IJITE INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN ENGINEERING (IJITE) ISSN: 2395-2946
VOLUME-13, NUMBER-02, 2016

Improve The Output Power Quality In Wind Generator Using Various Capacitor Range

Amit Shrivastava, Beaulah Moses

Department of Electrical & Electronics Engg.

Vikrant Institute of Tech. & Management, Gwalior, India

***Abstract*—Universal wind turbines are equipped with induction generators. Induction generators are preferred because they are low cost, rugged, and require very little maintenance. Unfortunately, self-excited induction generators (SEIG) require controllable Capacitor VARs to magnetize the machines and compensate the demagnetizing effect of loads. in this paper describes the effects of capacitive VARs on the output power quality of three-phase self excited induction generator. Capacitive VARs are employed to achive the required output of self-excited induction generator. The effect of capacitive VARs were analysis using MATLAB/ SIMULINK.**

***Key Words*— Induction Generator, Matlab, Wind Turbine,Self Excitation, Power Quality,**

I. INTRODUCTION

It is referred to that the point when capacitors would parallel join with those stator terminals for a induction machine, driven by external source, voltage develops during its terminals [1]. The induced emf and current in the stator windings will keep on going on Ascent until steady state will be attained, which will be impacted Toward those attractive immersion of the machine. Toward this working point, the voltage Also present will proceed with should sway at a provided for top esteem and recurrence. With the end goal self excitation to occur, to a specific capacitance value, there may be a comparing least speed [2-4]. Self-excited induction generators (SEIG's) would great hopefuls for wind powered electric era applications, particularly on remote areas, since they don't need outer energy supply to prepare those attractive field. Permanent magnet generators can also be used for wind energy applications but they suffer from the uncontrollable magnetic field, which decays over a period, due to weakening of the magnets, and the generated voltage tends to fall steeply with load. The self-excited induction generator (SEIG) has a self-protection mechanism because the voltage collapses when there is a short circuit at its terminals. Further, the SEIGs have other advantages such as low cost, reduced maintenance, rugged and simple construction, brush-less rotor (squirrel cage) etc. In this paper, we shall study the effects of variation in the value of capacitor bank used for compensation, on the voltage profile of SEIG. Efforts are made to find out the most suitable value of capacitance for SEIG, supplying constant inductive load and operating at constant wind speed. Power system toolbox of MATLAB 7.8.4 / SIMULINK is used for simulation.

II. SYSTEM DESCRIPTION

The proposed system consists of a 230V, 50 Hz, 275-kVA, induction generator, driven by wind turbine at a fixed inductive load of 0.7pf lagging. A three-phase delta connected capacitor bank parallel connected with to the induction generator. The value of this capacitor bank can be changed according to the voltage output and harmonics. The speed of wind is kept constant, for this study, at 10 m/s. The block of wind turbine uses a 2-D Lookup Table to Calculate the turbine output torque = (Tm) as a speed function of wind = (w_Wind) and turbine speed = (w_Turb). The Pm = (w_Wind, w_Turb) characteristic gets automatically loaded into the workspace = (psbwindgen_char array), when we open this setup. The turbine characteristic can be displayed by double clicking the block located below the Wind Turbine block.

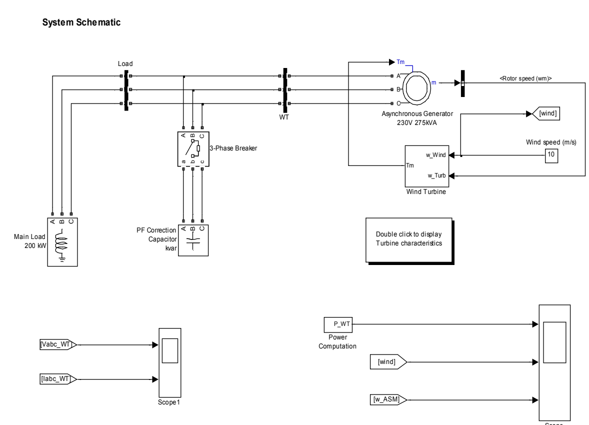

Fig. 1 System Model

The asynchronous machine operates in generator mode i.e. its speed is slightly above the synchronous speed. According to turbine characteristics, for a 10 m/s wind speed, the turbine output power is 0.75 p.u. (206 kW). Scope 1 is used to record the p.u. values of terminal voltage and current of the induction generator and Scope-2 records the power at the generator terminals, wind speed and the generator speed

