International Journal For Technological Research In Engineering
Volume 9, Issue 10, June-2022 *ISSN (Online): 2347 - 4718*

THE STATCOM IMPACT ON WIND FARM UNDER THREE PHASE STUDY OF FAULT CONDITION

Ramesh Kumar, Dr. Prabodh Kumar Khampariya
Department of Electrical Engineering
Sri Satya Sai University of Technology &Medical Sciences
Sehore, MP, India- 466001

ABSTRACT: - This paper studies the impact of STATCOM of a 3-phase fault for few seconds. The farm consists of number of wind turbines are connected together to generate huge amount of power. The induction generator based wind farm has some serious stability issues under faulty condition. The application of STATCOM provides necessary support to the system to maintain the stability under such disturbances.

INDEX TERMS: - STATCOM, stability, wind farm, induction generator based wind turbine, three phase fault.

I. INTRODUCTION

Now a day the cost of conventional fuels is increasing day by day due to limited availability of these resources. Every country is looking for opportunity in the sector of green energy. And they want to be self-dependent for their energy needs. There is lot of more scope in green energy sector, that is why number of research is going on in this direction.

Wind turbine is coupled to induction generator with the help of gear box. When the wind is allowed to flow through the blade of wind turbine, the turbine blades starts rotating and the electrical power is produced by induction generator. When a three phase fault occurs near the wind turbine it will resulting over speeding of induction generator (wind turbine) and may result instable system. The faulty part is disconnected from grid to clear the load on the grid. Thus the system is overloaded and tending to unstable.

In this paper the impact of STATCOM in a faulty power system is studied. The STATCOM Improves the fault ride through capability of a wind turbine based system by providing necessary support during and after clearing the fault.

2. WIND FARM MODELING

Number of wind turbines are connected together is known as the wind farm. Each wind turbine is coupled with induction generator (SCIG) to generate the electrical energy. The power output of a wind turbine is directly proportional to the cube of wind speed passes through the blade of wind turbine.

$$P_e \alpha V_w^3$$

$$P_w = \frac{1}{2} \rho A_r V_w^3 (\beta\lambda)$$

Where, ρ= Air density in Kg/m^3

A_r= Blade impact area

V_w= Wind velocity in m/sec

C_p= Power coefficient of wind turbine

3. STATCOM MODELING

Static synchronous compensator consists of a VSC (shunt inverter), connection filter, capacitor and a coupling transformer. The fig-1 shows the basic model of static synchronous compensator, connected to a bus with the help of coupling transformer. The reactive current supplied by STATCOM depends on voltage difference between VSC and AC line voltage.

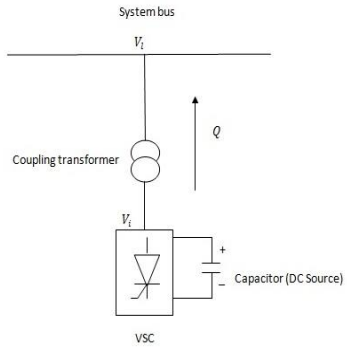


Figure 1 Basic model of STATCOM

4. SIMULATED SYSTEM DESCRIPTION

Fig.-2 shows a schematic diagram of simulated system. In this system a 60MW wind farm is connected to a 132KV AC grid line and a coupling transformer of 11/132 KV. A 30MVAR STATCOM is connected at the 132KV bus. A fixed capacitor compensation of 23MVAR is provided near the turbine at 11KV bus.

