REACTIVE POWER COMPENSATON AND VOLTAGE FLUCTUATION MITIGATION USING FUZZY LOGIC IN MICRO GRID

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***Abstract*— During the fault condition, wind generator gets disconnected which causes negative impact on power grid. Hence additional devices are required to overcome fault ride through capability to have better voltage regulation and also to meet grid code requirements. During interconnection of large wind farms with grid, Induction Generator starts to consume large amount of reactive power from the power grid. Shortage of reactive power may occur which in turn affects line voltage of the system. This causes voltage in the line to decrease or increase simultaneously which affects real and reactive power. Simple compensator such as transformer taps changer, Automatic voltage regulator and uninterrupted power supplies can be used to eliminate such power quality problems.The controller of the proposed system is based upon Synchronous Reference Frame Theory which has been carried out in MATLAB environment using Simulink. Controller plays an important role in reducing fluctuating voltage error signal efficiently. Simulation result shows that the proposed SVC and STATCOM with Controller is efficient in mitigating voltage sags and thus improving the power quality of the power grid. Fuzzy logic technique has been used as it has advantage of robustness, easily adaptive fast technology is also used and best results are achieved when compared to conventional technique.**

***Index Terms*— voltage regulation, SVC and STATCOM, Fuzzy logic, power grid, grid code**

I. INTRODUCTION

The basification of non-linear loads, which are based on power electronic devices characterized by high harmonic pollution, has increased the problems arising from the injection of harmonic currents in the network, in all sectors of energy consumption [1]. A basic single-phase TCR comprises an anti-parallel connected pair of thermistor valves with a linear air core reactor connected in series. The anti-parallel connected thermistor pair acts like a bidirectional switch, with one thermistors valve conducting in positive half cycles and the other thermistors valve conducting in negative half-cycles of the supply voltage [2].The VSC converts the DC voltage across the storage device into a set of three-phase ac output voltages. These voltages are in phase and coupled with the ac system through the reactance of the coupling transformer. Suitable adjustment of the phase and magnitude of the STATCOM output voltages allows effective control of active and reactive power exchanges between the STATCOM and the ac system [3].According to reference frame transformation theory, reference signal detected is made to transform from stationery frame a-b-c to rotator frame d-q axis. Controller is used to produce required signal for Pulse Width Modulation (PWM) from rotating frame signal [4].Basically, the motor drive system comprises a voltage source inverter-fed induction motor (VSIM): namely a three-phase voltage source inverter and the induction motor. The squirrel-cage induction motor voltage equations are based on an orthogonal d-q reference-rotating frame where the coordinates rotate with the controlled source frequency [5].In the implications of the rotating field from the three-phase voltage on partial discharge modelling and on the induced charges in the conductor are examined [6].Before passing in to PWM, the reference signal is produced by inverse transformation from rotating signal [7].

II. RELATED WORK

A. Conventional Method

The direct and quadrature components represent the active and reactive powers respectively. This method is applicable especially in three phase system. Control algorithm is developed by comparing the reference voltage and fluctuating voltage. This compared signal is passed to controller and thus it minimizes the error signal. Therefore controller is required to achieve controller performance at very faster rate. According to reference frame transformation theory, reference signal detected is made to transform from stationery frame a-b-c to rotator frame d-q axis. Controller is used to produce required signal for Pulse Width Modulation (PWM) from rotating frame signal. Before passing in to PWM, the reference signal is produced by inverse transformation from rotating signal. Here d-q Journal of Theoretical and Applied Information Technology. Transformation is otherwise said to be called as park's transformation. In controller the gain values are adjusted to get optimum performance. These gain values can be tuned based upon Ziegler Nichol's tuning or even by using Fuzzy controller. Proportional and integral controller helps to reduce error values as fast as possible. PWM is based on equal area theorem.

This technique uses sinusoidal PWM. The equal area theorem can be applied to realize any shape of waveforms. Equal area theorem states that responses tend to be identical when input signal has same area and time durations of input signals become small. F. The basic control algorithm developed. It briefly describes about the importance of reference frame theory and controller. In Pulse Width Modulation technique, suitable signal from controller has been generated as control signal which makes to produce desire reference signal so that corresponding carrier signal is produced. The carrier frequency is set in PWM block. So that appropriate pulse signal is created which acts as an input to power switch and Voltage Source Converter. Pulse width Modulation is able to control the switching device IGBT. Here reference signal is otherwise said to be modulating signal which is made to compare with carrier triangular signal. Then according to that signal, ON-OFF pulse occurs simultaneously with corresponding delay due to synchronization.

