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Enhancement of PI Voltage Controller Performance Based on Self-Excited Induction Generator STATCOM

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Abstract - **Principal objective of this paper is to investigate the behavior of STATCOM against SVC controller by setting up new control parameters. Essentially, STATCOM, and SVC linear operating ranges of the V-I and V-Q as well as their functional compensation capabilities have been addressed to meet operational requirement with certain degree of sustainability and reliability. Hereby, the other operating parameters likewise transient stability, response time, capability to exchange real Power and Power Losses have also been addressed in STATCOM against SVC control models. In addition to that, STATCOM-Controller's pragmatic response has been identified and determined reliability level to maintain full capacitive output current at low system voltage. Therefore, it indicates that STATCOM device has more effectiveness than the SVC in improving transient stability (first swing).**

Keywords- **FACTS Devices - Matlab, Measuring Transfer Function - Control Transfer Functions – STATCOM**

I. INTRODUCTION

The FACTs or the flexible ac transmission devices are the power electronics based compensating devices which are modeled to compensate the reactive power or exchange of the real power between the device and the system hence helping contributing for the stability and transient stability of the device. The heart of the FACT devices are the power electronics switches based devices. They carries out all the necessary task for the evaluation process. The FACT devices are famous and came to lime light as due to their excellent task performing ability and the fast switching response and the actions. Below one can see the various kind of the FACTS VAR generators has been listed. Here we will look upon the various possible ways for the compensation of the reactive VAR and the available alternatives for the compensation work to be look upon.

II. STATCOM

A STATCOM is one of the famous and important members of the FACT family. It has a very special ability to absorb reactive power and provide reactive power, and again absorbing real power in and providing real power out of the system. The STACOM is a shun compensated device .the STATCOM can provide 3-phase controlled waves of Various parameters like the phase angle ,frequency, voltage magnitude etc. it is actually a kind of a solid state switching device which have the capability to generate and accept real power and reactive power independently . Here the STATCOM has the heart of the device is the VSI that is the voltage source inverter. A static capacitor is used to provide the constant dc voltage supply to the STATCOMs voltage source inverter. The STATCOMs outer terminal is connected through a leakage reactance to the system or the main voltage bus that is to be connected. And here we have the constant power of the dc voltage is being supplied by the chosen well designed capacitor which can give a constant dc voltage to the VSI terminal of the STATCOM. The unique ability of the STATCOM to absorb the reactive power and the real power when needed with the fast response makes it a special device.

Here we can look for the STATCOM for the following purposes as listed below,

- To control of the dynamic voltage in a power system and in distribution system
- Used to treat during the power oscillation damping condition
- The device can be also be utilized to treat the transient stability of the power system
- Sometime the voltage flickering control can be easily be done through IT
- v. The uniqueness in the STATCOM is that it can exchange both active power and reactive power with the system with a connected line exchange with the dc energy system
- The STATCOM can be considered a very similar device just as it is a synchronous machine.

Both have the same tendency to generate 3-phase electrical power with the given controlled frequency, phase angle and the magnitude of the fundamental voltage. They both can generate the reactive power and active power for the system. But one of main difference between them the STATCOM can provide the electrical power exchange for the small period of time but the

synchronous machine can generate continuously for the given system .So, the above point shown the utility of the STATCOM circuit.

III. THE OPERATION PRINCIPLE

The operation principle of the STATCOM is very simple. It has to provide the given amount of the reactive power when needed and absorb the active power or reactive power when needed accordingly. The exchange of the power between the STATCOM and the device ac system is purely an electronic exchange system. The heart of the STATCOM lies in a VSC (voltage source converter). It is where the reactive power for the system is being generated. Not inside the capacitor where the reactive power is generated. STATCOM is purely a compact device and very effective in nature.

