronous generator via a coaxial configuration. Once the wind speed varies, the servo motor provides a compensatory energy to keep up constant generator speed. The additional servo motor power is additionally remodeled into electricity, and output into the load. This suggests that the motor power isn't wasted. Using a precise section tracking function design, the planned strong integral servo control scheme reduces the output voltage section shift within the excitation synchronous generator from wind excitation field current to confirm that the excitation synchronous generator totally absorbs the wind power, and converts it into electricity for the loads. Based on physical theorems, a mathematical model for the planned system is established to evaluate however the control operation performs within the designed framework. Disturbances, according to the servo motor power magnitude and also the generator power, the planned maximum power tracking theme controls the excitation field current to confirm that the excitation synchronous generator totally absorbs the wind generation.

II. Theory

II.1. Wind Power

The wind is used to get mechanical power or electricity. Wind turbines convert the K.E. within the wind into mechanical power. This mechanical power may be used for specific tasks (such as grinding grain or pumping water), or may be converted into electricity by a generator. Wind is that the movement of air from an area of high pressure to an area of low. In fact, wind exists as a result of the sun unevenly heats the surface of the planet. As hot air rises, cooler air moves in to fill the void. As long because the sun shines, the wind can blow. And as long because the wind blows, people can harness it to power their lives. Most wind energy comes from turbines which will be as tall as a 20-story building and have 3 200-foot-long (60-meter-long) blades. These contraptions appear as if large plane propellers on a stick. The wind spins the blades that turn a shaft connected to a generator that produces electricity. Different turbines work a similar method, however the turbine is on a vertical axis and also the blades look like a large egg beater.

II.2. Wind Energy

Wind turbines and windmills are used to convert wind energy into useful kind Wind energy may be an alternate plentiful renewable energy kind Wind turbines use wind energy to get electricity A wind farm is a assortment of wind turbines used for generating electricity From a thousand AD onwards folks used windmills to pump water and floor grains.

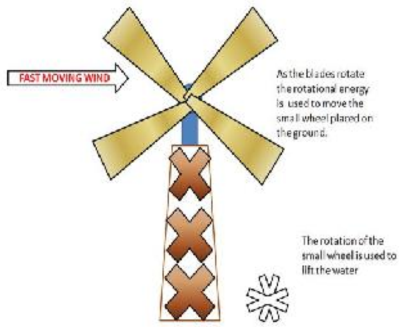

Fig. 1 Wind Energy System

The energy of wind converted into useful type (usually electrical current) is named wind energy". Wind energy may be a Renewable energy supply. Once used will be replaced. Example: Windmill-It may be a machine that converts the energy of wind to rotational energy with the help of huge blades connected to that. The windmills are used for lifting the ground water.4 to 6 blades are connected to a rotating frame round the rotating wheel and mounted on an outsized height.

III. Method

III.1. Maximum Power Tracking Control

In a natural environment, the wind generation varies with time. To stabilize the generator output voltage, current, and output power, the excitation synchronous generator output power should track the input power variation and react instantly by adjusting the excitation field current.

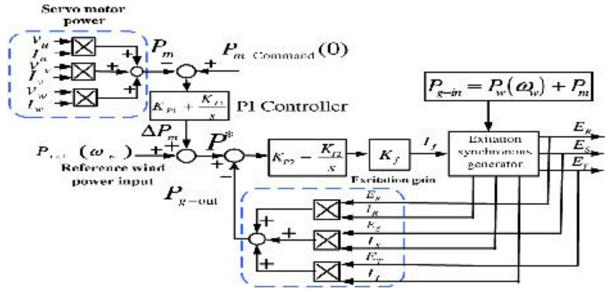

Fig.2 MPTC control loops

The planned MPTC theme includes 2 control loops as shown in Fig. 2, that is motor power control loop, and also the generator power control loop. By MPTC theme, it will create the motor consumption power minimize and most of wind generation will be transferred to the grid by the generator. The management strategy describes as follows.

$$P_{g-in} = P_\mu(\mu_\mu) + P_m \quad (1)$$

Where $P_\mu(\mu_\mu) = T_g \cdot \mu_\mu$ denotes the real wind input power, $P_m = T_m \cdot \mu_m$ is the servo motor output power, $P_{g-in} = T_g \cdot \mu_g$ is the excitation synchronous generator input power, and $\overline{P}_m$ is the calculation motor power.

III.2. Phase Tracking Control Scheme

Fig.3 shows the planned phase tracking control theme. Before the excitation synchronous generator system connects to the grid (SW=0), θ* equals to the grid voltage angle. The servo motor and generator electrical angle may be obtained using the motor encoder and also the grid voltage sensor, severally. The MCU compares the part difference between the 2 signals, and bit by bit adjusts the excitation synchronous generator rotor position to reduce the part deviation.

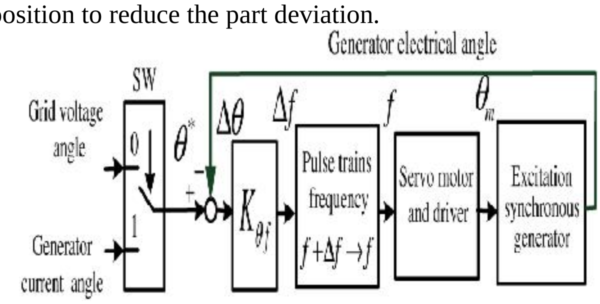

Fig. 3 Phase tracking control scheme

Fig. 3 reveals that, while the proposed system contains a phase deviation Δθ, the deviation frequency Δf can be expressed as follows:

$$\Delta f = K_{-f} \times \Delta^{-} \quad (2)$$

Where $K_{\theta f}$ denotes a constant gain. The new pulse frequency f can be obtained as follows:

$$f + \Delta f \rightarrow f \quad (3)$$

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IV. Result

A wind generation generator framework simulation model with an excitation synchronous generator and its corresponding sub-systems, using MATLAB/Simulink and MATLAB/Simpower software. Subsystems include the wind generation input, servo motor section tracking control, most power tracking control, excitation synchronous generator, and grid connection.