- Stage 1: Error Calculation
- Error is calculated on the basis of difference between reference and fluctuated voltage. Error rate is calculated as Vref – Fluctuated.
- Stage 2: Fuzzification

Fuzzification is the process where the crisp quantities are converted to fuzzy. It converts non fuzzy (numeric) input variables to fuzzy set (linguistic variable). The membership functions is defined as error and change in error as Positive Big (PB), Positive Small (PS), Positive Medium (PM), Zero, Negative Small (NS), Negative Medium (NM), Negative Big (NB).

B. Decision Making

The set of rules for fuzzy are represented below: There are 49 rules for fuzzy controller. The output is based on the evaluation of rules by the fuzzy sets and fuzzy logic operation.

C. Signal Processing

The outputs of FLC process are the control signals that are used in generation of switching signals of the PWM inverter by comparing with a carrier signal. Overall Block diagram of wind farm connected with power grid In this study Voltage sag occurs when three phases to ground fault occurs with time 0.03s to 0.08s. Usually voltage sag occurs due to over speeding of generator, disturbances on load, three phases to ground fault. Shunt compensating device such as SVC, STATCOM compensates reactive power as well as regulates voltage. The RMS value of the grid voltage and the fluctuating voltage value are applied to the control block. The output of the block is converted to the firing angles using PWM technique in which SVC and STATCOM acts according to signal thereby voltage sag is rectified across grid and load side. In place of controller, fuzzy logic is applied an

D. Block Diagram

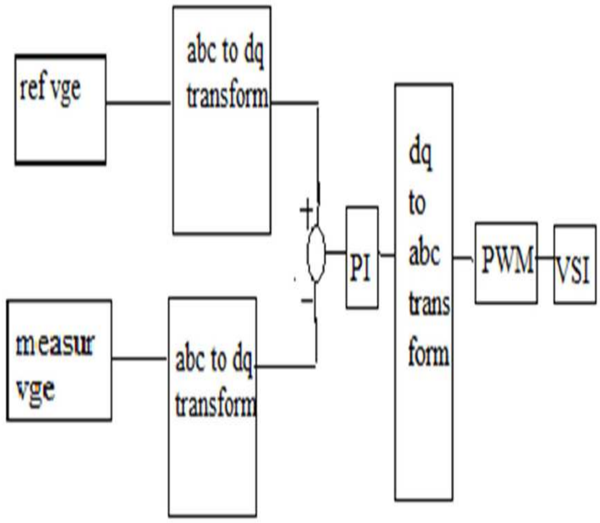


Fig 1.a) block diagram

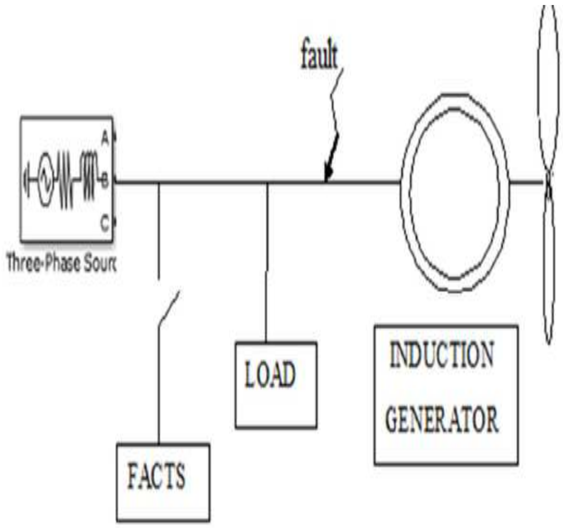


Fig 1.b) block diagram

E. DESCRIPTION

Detailed study of DFIG, of grid side vector control techniqueusing traditional has been studied from "A doubly fed induction generator using back to backPWM converters and its application to variable speed wind energy generation". Numerousresearchers have done extensive work to make the dc link capacitor voltage constant regardlessof any occurrence of grid faults.

