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Assessment of Transient Stability of Wind Connected Power System with the Help of PSS

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***Abstract*— The size of individual wind power plant is continuously increasing, while sites with good wind conditions often are located far from electrical loads. This often results in wind power plants connecting to weak transmission grids. Among the technical challenges, the voltage stability is identified as most critical to the stable operation of wind power plant within weak grid. If the wind power plant itself cannot provide sufficiently fast and extensive compensation, the typical solution for the voltage stability problem is to install dynamic reactive power compensation with fast voltage control capability, such as Synchronous Condenser. In analysing the electrical networks power flow solution is very essential. There are numerous power flow models for transmission as well as distribution systems. It is also evident from the literatures that several new models exclusively for distribution networks are being developed. This research work carried out on a dummy power system network having wind power plant and Power System Stabilizer (PSS). A MATLAB SIMULINK model for the same system has been developed to analyse that in case of three phase fault the coordination between wind farm and PSS could improve the transient stability of the power system.**

***Index Terms*—PSS, Electrical network, matlab, power plant**

I. INTRODUCTION

Voltage Stability and Voltage Security are thought of as vital considerations in power grid coming up with and operation. To produce reliable, secure and stable wattage to the purchasers, is that the main task of power grid engineer. To fulfil these needs at the same time, the ability system is to be operated nearer to its stability limits that cause a lot of stress on the ability system. Therefore, a study that determines the utmost power transfer capability of the ability system before voltage collapse should be meted out within the voltage secured atmosphere [5].

The elementary principle of an influence system stabilizer (PSS) is to produce damping to the oscillations of generator-rotor by dominant its excitation with the assistance of auxiliary helpful signal(s).

The stabilizer must produce a component of electrical torque in phase with the rotor speed deviations in order to provide sufficient damping. Synchronous generators are used to produce alternating current output voltages, namely single phase or three phase voltage outputs. A synchronous electric power generator consists of a stator and a rotor that has a field winding excited by a field voltage provided by an exciter. Current in the rotor creates a rotating magnetic field which induces current in the stator to produce an output voltage at the terminals of the stator. The amount of field voltage provided by the exciter controls the generator field magnetic strength. As the main generator field strength is controlled, so is the generator output voltage induced in the generator stator. The elementary principle of a power system stabilizer (PSS) is to provide damping to the oscillations of generator-rotor by controlling its excitation with the help of auxiliary stabilizing signal(s). The stabilizer must produce a component of electrical torque in phase with the rotor speed deviations in order to provide sufficient damping. Synchronous electric power generators are used to produce alternating current output voltages, namely single phase or three phase voltage outputs.

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II. METHODOLOGY

Power system coming up with is important for power system engineer. For coming up with the magnitudes and section angles of load bus voltages, active and reactive powers at generator bus, real power flow on transmission lines and voltage section angles at specified bus bars is needed. For this purpose load flow is that the very important tool to unravel the flexibility system coming up with issue.

This research work is comprised of the load flow analysis of twenty nine buses, seven power station networks. In initial part the literature review concerning load flow analysis is dispensed. Different blocks are implemented in second step of the project. Interconnection of different blocks in SIMULINK environment will be the 3rd step of the research work. Where the final step includes simulation of the overall network and the results obtained are discussed in this step too.

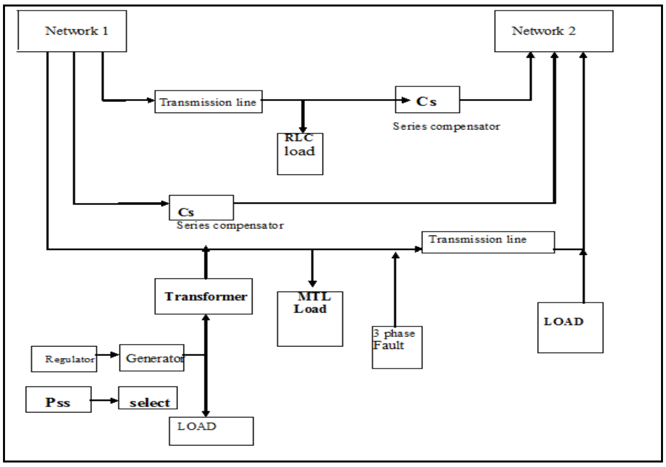

Fig.1. Block Diagram of Test System

III. RESULTS

Newton Rapson's method is used for load flow analysis of the power system network. The model is discretized using a 50 µ seconds sample time. A six-cycle three-phase fault is programmed at one of the 735 kV bus.