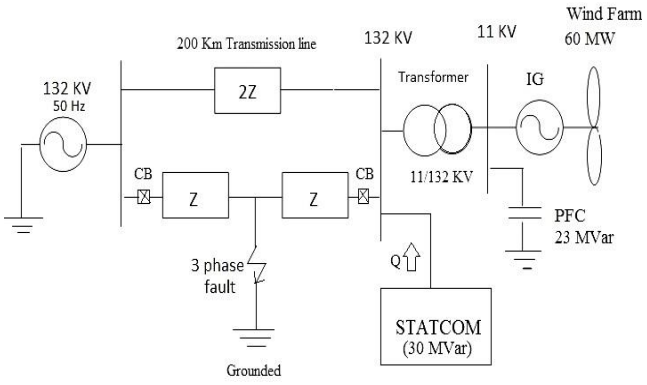


Fig.2 schematic diagram of simulated system

5. SIMULATED RESULT / MATLAB SIMULATION RESULT

The lumped parameters of induction generator are shown in Table-1. The system short circuit level is 1200MVA and X_1/R_1 ratio is 20. The system performance without using statcom is shown in fig.3 to investigate the performance a3-phase short circuit fault is applied at one of the transmission line at 0.85 sec and the fault is cleared by disconnecting line -2 from the network at one second time interval. Due to fault system voltage and torque reduces significantly,

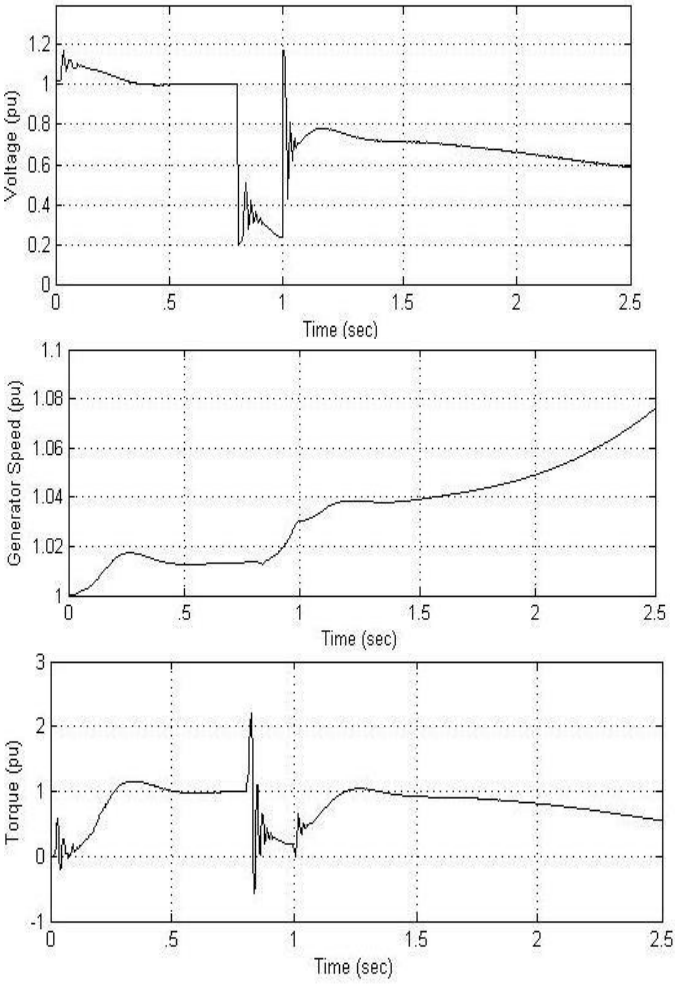
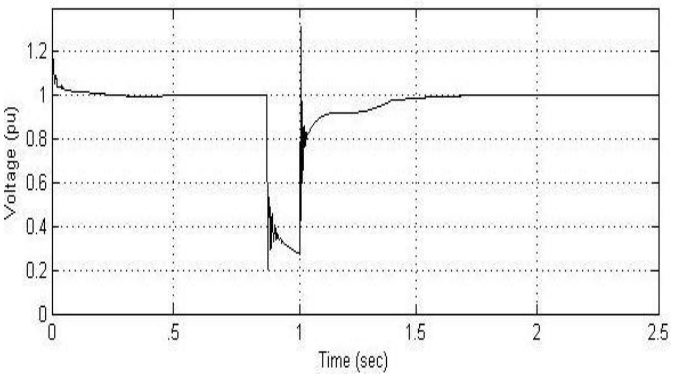