III. PROPOSED METHOD

A. Model of Wind Speed

Wind power is basically in the form of kinetic energy moving above the earth's surface. Wind turbine blades collect the kinetic energy of air transforming into mechanical or electrical forms. The effectiveness of converting wind to other useful energy forms depend on the efficiency with which the rotor interacts with the wind flow. Kinetic energy contained in wind is given by where *m* denotes the rate of flow of air and 2 *v*represents the speed of wind when undisturbed by anything. Taking into account a wind rotor of cross sectional area a exposed to the wind flow, *where AV* denotes the volume flow and represents the mass flow. *V* is the volume of air accessible to the rotor. Hence power, can be expressed as *from* equation, we find that factors affecting the power available in the wind stream are the area of the wind turbine rotor, density, and the wind velocity. However the wind velocity effect is more due to its cubic relationship with the power.

B. Block Diagram

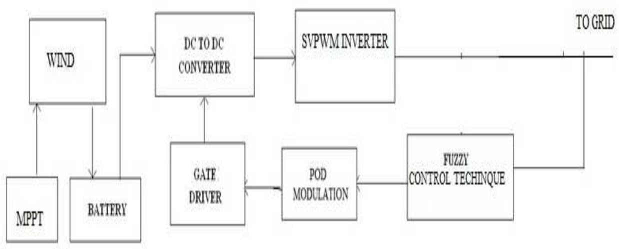


Fig 4.1. block diagram

C. Block Diagram Explanation

Control of supply side using simple controller was achieved to make the dc link voltage constant. Voltage balance equations are derived with respect to reference frame rotating at Current control and voltage control loops are designed using the controllers only. A three phase PLL technique was implemented to measure the phase angle.

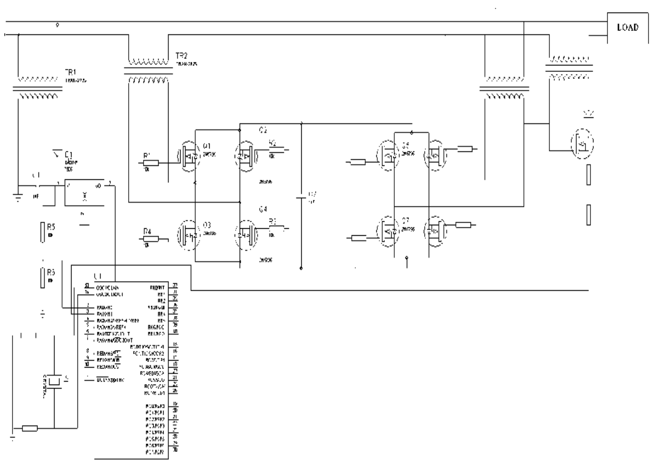


Fig.2 Circuit Diagram

D. Problem statement

Characteristics curve stating the relation of power, torque to rotor speed was coded for different wind velocities. Plotting was done in order to extract maximum amount of energy that could be converted to useful mechanical power. Implementing grid side using only controllers resulted in variation of the dc link voltage. Therefore a fuzzy controller was used instead of controllers to improve the dynamic response of the system.