With details of voltages at different buses a comparative graph is constructed in fig. .

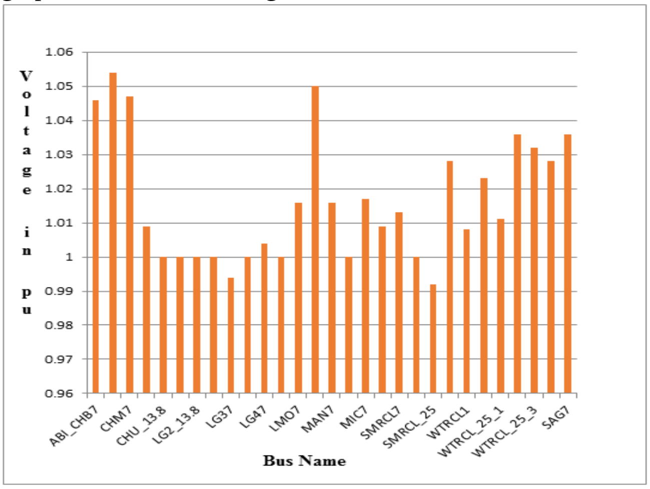

Fig. 2 Variation in bus voltage magnitudes

The above chart shows that when a suitable reactive compensation is available near to the particular bus the bus voltage magnitude profile is much better.

I) Effect on Speed of Synchronous Generators

By observing Fig. 5.2 and Fig. 5.3 it is cleared that when PSS is connected to the power system network is easily controlling the variation in speed of the different generators in the system. It is cleared from the simulation graph that after three phase fault the variation in the speed of synchronous generators as well as the wind farm became large this may lead to the instability of the power system but when PSS is connected to the system it controls the governing system of the generators to control the large variations in speed of generators and thus maintained the stability of the system.

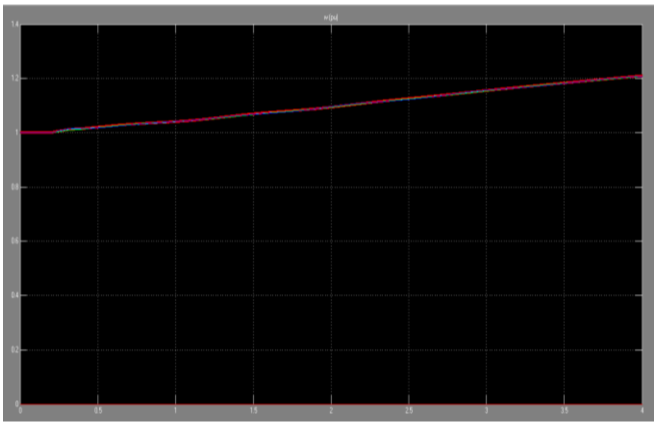

Fig. 3 Variation in Speed of different Generators without PSS

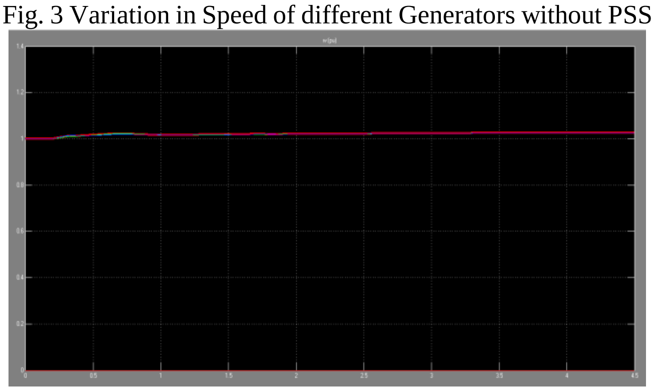

Fig. 4 Variation in Speed of Different Generators with PSS

II) Effect on Terminal Voltages of Synchronous Generators

The graphs 5.4 and 5.5 reveals that three phase short circuit fault creates voltage imbalance in the system which directly affeted the transient stability. Excessive reactive power (due to capacitive transmission lines) increases the system voltage to a certain level, terminnal voltages of generators also increased, as the effect of AVR (Automatic Voltage Regulators) the terminal voltage start setteling down but PSS also helps to settle down this voltage and lowered down don the final value.