Its power electronics equipment inters connects between each other and they generate the required reactive energy for the exchange with the reactive system. Its unique ability to provide leading VAR and accepting the lagging VAR from the system makes it stand aside. This obviates the requirement of the reactor or capacitance heavy banks with a simple compact power electronics module can be neglected. The main exchange of the energy between the system and the STATCOM can be carried out by the changing the voltage magnitude and the phase angle of the output of the STATCOM of the system.

When the voltage of the STATCOM is increased above the bus system voltage the STATCOM provides the reactive power and when the system bus voltages is deeps down from the given bus voltage the STACOM draws the reactive VAR from the system. And if the output is equals the bus voltage of the ac system the no exchange of the electrical power happens.So making the changes in the value of the phase angle of the STATCOM can effects the reactive power exchange with the system and the value of the phase angle of the STATCOM is increased above that of the ac bust system then STACOM provides the real power in to the system and the when the ac voltage phase angle is greater than the STATCOM phase angle then real power flows into the system.

The STATCOM is connected to the AC bus system through an inductor. so when the STATCOM provides the output power , the power flowsthrough the inductor hence the outgoing power is the capacitive inductive power in nature, and when the energy is coming it from the energy source , the electrical currents comes from the inductive load and the STATCOM circuit absorbs the inductive reactive power, and here while absorbing the electrical power the VSC acts as an 3 phase rectifier bridge, the pulse width modulation process helps in this process and makes the reactive power absorption process a simpler one in the direction.

The designing of the STATCOM VSC and the reactor determines a measure role in the deciding the functioning output of the STATCOM and plays a major role in playing the STATCOMS output voltage source.

IV.CHARACTERISTIC OF STATCOM

The STATCOM can provide both reactive power in capacitive form and reactive power in the inductive form. And they occurs independently, another point can see from that is the device can provide the rated capacitive current even in the voltage of 0.15pu voltage also. This implies that the STACOM is being capable of providing the full capacitive power and is independent of the system voltage irrespective; another function of the STATCOM is to handle the power circuit during the faulty conditions too, so during the fault condition the STATCOM has to generate a very large amount of the capacitive power too. So the transient limit of the STATCOM circuit is extended from the rated value of the capacitor, which can even conveniently provide the reactive power during the faulty condition. The maximum amount of the transient current that is allowable is decided by the factor of the current switch off capability of the power electronic switch of the voltage source inverter.

V. RESULTS USING THYRISTOR BASED STATCOM

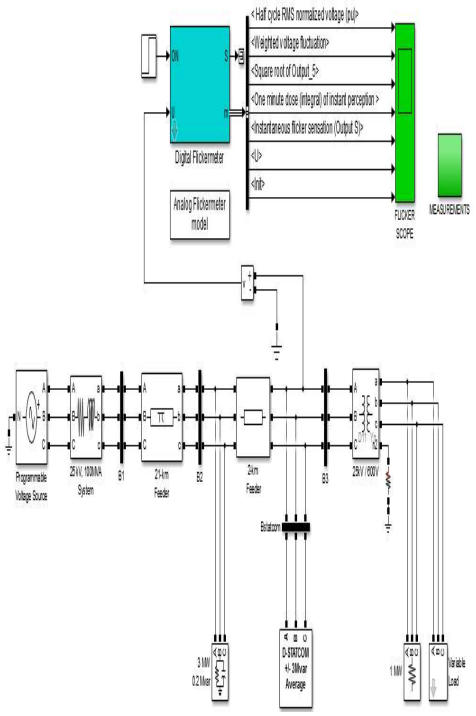

Fig.1 Statcom Modelling Matlab.