IV. RESULT AND DISCUSSION

A. Simulation block diagram

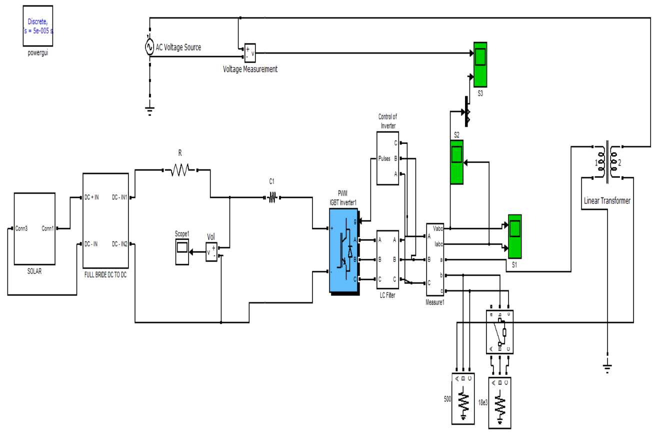
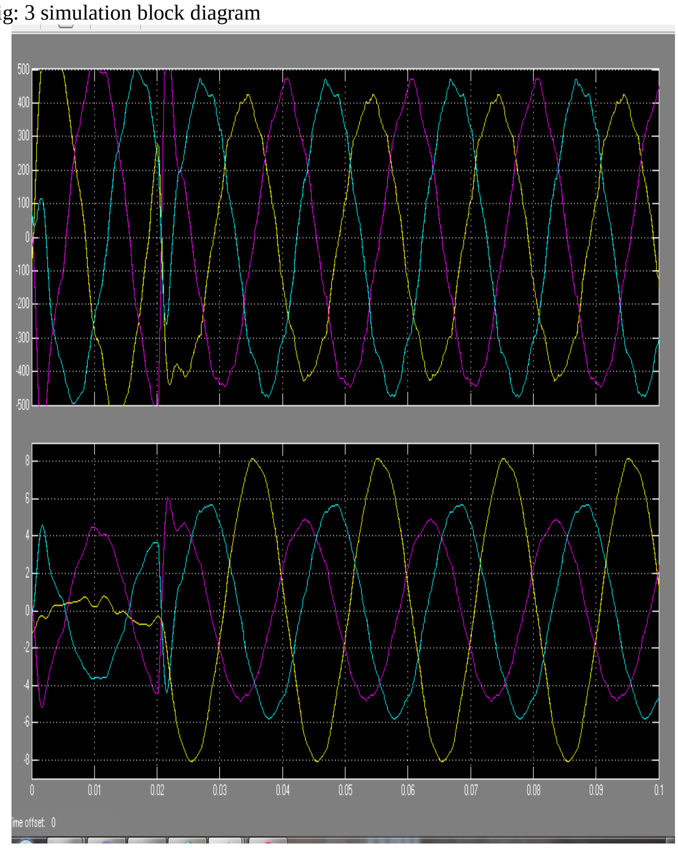
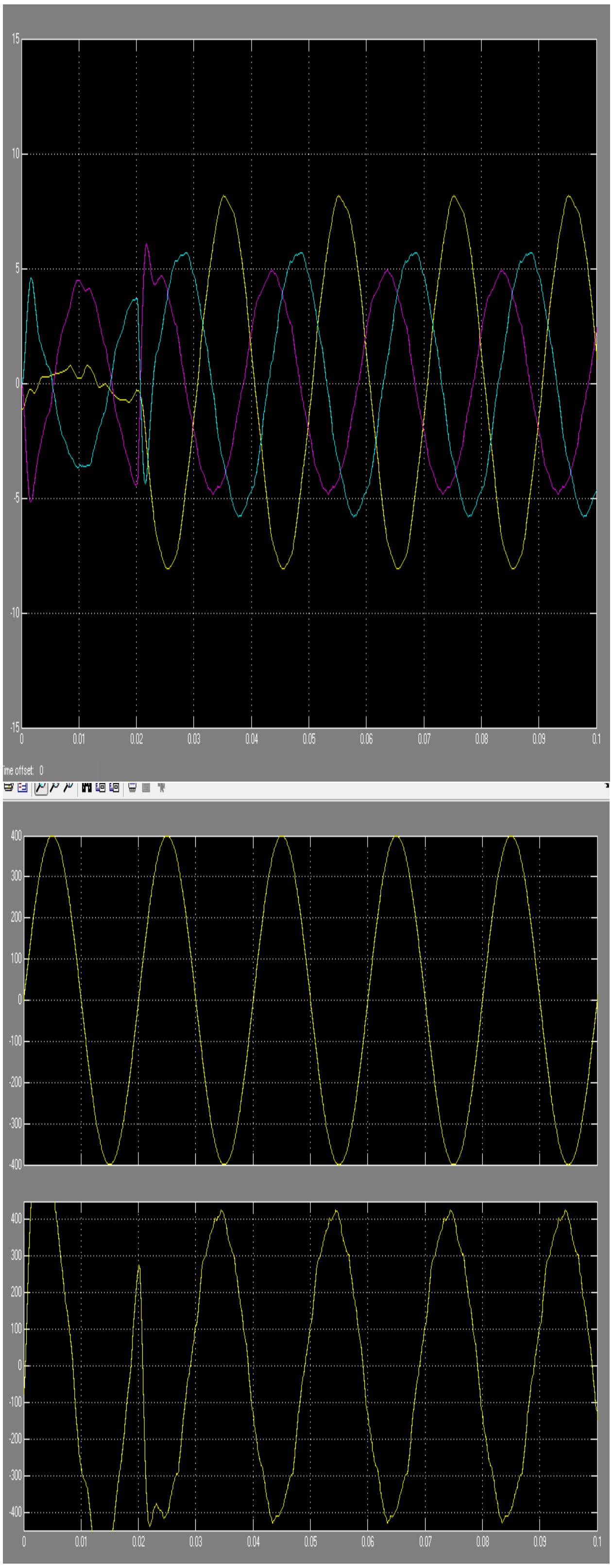