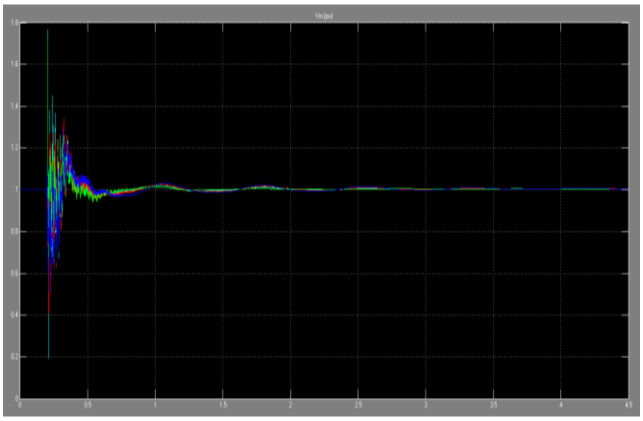

Fig. 5 Terminal Voltages When PSS was Not Employed

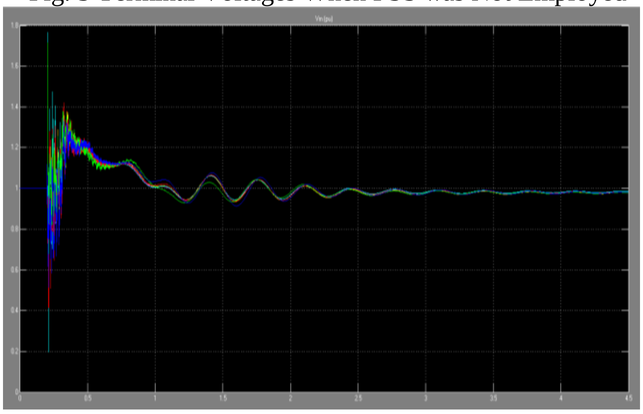

Fig. 6 Terminal Voltages When PSS was Employed

III) Effect On The Speed Of Wind Turbine

The figures 5.6 and 5.7 shows that when a three phase fault occurs in the wind farm connected power system the reactive power imbalance occurs, the transmission lines became capacitive and thus due to increase in reactive power the system voltage also increased, following that the speed of wind generater started increasing anormously.

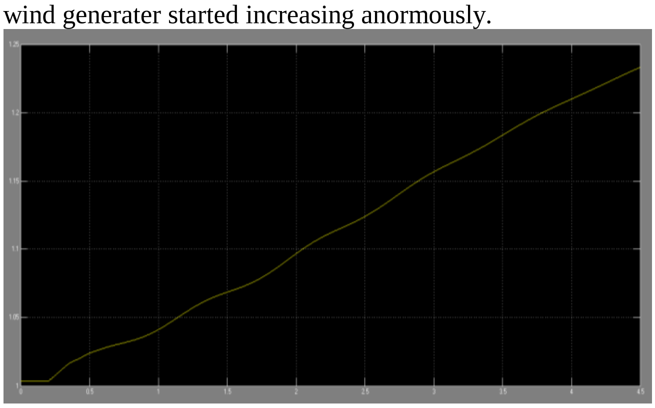

Fig. 7 Variation in speed of Wind turbine when PSS was not Employed

As PSS is employed in power system already it started controlling this rapid increase in turbine speed to a particular value. Simulation graphical results shown that after a small damping the speed of wind turbine settled to a safe value.

