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Active Filter and Reactive Compensation Using Dstatcom

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ABSTRACT

The purpose of this study is to exploit the DSTATCOM demo model and the block Using MATLAB Simulation, the controller's parameters are tweaked. The primary goal of the study is to demonstrate how distribution statcom (DSTATCOM) may be used to lessen voltage variations such as sag and swell situations in distribution systems. Different DSTATCOM (distribution static compensator) topologies are examined in this paper. The distribution static compensator (DSTATCOM) is a shunt-connected device that may correct load current power quality issues. The installation of a shunt active filter on a power distribution system is the intended use. By regulating reactive power, the active filter also has the capacity to control the voltage on the distribution line. The dynamic performance of coupled harmonic damping and spectral analysis is investigated theoretically. As a result, harmonic damping makes it feasible to increase both the stability of the combined harmonic damping and the control loop for voltage regulation. In Matlab/Simulink, the system with the control strategy is implemented. Figures display the simulation findings. The primary goal of the study is to demonstrate how DSTATCOM may be used to lessen voltage swings in distribution systems, such as sag and swell circumstances.

Keywords : PWM, DSTATCOM, DVR, Artificial Immune System, Direct Current Control, Voltage Source Converter, Power Quality

I. INTRODUCTION

Reregulating the industries and allowing for private competition would help the electrical power utilities operate the power system networks more efficiently. For overload relief, effective operation, and dependability, new techniques to power system operation and control must be developed. In order to support dynamic disturbances including switching of transmission lines, loss of generation, short circuits, and load rejection, active control must be quick enough to maintain the appropriate voltage levels and system stability [1]. Beyond the fundamental idea of independent control of active and reactive power flows, Flexible AC Transmission Systems (FACTS) are a successful approach to the issue of reactive power control and voltage in transmission and distribution systems, providing a desirable alternative for achieving such goals. Initially, thyristor-based devices such as TCR (Thyristor Controlled Reactor), TSC (Thyristor Switched Capacitor), and SVC (Static Var Compensator) were used to solve these issues, but nowadays, controlled switch-based devices like GTO, IGBT, and IGCT are widely used. The dynamic voltage control is the main purpose of the Static Synchronous Compensator (StatCom) and Static VAR Compensator (SVC), two different types of shunt controllers for the injection of reactive current. In relation to the SVC, the square of the line voltage is a function of the current's reactive power, which is a function of the line voltage. Thus, the injected reactive power is lowered to 64% while the dynamic voltage, let's say, is at 80%, precisely when more is required. StatCom size would be far less for comparable performance, and should be the more cost effective of both. One of the most popular FACTS devices [2] for numerous applications is the StatCom. The StatCom varies from the SVC in that it may create reactive power from tiny values of storage elements and behaves similarly to the SVC while working in the linear area. The SVC, on the other hand, is seen as a variable admittance by the system, while it is a source of synchronous voltage [3][4]. The StatCom has operating characteristics from the perspective of reactive power that are comparable to those of a rotating synchronous compensator without the mechanical inertia, and it offers quick controllability over the three-phase voltages in both magnitude and phase angle. Due to the wide range of construction and operating options, it has drawn a lot of attention. The improvements and benefits that can be gained when using a StatCom include the following:

- Rapid response to system disturbances.
- Provides smooth voltage control over a wide range of operating conditions.
- Dynamic voltage control in transmission and distribution systems;
- power oscillation damping in power transmission systems;
- transient stability improvement; • ability to control not only reactive power but, if needed, also active power (with a DC energy source available)
- a small footprint, due to the replacing of passive banks by compact electronic converters;
- modular, factory-built equipment, reducing site works and commissioning time;
- use of encapsulated electronic converters, which minimizes environmental impact on the equipment.

II. LITERATURE REVIEW

Mrs. M. Sindhubala and Ms. Allan Mary George (2013) provided the precept of this paper is to realize the consequences of harmonics in a strength system and to limit the consequences of the energy machine harmonics. This distortion will bring about low strength nice and stepped forward disturbances in strength system. So this harmonic technique is used to improve the electricity excellent. The increase in power high-quality the use of a technique is explained in element right here.