Fig: 3 simulation block diagram





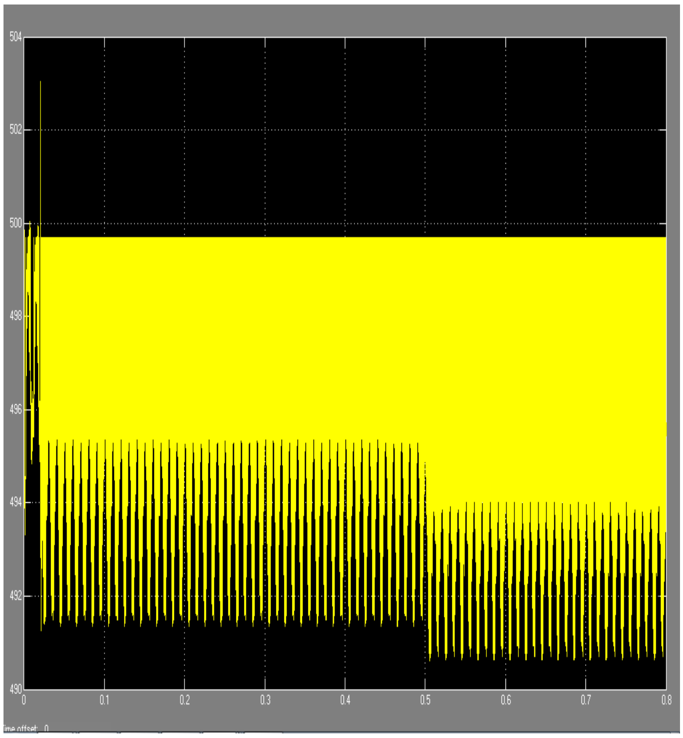


Fig: 4 Simulation waveform

V. CONCLUSION

In this work, test system is developed using matlab Simulink software. It is shown that power quality improvement is achieved successfully with SVC and STATCOM. This work shows that both devices can compensate the voltage sag and support to stabilize the wind farm connected to grid. Compared to SVC, STATCOM performs fast and takes lesser time for clearing of faults, but oscillations are more in STATCOM compared to SVC. In the proposed system, a FACTS device with controller is designed to decrease voltage fluctuations and to improve power quality. The control scheme is further improved by using Fuzzy logic controller and voltage sag is minimized. Better results are achieved and comparisons of results are made with and Fuzzy controller. Advanced control technique such as Fuzzy results better when compared to SVC. If the controller is replaced further by ANFIS then problems such as harmonics, power factor can also be corrected.

REFERENCES

[1] M.Liserre, R. Cardenas, M. Molinas, and J. Rodriguez, “Overview of multi-MW wind turbines and wind parks,” IEEE Trans. Ind. Electron, 58, April. 2011, vol. 58, no. 4, pp. 1081–1095.

[2] Tascikaraoglu A, Uzunoglu M, Vural B, Erdinc O. “Power quality assessment of wind turbines and comparison with conventional legal regulations: a case study in Turkey”. Applied Energy, 2011; 88: 1864–72.

[3] M. Tsili and S. Papathanassiou, “A review of grid code technical requirements for wind ,” IET Renewable Power Generation.,September 2009, vol. 3, no. 3, pp. 308–332.

[4] Wang, JiaxinNing. “Development of low voltage ride through control strategy for wind power generation using real time digital simulator”. Power system conference and exposition, 2009.IEEE/PES.

[5] Hafidz SA, Basu KP. “Ride through capabilities of load during voltage sag/swell and power interruption with zigzag transformer”. In: Innovative technologies in intelligent systems and industrial applications, 2008, IEEE conference.