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# A Review Article of Statcom Mid Point Voltage Regulation

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***Abstract*** **- This paper reviews the development of static synchronous compensator (STATCOM), and analyzes the structure of its main circuit, its working principles and control strategies. At last, this paper comes to a conclusion of technical characteristics of STATCOM and outlook of its development trends. Fast acting STATCOM, a representative of FACTS family, is a promising technology which is extensively used as state-of-the-art dynamic shunt compensator for reactive power control in transmission and distribution system. STATCOM controller employs various solid-state converter topologies, magnetics configurations, control algorithms, and switching techniques and so on. The development of STATCOM controller has been well reported in literature with its versatile application in power system. Thus deep investigation of STATCOM from the perspective of its intelligent control and the configuration of STATCOM's main circuit is valuable.**

***Keywords***- **Transmission networks, FACTS, proportional-integral control, STATCOM, reactive power compensation, voltage stability.**

## I. INTRODUCTION

Electric power system being a complex system in its structure and task is confronting numerous difficulties step by step. The serious issue in power framework is its unsteadiness. Power framework strength is the ability of the framework to keep up a working harmony point in the wake of being exposed to an unsettling influence for given beginning working conditions. Generally voltage guideline is performed by the excitation framework and in this manner helps in controlling the framework voltage. Appropriate gadgets like Automatic Voltage Regulators (AVR) are utilized for the guideline of produced voltage. AVR's typically keep up the generator voltage size at a predetermined dimension.

AVRs are broadly utilized on the dynamic or enduring state soundness of the power framework as low frequencies motions persevere for an extensive stretch and may influence the capacity of intensity move. Electrical power request is ascending at an extremely higher rate in view of fast modern advancement. So as to fulfill the interest, control transmission must be raised alongside the current offices. Accordingly it is fundamental to focus for the power stream control. The power framework ought to be adaptable to adjust to any flashing changes in framework conditions. In an AC control framework, there must be a harmony between the created power and varieties in burden request while keeping the framework recurrence and voltage levels as steady. On the off chance that age isn't adequate, the voltage and recurrence drop, and the heap diminishes to adjust the absolute age less misfortunes in transmission. Be that as it may, there are just a couple of percent edges for such a self guideline. Henceforth the framework is fell. Generator excitation controller typically improves dependability for littler blames yet not reasonable for bigger issues that happen close to generator terminals. Along these lines, conventional strategies must be audited and new ideas must be made that accentuates an effective utilization of assets of existing force framework keeping up dependability and security of the system[1-5].

In this paper, survey and utilization of utilizing STATCOM in system with BESS are displayed. Next area gives survey in more prominent subtleties and Sections 3–5 give application showing of STATCOM + BESS. For experiments, a power transmission framework with a solitary machine generator associated with an interminable transport is considered. For rearrangements reason the traditional model of a generator is expected with a vast transport as a consistent voltage source. The model is executed in MATLAB/Simulink and PC reproduction results under various issue (3-stage to ground shortcoming) clearing times are examined for transient soundness. The outcomes are then contrasted and STATCOM set in the framework. The examination is then stretched out by including a vitality stockpiling gadget (battery) to the STATCOM. The last outcomes demonstrate that the option of vitality stockpiling enables the STATCOM to infuse or potentially retain dynamic

and receptive power at the same time and, in this manner, gives extra advantages and upgrades in the system[7-8].

## II.STATCOM

Operating principle: STATCOM is a FACTS device, Voltage Source Converter (VSC)-based device, having a voltage source behind a reactor. STATCOM regulates voltage by generating or absorbing reactive power. During low system voltages, it acts as STATCOM capacitive by generating reactive power. During high system voltages, it acts as STATCOM inductive by absorbing reactive power. Variation in reactive power is handled by the VSC which is connected to the secondary of a coupling transformer.

The active power capability of STATCOM is very less because the VSC using GTOs or IGBTs synthesizes only the voltage source from a DC capacitor. But if an energy storage device is connected across the DC capacitor STATCOMs active power capability can be increased [9-13]. The performance of STATCOM is similar to that of SVC but if the system voltage is at lower voltage regulation range, STATCOM is able to generate large amount of reactive power than that of the SVC. Also the response time is less while using STATCOM because of the VSC, no delay is associated with the firing of thyristors. A model of STATCOM is given in Fig. 1.
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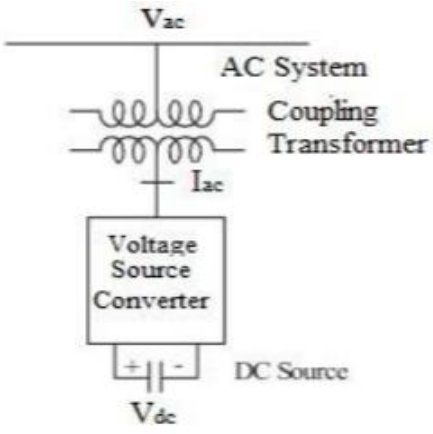


Fig.1.STATCOM model.