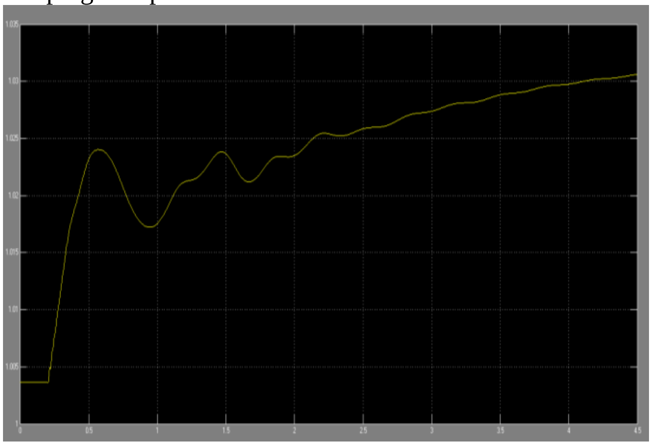

Fig. 8. Variation in speed of Wind turbine when PSS was Employed

IV) Effect on Voltages of SMRCL Load System

As the three phase fault occurs near to the SMRCL load bus the bus voltages fall due to short circuiting. The Simulation resultant graphs shown that PSS improved the voltage profile by improving the governing system of synchronous generators as well as wind turbine.

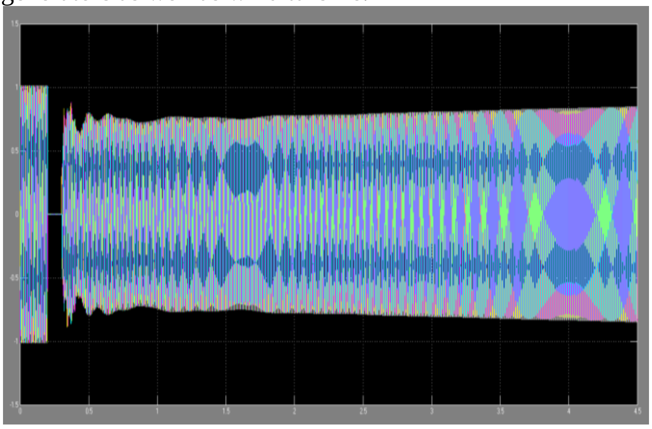

Fig. 5.8. SMRCL Load Bus Voltages without PSS

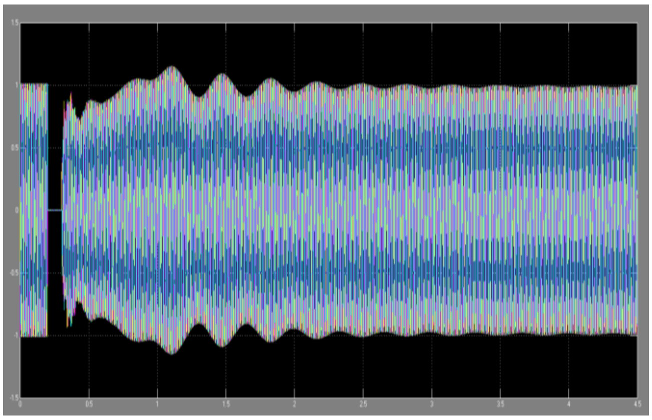

Fig. 5.9. SMRCL Load Bus Voltages without PSS

IV. Conclusion

Wind connected power system often face instability during operation, due to fluctuation in speed of wind turbine during changing winds, fluctuation in reactive power as the result of short circuit faults or variation in load and some other disturbances. These reasons make the link between grid and wind farm weak.

If any severe fault occurs at any point of the system (win farm connected power system) the instability cause the fluctuations in generator speed, if appropriate steps will not be taken the generators may out of synchronism and the grid will be unstable.

To control the oscillations in generators Power System Stabilizer is an effective tool. In this research work a power system network containing synchronous generators, Power System Stabilizer, transformers, series compensated transmission line, load, wind generator etc. had been modelled using MATLAB SIMULINK. The resulting graphs are traced for speed of synchronous generators, speed of asynchronous generator, terminal voltages of the same. These graphs shows that after connecting the PSS in the system the speed of generator had less oscillations during three phase to ground fault, as well as terminal voltages also have less fluctuations.

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