Fig 3 system response without using STATCOM



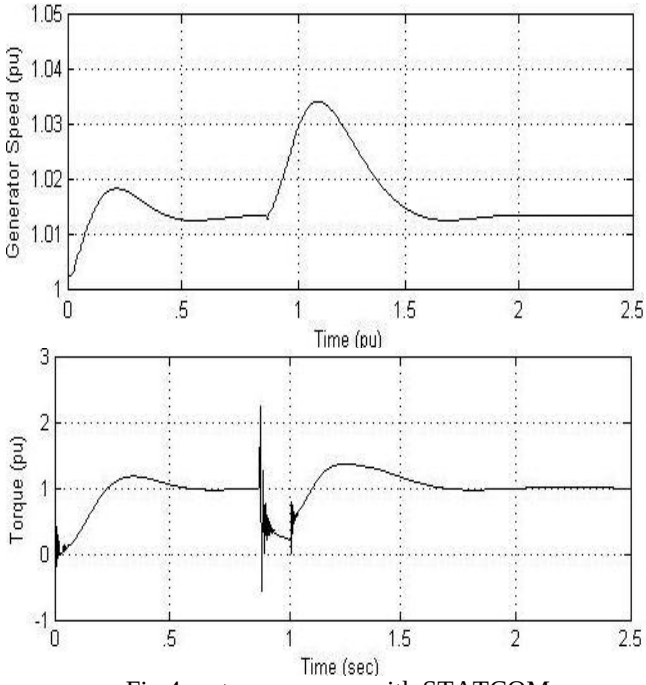


Fig 4 system response with STATCOM

Voltage reduces to approximately 20% of its rated value.and the speed of IG starts increasing and the slip is also increasing. When the fault reaches to 78% of rated value. Since the difference in Mehanical torque and electrical output is more theat result in continuous acceleration of generaor and speed of generator continues to increase, and finally reaches to unstable situation..

Fig.4 shows the result with application of statcom. Which has DC capacitor of 300μF. And DC link voltage of 40KV. The simulation result shows that statcom provides necessary support to the system during fault. The voltage level recovers to higher value than previous one and finally settled to their nominal value. The generator speed do not increase more than3.5% of their desirable value and it starts decreasing after clearing fault and settled to their rated value at 1.6 second.

Rated voltage	11KV
Rated power	60MW
Rotor resistance	0.01214pu
Stator resistance	0.0108pu
Rotor inductance leakage	0.1407pu
Stator inductance leakage	0.107pu
Lumped inertia constant	3s
Mutual inductance	4.4pu

Table-1

6. CONCLUSIONS

From the investigation it can be concluded that a wind farm has adverse effect on system voltage and generator speed due to severe fault condition. And this may leave to unstable operation. The static capacitor is not capable of providing necessary support during fault condition. Here statcom which

is a kind of dynamic reactive compensator provides better reactive power support to the system.

REFERENCES

[1] Mohammad Ilyas, Mohammad Ubaid Soherwardi "STATCOM for improvement of dynamic performance of wind farms in power grid" IJMER may 2014.

[2] A. Larsson,"Flicker emission of wind turbines during continuous operation," IEEE Trans. Energy Conversion, vol. 17, No. 1, pp. 114- 118, Mar. 2002.

[3] Lie Xu, Liangzhong Yao, and Christian Sasse "Comparison of Using SVC and STATCOM for Wind Farm Integration" 2006 International Conference on Power System Technology.

[4] J. W. Smith, D. L. Brook, "Voltage impacts of distributed wind generation on rural distribution feeders," IEEE PES TDCE, vol. 1, pp. 492- 497, 28 Oct.-2 Nov 2001.

[5] Zengqiang Mi, Yingjin Chen, Liqing Liu, Yang Yu "Dynamic Performance Improvement of Wind Farm with Doubly Fed Induction Generators Using STATCOM" 2010 International Conference on Power System Technology.

[6] Wei Qiao and Ronald G. Harley, "Power Quality and Dynamic Performance Improvement of Wind Farms Using a STATCOM" 2007 IEEE

[7] T. Ackermann, Wind Power in Power Systems. New York:Wiley, 2005.