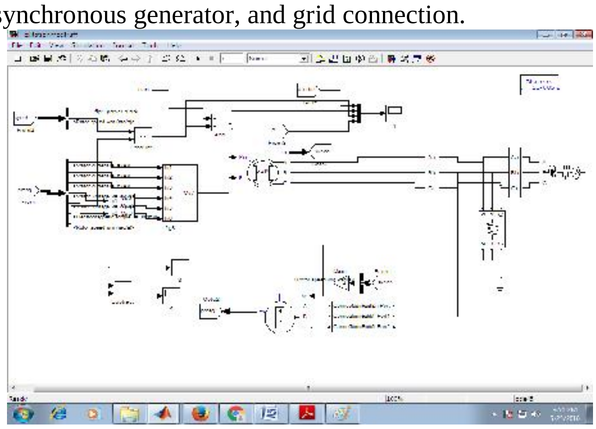

Fig. 4 Matlab model

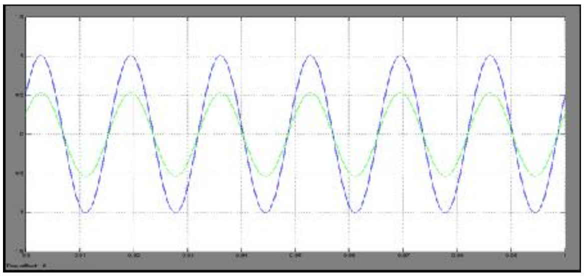

Fig.5 Phase voltage and current of the excitation synchronous generator

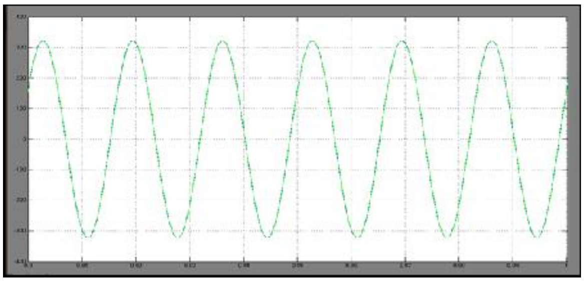

Fig.6 Voltage phase tracking

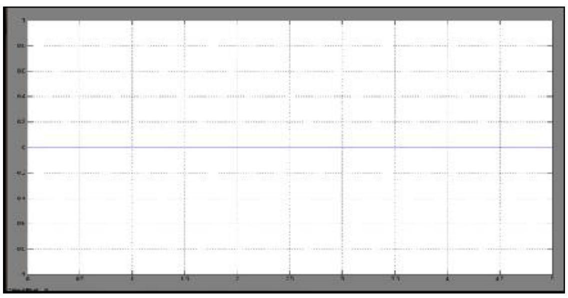

Fig.7 Shaft acceleration

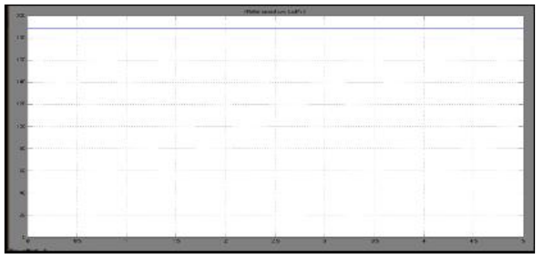

Fig.8 Shaft speed

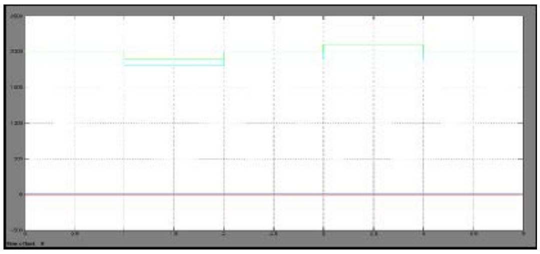

Fig.9 Power tracking curves

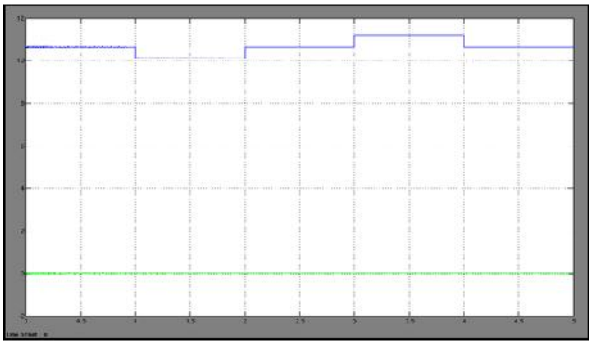

Fig.10 Generator input torque

V. Conclusion

This paper presented an excitation synchronous wind power generator with MPTC scheme. In the proposed framework, the servo motor provides controllable power to regulate the rotor speed and voltage phase under wind disturbance. In addition, the maximum output power tracking scheme governs the input and output powers to achieve high performance. The excitation synchronous generator and control function models were designed from the physical perspective to examine the presented functions in the proposed framework. Experimental results demonstrate that the proposed wind power generator system achieves high performance power generation with salient power quality

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