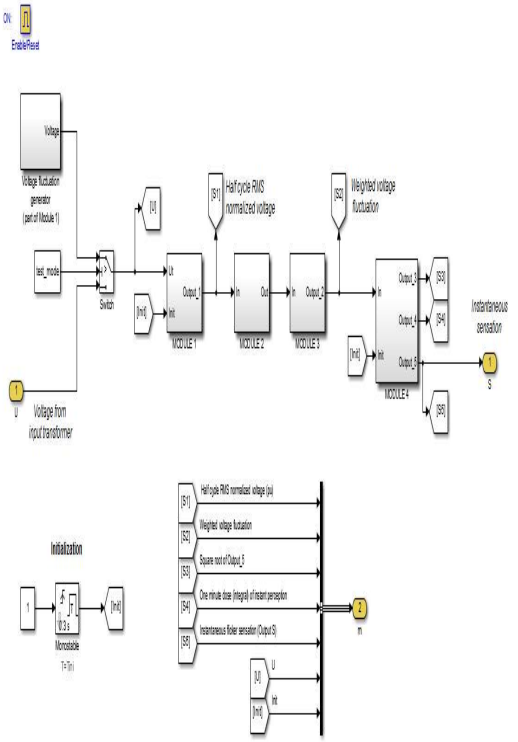

Fig. 2 Subsystem of model.

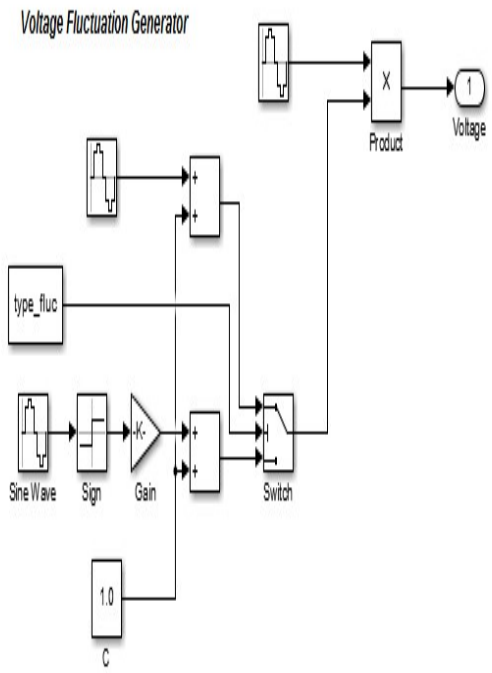

Fig. 3 Voltage fluctuation generator.