Geena Sharma and Kanchan Jaswal (2016) proposed lively energy filters are the emerging gadgets, which can decrease harmonic pollutants successfully. Normally, the shunt APF is managed such that it eliminates the load modern harmonics and supplies load reactive electricity to acquire harmonic unfastened supply currents at unity strength component. However, those manipulate objectives can not be performed simultaneously when the deliver voltages are distorted and unbalanced (non- ideal).

Daniel Fallows et al. (2018) offered a comprehensive literature review of strategies for harmonic associated strength high-quality development of electrical technology systems. An increasing interest in those elements is due to the ever extra stringent energy satisfactory requirements, deriving from new grid codes and compliancy requirements, aimed toward restricting waveform harmonic distortion at all points of the distribution network.

Daniel J. Carnovale et al. (2016) offered within the near destiny, predictions regarding the “virtual economic system” imply that greater than 50% of all electricity ate up inside the North America might be thru energy digital devices including transfer-mode strength substances, variable frequency drives, and other electricity electronic gadget. Harmonics drawn by way of these masses have appreciably modified the energy system requirements to guard those loads and to protect the device from these loads. The feature of the distribution system is to supply essential modern to the terminals of the weight. Generally, essential present day is the handiest issue of current which plays beneficial paintings. In comparison, harmonic cutting-edge is in reality the “by-product” of the manner non-linear loads draw modern-day and are not essential to carry out beneficial work.

Jonathan K. Piel (2004) Power intake of harmonic drawing loads is an increasing challenge for cost conscious facility managers and engineers. The paper illustrated that up to 8% kW reduction might be realized by means of casting off harmonic present day at diverse points in a power distribution gadget, with the greatest advantages achieved with harmonic mitigation implemented at the point of use. The research and effects were reached thru mathematical modeling of gadget losses and performance. This paper presents the design and simulation hybrid lively clear out based on voltage detection together with seventh-tuned LC passive strength filter and a 3ϕ energetic electricity filter related in collection to mitigate the harmonic propagation under the worst-case state of affairs that is beneath no load. The filter is attached in parallel to the device. Simulation is accomplished for a 415V, 50Hz machine in MATLAB. The THD is reduced from 19% without filter out to 15% with the addition of hybrid clear out.

III.OPERATING PRINCIPLE OF THE DSTATCOM

A controller, a series of coupling reactors, and a VSC make up the three primary components of the DSTATCOM system. The creation of a controlled ac voltage source via a voltage source inverter (VSI) linked to a dc capacitor is the fundamental working concept of a DSTATCOM deployed in a power system (energy storage device). Typically, the transformer leakage reactance is hidden by the ac voltage source. The voltage differential across this reactance is what drives the transfer of active and reactive power between the power system and the DSTATCOM. The voltage-quality issue at a PCC, where the DSTATCOM is coupled to the power networks, is a worry. The controller receives all necessary measurements of voltages and currents to compare with the directives. The power converter's primary semiconductor switches (IGBTs, which are employed at the distribution level) are driven appropriately by a series of switching signals that the controller produces after performing feedback control. Figure 1 shows the DSTATCOM's fundamental diagram.

Figure 1: Block Diagram of the voltage source converter based DSTATCOM

By controlling the firing angle, the ac voltage is controlled. The bus voltage, to which the DSTATCOM is linked, and the output voltage of the VSI should ideally be in phase. In steady state, there is no actual power exchange other than losses and the dc side capacitance is kept at a set voltage. The DSTATCOM is different from other reactive power producing devices (such as shunt Capacitors, Static VAR Compensators, etc.) in that the capacity for energy storage is only necessary for system imbalance or harmonic absorption. The DSTATCOM has two control goals in place. The power system's ac voltage control at the bus where the DSTATCOM is linked is one, and the other is dc voltage regulation the capacitor inside the DSTATCOM. Shunt reactive power injection can be used to regulate the bus voltage, as is well known. Two voltage regulators are created for these reasons in the traditional control scheme: an ac voltage regulator for bus voltage management and a dc voltage regulator for capacitor voltage control. Both regulators are proportional integral (PI) type controllers in the most straightforward method. As a result, d-axis and q-axis components of the shunt current are separated. By using different PI regulators, respectively, dc voltage errors and ac-bus voltage errors are used to get the reference values for these currents. Another set of PI regulators, whose outputs are the d-axis and q-axis control voltages for the DSTATCOM, are then used to regulate these reference currents.