III. SIMULATION RESULTS AND DISCUSSIONS

The above mentioned system is simulated in MATLAB, using the SIMPOWER system tool box of SIMULINK, to study the effects of variation in capacitive compensation /VAR on the voltage profile. The SIMULINK model of the system is shown in figure.1.The simulation time 30sec. Machine parameters are given in section -5

Case –I: Capacitor Bank Value = 55 KVAR

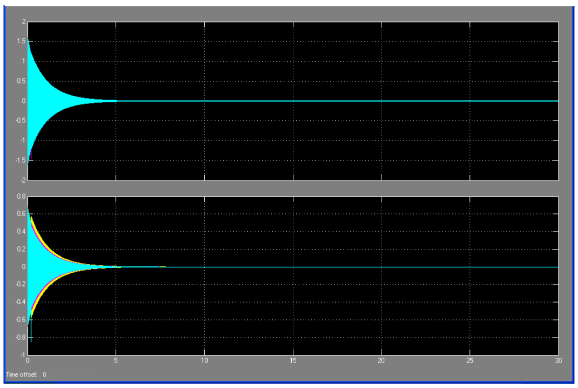

Fig. 2.1.1 Induction generator terminal Voltage V_L, and line current I_L

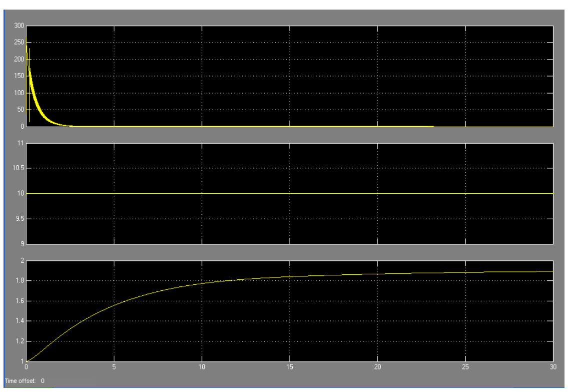

Fig. 2.1.2 Power in kw, wind speed in m/s and induction generator speed in p.u.

When we operate system at 230V, 50Hz with the value of capacitor bank at the terminal of induction generator is 55 KVAr (fig.2.1.1)at the starting i.e. during the instant (1sec to 4 sec) the voltage drop to the value of 1.5p.u.after 5 sec. voltage output is reduced to zero. Similar kinds of variations are also recorded in the current. During the instant (1sec to 4 sec) the value of current 1.5p.u.after 5 sec. voltage output is reduced to zero. The Power output is reduced to zero during the large dip in the voltage (fig 2.1.2). The wind speed is shown constant at 10m/s. the generator speed is reached up to 1.9p.u.after variation from 1.7p.u.at 10 sec. and 1.8p.u.at 15 sec.