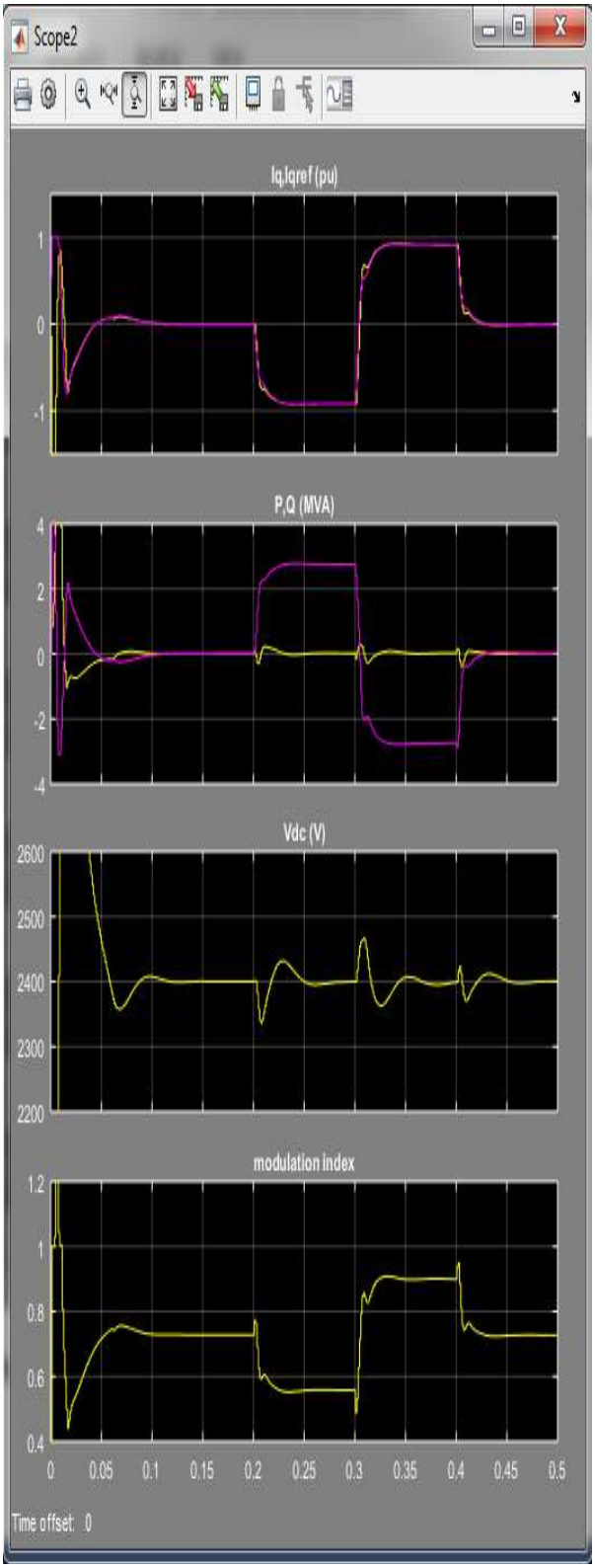

Fig.4 Parameters variation of STATCOM

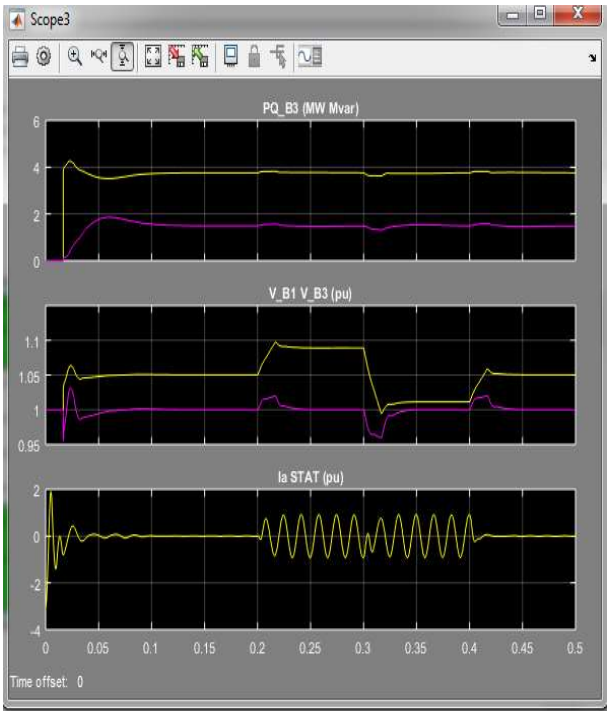

Fig.5 Voltage, Current, Power variation.