IV.MATHEMATICAL MODELLING & SIMULATION USING MATLAB

DSTATCOM essentially comprises of a DC capacitor attached to one end of a PWM voltage source inverter circuit. Due to their smaller size and reduced switching losses, integrated gate bipolar transistors (IGBT) are used in inverter circuits at the distribution voltage level (11kv). Additionally, specialised power devices have relatively modest power ratings. As a result, the pulse width modulation (PWM) switching mechanism may be used to adjust the output voltage. The Universal Bridge Block from Sims Power Systems' Power Electronics subset is used to create IGBT-based PWM inverters. a coupling transformer that guarantees network and PWM inverter connection at 25kV/1.25kV. an IGBT bridge and two voltage-sourced PWM inverter. Compared to a single bridge, this dual inverter system produces less harmonics, leading to smaller filters and improved dynamic response. The initial harmonics in this situation will be about 3.36 kHz since the inverter modulation frequency is 28*60=1.68 kHz. At the inverter output, there are LC damped filters attached. At 60 Hz, a sequence of resistances and capacitors provide a quality factor of 40. a 10000-microfarad capacitor serving as the inverter voltage regulator's DC voltage source and managing the voltage at bus B3 a PWM pulse generator with a 1.68 kHz modulation frequency. Figure 2 depicts a 25KV Power Dstatcom pwm demo model that was utilized in this paper.

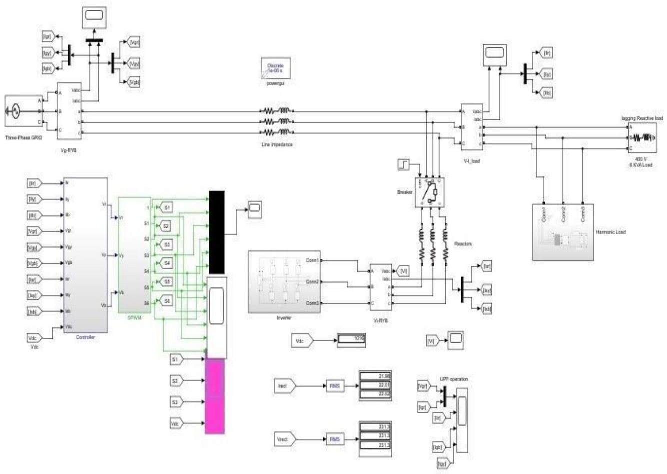

Figure 2: Simulink model

When VSI Block activated the grid current is reduced with compare with input current. The Fig 3 shows the load current graph when VSI activities.