Case –II Capacitor Bank Value 75KVAR

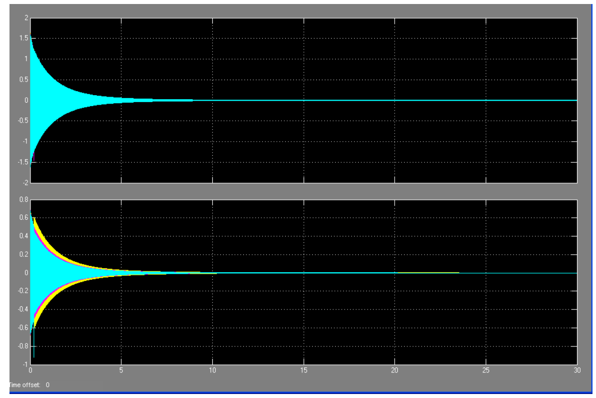

Fig. 2.2.1 Induction generator terminal Voltage V_L, and line current I_L

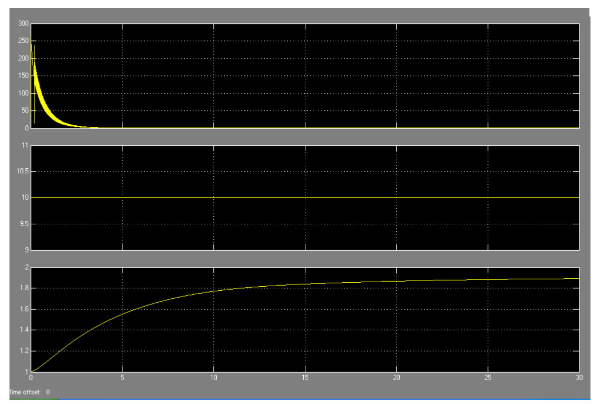

Fig.2.2.2 Power in kw, wind speed in m/s and induction generator speed in p.u.

When we operate system at 230V, 50Hz with the value of capacitor bank at the terminal of induction generator is 75 KVAr (fig.2.2.1)at the starting i.e. during the instant (1sec to 7 sec) the voltage drop to the value of 1.5p.u.after 8 sec. voltage output is reduced to zero.

Similar kinds of variations are also recorded in the current. during the instant (1sec to 7 sec) the current drop to the value of 1.5p.u.after 8 sec. voltage output is reduced to zero.

The Power output is reduced to zero during the large dip in the voltage (fig2.2.2). The wind speed is shown constant at 10m/s. the generator speed is reached up to 1.9p.u. after variation from 1.7p.u. at 10 sec. and 1.8p.u. at 15 sec.

Case-III Capacitor Bank Value = 95KVAR

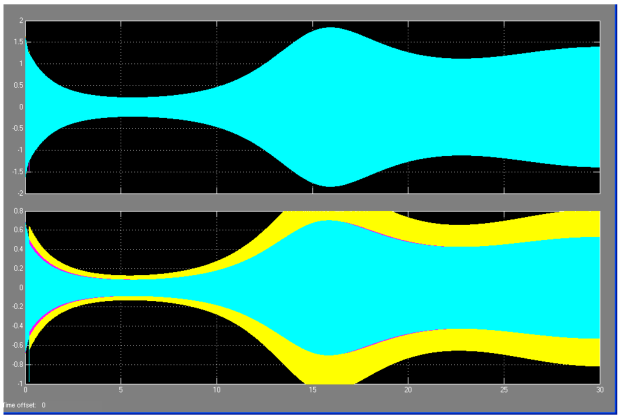

Fig.2.3.1 Induction generator terminal Voltage V_L, and line current I_L

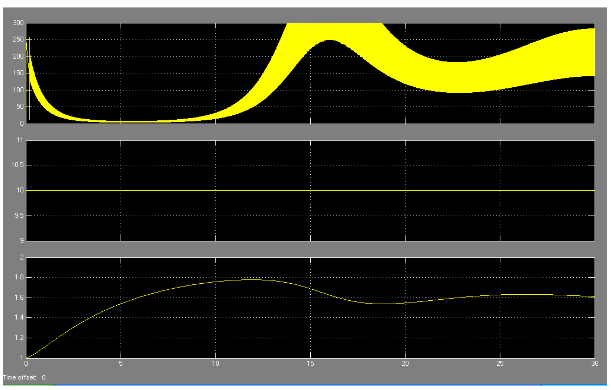

Fig. 2.3.2Power in kw, wind speed in m/s and induction generator speed in p.u.