The relation between the fundamental component of the converter ac voltage output and voltage across dc capacitor is given as

$$Vout = kVdc$$

Where k is coefficient that depends on the number of switching pulses, converter configuration and the converter controls. The fundamental component of the converter voltage output i.e. Voutis dependent on Vdc, can be controlled by varying the dc voltage across capacitor which can be done by varying the phase angle α of the converter switching. The direction of reactive power flow either from system to the coupling transformer or from coupling transformer to the system is decided by the difference between the converter voltage output and the ac system bus voltage. The dc capacitor is charged to a satisfactory dc voltage level by the real power supply into the converter. During the course of each switching cycle, the capacitor is charged and discharged, but under steady state conditions, the average capacitor voltage remains unchanged. In steady state, the ac system power is used to replenish the switching losses. The ability of STATCOM to supply/absorb real power is determined by the size of dc capacitor and the active power switching losses. Whenever the dc capacitor and the losses are relatively small, the amount of real power transfer is also relatively small. This implies that the STATCOM's output ac current Iac, has to be approximately + 900 with respect to ac system voltage at its line terminals.

## III. MODEL OF STATCOM

System Configuration: Fig. 2. Shows the equivalent circuit of STATCOM. In this system, Rs is the series resistance with the voltage source inverter (VSI). It is the sum of the inverter conduction losses and the transformer winding resistance losses. Ls is the transformer leakage inductance. Rc is the shunt resistance with the capacitor. It represents the sum of the power losses in the capacitor and the switching losses of the inverter. In Fig. 2. Val, Vbl and Vcl are the three phase bus voltages; Vas, Vbs and Vcs are the three phase output voltages; and ias, ibs and ics are the three phase output currents.

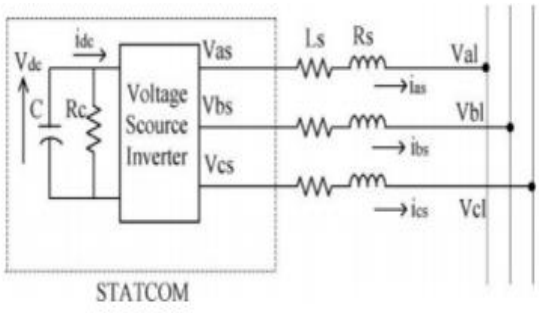


Fig.2 STATCOM - Equivalent circuit.

## IV.ISSUES OF OLD ARTICLES

**1. AgasheNeha M., R D. Kulkarni, A. R. Thorat "Power Flow Study and Analysis utilizing STATCOM"** STATCOM is Flexible AC Transmission System (FACTS) gadget which can be utilized to keep up the voltage profile at the transport in the power framework. This paper has examined the STATCOM task and it's V-I qualities. In this paper the power stream is determined with STATCOM with the assistance of iterative Newton-Raphson strategy. Six transport framework is considered to approve the outcomes got and

they are given and without utilization of STATCOM in the framework.

**2.Ajinkya Pachghare1, R.M.Sahare2,** "Voltage Regulation and Reactive Power Compensation by STATCOM dependent on 48-Pluse GTO (VSC)" In this paper we displayed STATCOM dependent on 48-beat GTO for responsive power remuneration and voltage guideline. Here we propose to handle the current issue in power transmission frameworks with multiple controller frameworks. The containing a 48-beat GTO(Gate Turn-Off) thyristor voltage source converter for combine reactive power pay and voltage guideline of the electric matrix arrange. This reproduction of STATCOM are developed in MATLAB/simulink by using the squares from the power framework square set mean while control framework is modeled. The proposed work is to decouple the both voltage and current control technique with two controllers by SATACOM. This issue is guarantee that the framework works in stable condition with STATCOM with different loads and the stage bolted circle inalienable deferral greatly affects dynamic task of STATCOM and furthermore is to regulate the proposed strategy and to upgrade the dynamic execution of STATCOM this proposed 48 heartbeat control plans are approved.

**3.Avinash Kumar Nishad1, Ashish Sahu2,** "Advancement and Simulation of Voltage Regulation System of A.C. Transmission lines utilizing Static Synchronous Compensator (STATCOM)" A Due to the quick innovative advancement, the usage of electric vitality increments in every case anyway different arrangement of transmission are not broad to the comparative dimension since structure of new lines is hard for ecological just as money related reasons that is the reason the frameworks are driven closer as far as possible bringing about blockages and perilous circumstances jeopardizing the framework assurance.