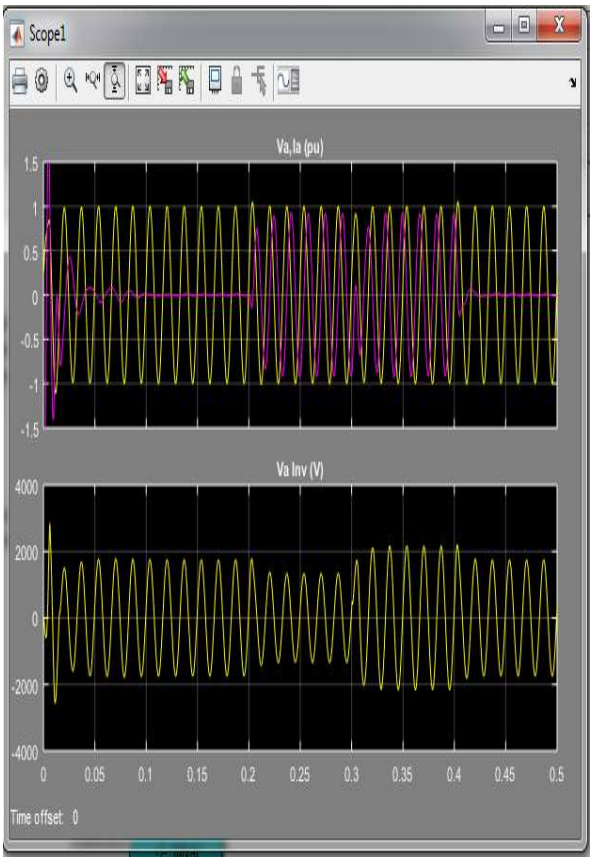

Fig. 6 Voltage deviation.

VI.CONCLUSION AND SCOPE FOR FUTURE WORK

The research work presented in the thesis mainly deals with analysis and development of fuzzy and PI voltage controller for self-excited induction generator based on STATCOM. The modeling and simulation of SEIG-STATCOM has been carried out for different types of loads. The MATLAB based model of SEIG is developed in q and d stationary reference frame. The SEIG develops its terminal voltage with the help of excitations capacitors. But with application of load, terminal voltage falls down from its rated value. A STACOM based voltage regulator is developed for regulating the SEIG voltage in MATLAB. The proposed scheme for maintaining the voltage of SEIG constant is simple and easy to implement. The STATCOM improves the voltage regulation by injection of compensation currents. The STATOM is design for various loads like linear/ non-linear, balanced/unbalanced. From the simulation result it has been found that the non-linear load injects harmonics in the systems, which are also eliminated by STATCOM. Hence it is concluded that STATCOM can act as voltage regulator, load balancer and harmonic eliminator. In designing of STATCOM, PI and Fuzzy controllers are used and their simulation results are compared. The Fuzzy controller based STATCOM gives better dynamic performance. From the simulation result it is also found that the Fuzzy controller has less peak overshoot, fast response and smooth steady state response as compared to conventional PI control. Hence SEIG-STATCOM with fuzzy controller is a good candidate for improving the performance of the regulator.

REFERENCES

[1] E. D. Basset and E. M. Potter, “Capacitive excitation for induction generator,” AIEE Trans. On Electrical Engineering, vol. 54, pp. 540-545, May 1935.
[2] C. F. Wagner, “Process of self-excitation of induction motors,” AIEE Trans. On Electrical Engineering, vol. 58, pp. 47-51, February 1939.
[3] J. E. Barkle and R. W. Ferguson, “Induction Generator theory and application,” AIEE Trans. on Electrical Engineering, vol. 73, pp. 12-19, January 1954.
[4] A. S. Langdorf, Theory of Alternating current machinery, 2nd Ed. New York, McGraw-Hill, 1995
[5] B. C. Doxey, “Theory and application of the capacitor excited induction generator,” The Engineer, vol. 216, pp. 893-897, 1963.
[6] A. K. Tandon, “Investigations on the phenomenon of capacitor self-excitation in induction machine and its applications,” Ph. D. Thesis, Dept. of Electrical Engineering, IIT Delhi, India, 1984.
[7] D. Levy, “Stand alone induction generators,” Electric Power System Research, vol. 41, pp. 191-201, 1997.

[8] A. K. Tandon, S. S. Murthy and G. J. Berg, "Steady state analysis of capacitor self-excited induction generator," IEEE Trans. on Power Apparatus and Systems, vol. 103, pp. 612-617, March 1984.
[9] A. K. Tandon, S. S. Murthy and C. S. Jha, "New method of computing steady state response of capacitor self-excitation induction generator," Institution of Engineers, India, vol. 65, pp. 196-201, June 1985.
[10] N. H. Malik and S. E. Haque, "Steady state analysis and performance of an isolated self-excited induction generator," IEEE Trans. on Energy Conversion, vol. 1, pp. 134-139, September 1986.