Large variation in the voltage profile are recorded when the value of capacitor bank at the terminal of induction generator is 95KVAr (fig.2.3.1) at the starting i.e. during the instant (2sec to 9 sec) the voltage drop to very low value of 1.5p.u. after 10sec. the voltage started increasing and reached up to 1.8 p.u. momentarily then after going a low value of 1p.u. it finally settles to 1.3 p.u. similar kinds of variations are also recorded in the current. During the instant (2sec to 9 sec) the current reaches to very low value of 1.5p.u. After 10sec. the current started increasing and reached up to1.8 p.u. momentarily then after going a low value of 1p.u. it finally settles to1.3 p.u. The Power output is reduced to zero during the large dip in the voltage (fig2.3.2). Power reaches its maximum value at the instant t=17sec. reduces to a value as low as 550kw and then finally settles to 298kw. The wind speed is shown constant at 10m/s. the generator speed is reached up to 1.6p.u.after variation from1.8 p.u. at 13 sec. and 1.6p.u.at 17 sec.

Case-IV Capacitor Bank Value = 115 KVAR

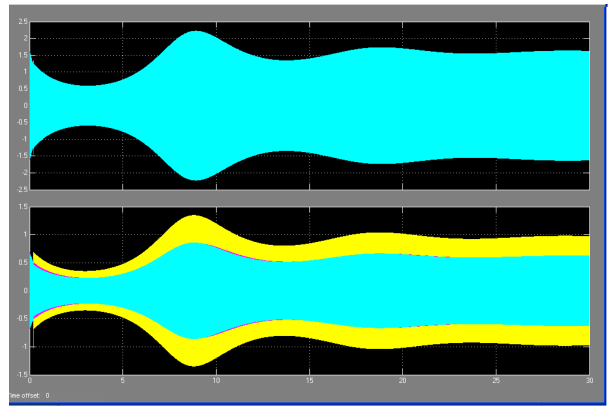

Fig.2.4.1 Induction generator terminal Voltage V_L, and line current I_L

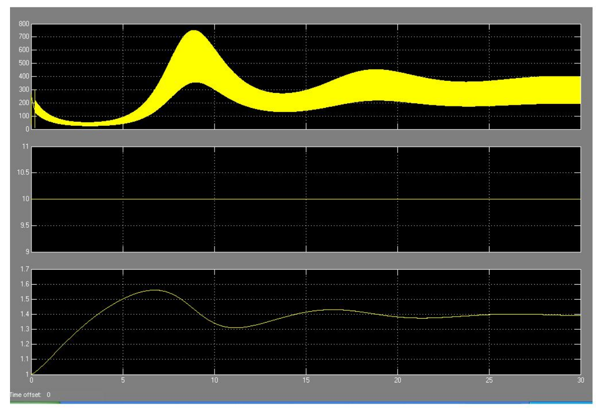

Fig.2.4.2 Power in kw, wind speed in m/s and induction generator speed in p.u.

When the value of capacitor bank is changed to 115 KVAr the improvement in the voltage profile is seen. during the instant (2sec to 9 sec) the voltage drop to very low value of 1.5p.u. after 10sec. the voltage started increasing and reached up to 2.2 p.u. momentarily then after going a low value of 1.7p.u. it finally settles to 1.5 p.u. Similar kinds of variations are also recorded in the current. During the instant (2sec to 9 sec) the current reach to very low value of 1.5p.u. after 10sec. the current started increasing and reached up to 2.2 p.u. momentarily then after going a low value of 1.7p.u. it finally settles to 1.5 p.u. the duration of dip in the voltage and magnitude is reduced and becomes stable at value nearly 1.5 p.u. at a faster rate(fig 2.4.1).Variations in the output power are shown in the figure 2.4.2. A variation is from 190kw to 750kw and becomes steady at 380kw. The wind speed is constant at 10m/s. the generator speed variations are also reduced.

IV. Conculation

The practical attempted to investigate the effects of three-phase capacitor bank/reactive power source, on the performance of SEIG's under general inductive-resistive load. Simulation results, as observed, indicate the importance of such practice. For the specific machine (used for simulation), reactive power source with 95 KVAR gives smooth voltage

profile and satisfactory operating results. This emphasizes the need of appropriate technique to select the optimum rating of capacitor bank and the in turn improvement in the performance of the machine.