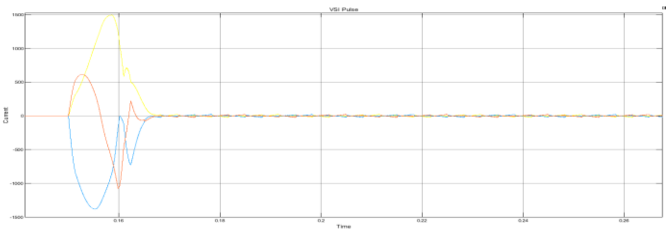

Fig3 VSI Current control

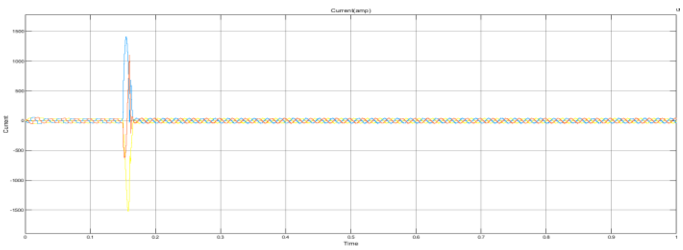

Fig 4 Current distortion Due to Harmonic

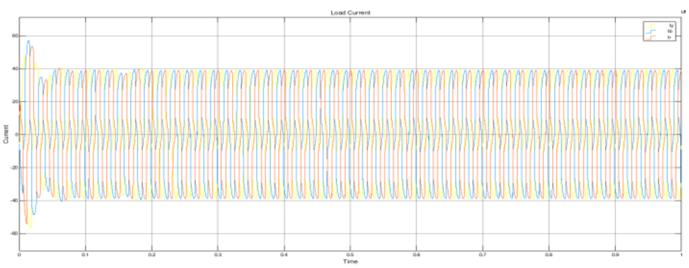

Fig 5 Load Current with reduce harmonic Using DSTATCOM

To total harmonic distortion of individual phase Current.

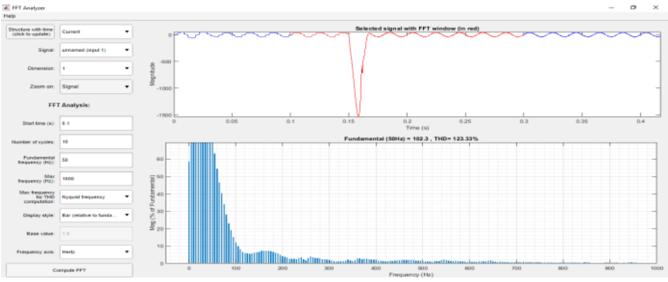

Fig 6 THD= 123.33% of Input Current of R Phase.

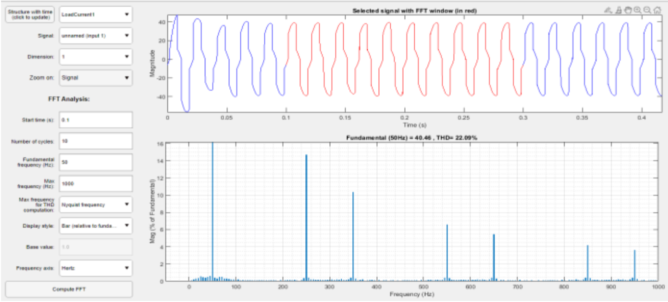

Fig 7 THD=22% of Load Current of R Phase After harmonic reduce.

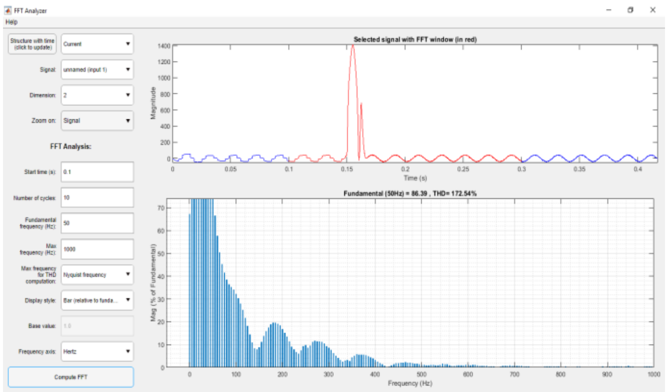

Fig 8 THD=172% of Input Current of Y Phase.

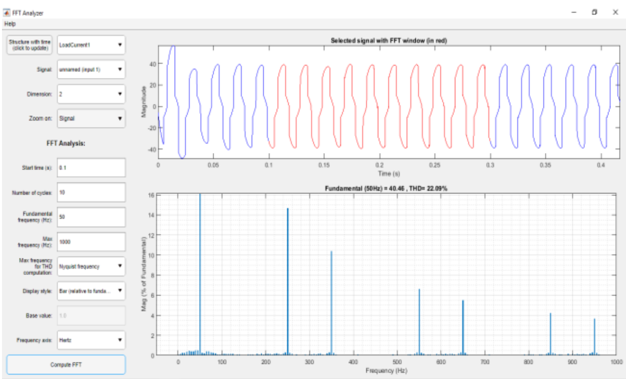

Fig 9 THD= 22% of Load Current of Y Phase After harmonic reduce.