Adaptable AC Transmission Systems (FACTS) are a Power Flow Control gadget which offers the chance to impact power streams and voltages and in this manner to improve framework wellbeing measures. From the most recent couple of years static synchronous compensator plays a basic capacity in guideline of voltage inside AC Transmission Systems. An examination voltage irregulation issue regularly happens in the three stage A.C. transmission lines and its answer by taking forward, advancement of a voltage guideline framework utilizing a FACTS gadget static synchronous compensator (STATCOM) have been talked about. After the fruitful recreation of the STATCOM in MATLAB Simulink the resultant waveform of voltage demonstrates the voltage guideline ability of the STATCOM based three stage A.C. transmission line framework.

**4.Felix Stephen S*, Jacob Raglend I,** "A survey on pi control of statcom for voltage regulation"Because of developing interest and limitations in structure new lines Transmission frameworks are getting to be worried in keeping up the security of the framework. In transmission systems, Flexible AC Transmission System (FACTS) is a power electronic based innovation to improve controllability, soundness and power move ability of air conditioning transmission framework. Certainties gadgets are observed to be successful for strength pursued by an aggravation.

Static Synchronous Compensator (STATCOM) which is a shunt gadget of FACTS family is effective in controlling voltage either by retaining or by creating responsive power. Contrasted with different FACTS gadgets, STATCOM can give quick and productive receptive power backing to keep up power framework voltage security. This paper proposes a PI control model that controls the voltage during an aggravation. The proposed controller is executed under MATLAB/SIMULNK condition. In the reenactment test, the PI control indicates steady greatness under different working conditions, for example, unique beginning control increases, distinctive burden levels, and change of transmission organize, back to back unsettling influences, and an extreme aggravation.

**5.Arindam Chakraborty1, Shravana K.Musunuri2, Anurag K. Srivastava3 and Anil K. Kondabathini4,** "Incorporating STATCOM and Battery Energy Storage System for Power System Transient Stability: A Review and Application" Integration of STATCOM with vitality stockpiling gadgets assumes a basic job in improving the power framework task and control. Critical research has been done here for useful acknowledgment of advantages of the incorporation. This paper, however, pays specific significance to the presentation improvement for the homeless people as is feasible by STATCOM with battery-power edstorage frameworks.

Utilization of STATCOM with capacity as to irregular sustainable power sources, for example, wind power generation is likewise examined in the paper. Toward the start of this paper, a general survey of the STATCOM and vitality storage systems are expounded. A concise diagram of the upsides of utilizing STATCOM related to vitality stockpiling frameworks in achieving power framework security is displayed. In the second piece of the paper, a run of the mill transient solidness model of a STATCOM is presented. The element of genuine and receptive power reactions of the coordinated framework to drifters is examined. The investigation is aimedat demonstrating that the blend of STATCOM and battery vitality stockpiling essentially improves the presentation of the framework. The last outcomes demonstrate that the

STATCOM responsive power/voltage control helps in transient steadiness upgrade.

**6.RezaSirjani**, "Ideal Placement and Sizing of PV-STATCOM in Power Systems Using Empirical Data and Adaptive Particle Swarm Optimization": Solar vitality is a wellspring of free, clean vitality which keeps away from the dangerous consequences for the condition that have for some time been brought about by power age. Sun powered vitality innovation rivals petroleum derivatives, and its improvement has expanded as of late. Photovoltaic (PV) sun based homesteads can just create dynamic power during the day, while around evening time, they are totally inactive. In the meantime, however, dynamic power ought to be bolstered by responsive power. Responsive power remuneration in power frameworks improves control quality and steadiness.

The utilization during the evening of a PV sunlight based ranch inverter as a static synchronous compensator (or PV-STATCOM gadget) has as of late been proposed which can improve framework execution and increment the utility of a PV sun powered homestead. In this paper, a technique for ideal PV-STATCOM arrangement and measuring is proposed utilizing exact information. Considering the destinations of intensity misfortune and cost minimization just as voltage improvement, two sub-issues of arrangement and estimating, separately, are settled by an influence misfortune list and versatile molecule swarm advancement (APSO). Test outcomes demonstrate that APSO performs better in finding ideal arrangements as well as combines quicker contrasted and honey bee settlement improvement (BCO) and helping search calculation (LSA). Establishments of a PV sun based homestead, STATCOM, and PV-STATCOM in a framework are each assessed as far as proficiency and cost.

## V. CONCLUSION AND FUTURE WORK

In most of the literatures, various STATCOM control models have been discussed and also PI controller applications are included. The control parameters of the PI controller have to be adjusted for the optimal performance of STATCOM at given or different operating points. An adaptive PI control model can be preferred, that can self adjust the controller gain parameters dynamically under disturbances thereby the performance of the entire system always matches the desired response, regardless of the change of operating conditions. This work can be applicable under various operating conditions, such as different initial control gains, change of the transmission network, different load levels, consecutive disturbances and a severe disturbance. Future work can be carried with the investigation of multiple STATCOMs, because the interaction among different STATCOMs may affect each other. Also, the extension to other power system control problems can be explored.

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