V. System Peramaters

5.1. a Three Phase Induction Generator

1. Rotor type	Squirrel cage
2. Reference frame	Rotor
3. Nominal Power	275KVA
4. Voltage (line to line)	230V
5. Frequency	50Hz
6. Stator resistance (pu)	0.016
7. Stator Inductance (pu)	0.06
8. Rotor resistance (pu)	0.015
9. Rotor Inductance (pu)	0.06
10. Mutual Inductance (pu)	3.5
11. Inertial constant	2
12. Fraction factor	0
13. Pair of poles	2

5.1. b Three phase load

1. Nominal Power	200KW
2. Voltage (line to line)	230V
3. Frequency	50Hz
4. Configuration	Y grounded

5.1. c Power factor correction capacitor

1. Pf correction capacitor case1	55 KVAr
2. Pf correction capacitor case2	75 KVAr
3. Pf correction capacitor case3	95 KVAr
4. Pf correction capacitor case4	115 KVAr
5. Configuration	Delta
6. Nominal Voltage	230V
7. Frequency	50Hz

5.1. d

Scope 1:

1.1 The Induction generator terminal voltage V_L was recorded 1.2 The Induction generator terminal current I_L was recorded

Scope 2:

2.1 The Induction Generator Power in KW was recorded

2.2 The wind speed in m/s was recorded

2.3 The generator speed in pu was recorded

References

[1] Basset, E.D. and Potter, F.M., "Capacitive excitation of induction generators", Trans. Amber. Inst. Elector, Eng., 54, 1935, pp.540-545.

[2] Grantham, C., Sutanto, D. and Mismail, B., "Steady-state and transient analysis of self-excited induction generators", Proc. IEE,Vol. 136, Pt.B, No. 2, 1989, pp. 61-68.

[3] Elder, J.M., Boys, J.T. and Woodward, J.L., "Self-excited induction machine as a low-cost generator", IEE Proc. C, 131, (2), 1984, pp.33-41.

[4] Salama, M. H. and Holmes, P.G., "Transient and steady-state load performance of stand-alone self-excited induction generator", IEE Proc.-Electr. Power Appl., Vol. 143, No. 1, January 1996, pp.50-58.

[5] P .SYAM , P.K.Nandi and A.K. Chattopadhyay "Improvement in power quality and a simple method of subharmonic suppression for a cycloconverter-fed synchronous motor drive" IEEE Proc.-Electr.Power Appl. Vol.149,No.4,July 2002

[6] M. Hacil,A.L. Nemmour, A. Khezzar and M. Boucherma "Improvement generating power quality of a doubly-fed induction generator with a second order LC- filter in the rotor circuit" IEEE, international conference on electrical machine 2008.

[7] W.Edward Reid "Power quality issues- standards and guidelines" IEEE Transactions on industry applications, vol.32, No.3, May/June 1996.

[8] A.El.Mofty & K.Youssef "Industrial Power Quality Problems" IEEE Coference publication no .482,18-21june 2001.

[9] ICREPQ 03-International conference on Renewable Energies and Power Quality Vigo, Espanha, 9-12 de Abril de 2003,paper394, ISBN: 84607 6768.

[10] Luis A Moran,Juan W Dixon, Jose R Espinoza &Rogel R Wallace " Using active power filter to improve power quality" seminario d electronic de potencia 2000.

[11] Alok Thapar, Tapan Kumar Saha, and Zhao Yang Dong "Investigation of power quality categorization & simulating its impact on sensitive electronic equipment" IEEE, international conf. 2003.

[12] World wind Energy Association " New World Record in wind Power Capacity:14.9 GW added in 2006- worldwide capacity at 73.9GW, WWEA expects 160GW to be installed by 2010" Press Release 29 January 2007.

[13] S. Khalid and Bharti Dwiedi –Power Quality Issues, Problems, Standards& Their Effects in Industry with Corrective means "IJAET-May2011, ISSN: 2231-1963.

[14] Sachin Kumar, Shyam Sunder Goyal "Role of Reactive Power Source on Performance of Three Phase Self Excited Induction Generator" IRACST- Dec. 2012.

[15] Sachin Kumar, Sovit Kumar Pradhan & Alok Yadav "Effect of Capacitive Excitation on Voltage Stability of Three Phase Self Excited Induction Generator" IJEEER –Mar.-2013.