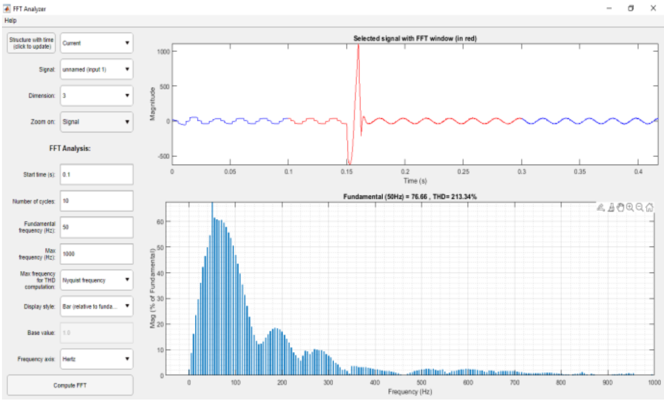

Fig 10 THD = 213% of Input Current of B Phase.

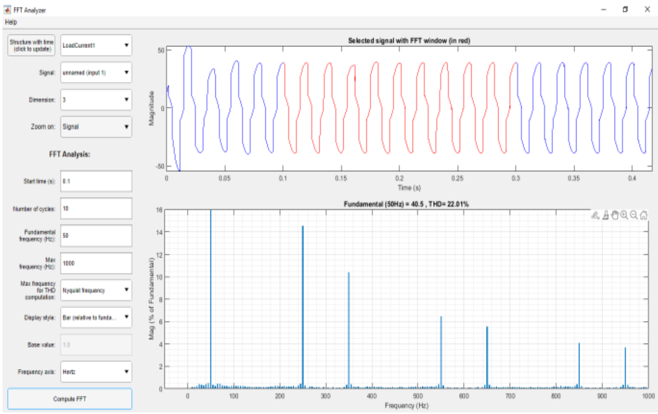

Fig 11 THD=22% of Load Current of B Phase After harmonic reduce

V. CONCLUSION

It is possible to look at the voltage sag and swell issues in a distribution system. Positive numbers show the DSTATCOM's consumption of active or reactive power, while negative values represent its generation. As a result, the network's voltage sag and swell conditions are improved and the voltage is recovered to around 1 pu of voltage by the use of DSTATCOM. Consumers of energy at all levels of consumption place a growing amount of importance on the issue of power quality. Both the industrial and home environments frequently contain sensitive machinery and non-linear loads, which has led to a growing concern over power quality. PID controllers are the sort of controllers utilized by DSTATCOM. The modulation method is employed to trigger IGBT's is PWM. In the simulation, the DSTATCOM with capacitor bank energy source is utilized. It is thus because the capacitor bank costs less money, needs less upkeep, and charges and discharges more quickly. The DSTATCOM is being connected to loads on the distribution network. The matlab/simulink programmed is used for simulations and results of DSTATCOM employing ultra-capacitor and electrolytic capacitor. When compared to an electrolytic capacitor, an ultra-capacitor creates less distortion. In the case of an ultra-capacitor, the modulation index is improved. When we look at the converter's voltage, the ultra-capacitor produces good voltage stability in DSTATCOM. However, ultra-capacitor provides far better harmonics as compared to an electrolytic bank when using DSTATCOM. In many circumstances, DSTATCOM offers superior performance to conventional mitigation techniques. The characteristics of the supply at the point of connection, the demands of the load, and economics, or the value supplied to the customer by the installation of a power electronics-based device, ultimately determine which option is best. The possibilities and affordability of cutting-edge technologies like DSTATCOM will further rise with the ongoing development and commercial availability of high power transistors.

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