Improvement of I-V Profile in the Power Distribution Network Using D-STATCOM With Dynamic Load

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Abstract- *Mostly electrical devices and equipment's are prone to some electrical disturbances and in these devices are not able to cop up with the voltage dips or sags. Thus it leads to the reduction in the power quality. To attain a higher level of power quality, compensators to the power systems can be implemented. Dynamic static compensator termed as DSTATCOM is coupled with the electrical system for transferring the load's reactive power and the reduction of the harmonic distortion. DSTATCOM is effective for limiting the losses with an improvement in the regulation of voltage. This study provide an overview to the various topics including the voltage dip and mitigation, static compensator and the work that had been done in past by various authors for harmonic distortion mitigation in power grid systems. The traditional systems were implemented by using DSTATCOM along with PI controller to analyze how system performs under various abnormalities. But for the reasons of no stability in voltage for a particular power system for various detected fault conditions like LG and LLG faults. For solving these types of issues, a novel approach is used by applying the DSTATCOM along with the PI controller on the system based on the 3 phase load. That lead to the balancing of loads in the condition they were dynamic. The recommended work is simulated for proving the effectiveness of the system for the reduced harmonic distortion and power quality.*

Keywords—DSTATCOM, PI Controller, Smart Grid.

I. INTRODUCTION

The collection of wires and equipment's that is utilized for design the connection between source of electricity and consumers for fulfilling their demands is termed as electric power grid. This system has been applauded as noteworthy achievement of 20th century but still it faces various problems. To fulfill the customers need, sometimes the devices and equipment's used for transmission reach up to their limits[1-4]. Various problems arise when the transmission power increases: instability of system, higher power losses for transmitting the electric power and crossing of voltage limit [5]. The electrical grid system is designed in a new form and termed the system as "smart grid system", "IntelligentGrid", "Grid Wise", "FutureGrid", etc. In 2005, European Technology Platform (ETP) has announced the Smart Grids system [6]. The grid system introduced at that time was developed for achieving the demands of European electricity networks so that it can supply electricity to consumers effectively; network users can easily access it [7]. In addition to this it was developed to utilize the renewable sources of energy, it was developed to provide reliable form of electrical power transmission and provide optimum energy management.

II. VOLTAGE DIP

The Voltage dip may be described as an event that takes place for short span in which the signals of r.m.s voltage level get decreased. It is usually determined with the help of two parameters that are as follow: magnitude and time duration. [8] The dip in the voltage signal generally lies in between 10% to 90 percent of minimal voltage value and the time period of signal varies from half cycle up to a minute. Considering the system having three phases, the voltage dip can affect phase to phase voltage as well as ground voltage level. The circumstances that may lead to voltage dip are as follow: disturbance in utility system, breakdown in customer's facility system or there is quick change in the value of actual load for the current due to the initiation of a motor or transformer unit energizing. Generally the fault arises due to short circuit in a connection where single phase is connected to ground or phase is connected to phase that may leads to larger current flow [9]. Due to this large current flow the value of voltage gets dropped that intentionally take on the network's impedance. At the time when fault occurs, there is a certain amount of voltage gets dropped for the faulted phase but it does not affects the non-faulted phase. With the improvement in automation sector and deregulations [10], the parameters required to maintain the quality of power has been changed. If there is any kind of variation in line voltage done the comparison with the ideal sinusoidal waveform, then it will also affect the drive converters along with the computer and process control devices. The usual issues that can be raised are Voltage sags, distortion in the signal due to presence of harmonics; flicker and non-continuous power supply. As these problems are increasing on wide scale therefore new equipment's need to implement in the place of ordinary devices like PWM converter based shunt connected Power Conditioners also referred as DSTATCOM (Distribution Static Compensator) [11].The flexibility in the operation in the section of utility and other for the industries can be introduced by adding the energy storage unit with power conditioners

[12]. Two identical loads with having different feeders were considered for this test model.

Out of two feeders, one is linked with the DSTATCOM and other remained as it is. The test model has been examined for various fault conditions. The controller of proportional integral (PI) were used to implement the control technique, these PI controller initiates with difference current produced by the difference between the DSTATCOM current and reference current value. The value of signal thus obtained is termed as reference voltage of the inverter or reference modulating signal [13].

The problem arises due to voltage dips in transmission along with the distribution systems that can improve by implementing different techniques. For making the power applications more effective, the various types of controllers have been proposed that can be used with newly developed power electronic devices. These types of equipment were used to coordinate and make the voltage level of the system stable [14]. These devices has the static power electronic device (PED) for controlling operation and with a generator and absorber for static VAR. This equipment can be utilized for quick compensation reactive power in the network of power system [15].

III. PROBLEM FORMULATION

With the improvement in the technology, power quality becomes important factor for the consideration when discuss a power systems. With the use of traditional systems, voltage sag remains constant. There may be various reasons due to which voltage sag happens. In case of the Network based on Utility distribution various problems and hindrance in service interruptions may be faced for the reasons of industrial load sensitivity and operation in the commercial sections. These outages may leads to the increase in the financial losses.

Different problems may be faced for the traditional systems such as instability of the voltage for the power system, and voltage sag. These were different problematic situations for faults like LG and LLG. By limiting the power systems trend and by moving towards the distributed form of power generation, power related to the quality transmission will take other dimensions. To resolve the issues of quality of the power for distribution system of power, some customized power devices can be proposed. Consequently, D-STATCOM implemented for keep the quality of power and transmission of reactive power.

IV. PROPOSED WORK

DSTATCOM is abbreviated as Dynamic static compensator which modeled under the concept of undeviating and deviating loads. DSTATCOM is utilized to distribute Alternating Current. For this distribution some factors like compensation of reactive current, mitigation of harmonic current and balancing of load were important. It has been accomplish for distribution system based on three phases. Since now it’s been utilized for enhancing the power quality network’s distribution with static linear. Thus we are proposing our DSTATCOM in loads that were dynamic. Through which we will focus on the enhancement of load balancing for loads were dynamic by utilizing the DSTATCOM. Dynamic loads values remain fluctuate due to which is might be difficult to make it stable for different techniques. Induction motor load is the example of dynamic load. For balancing dynamic loads generally the load system based on three phases is used.

As a result DSTATCOM will be used for the quality improvement for the power along with the balancing of load in the power systems.

V. RESULTS

This section of the study represents the results that are obtained after implementing the recommended technique. The aim of the recommended technique is to achieve the compensation for the identification of fault in a power system.

The image below represents the model for the recommended technique. In this there is a power supply that is transferred to the transformer which produces two outputs. Then these outputs are used to analyze the two different systems one with DSTATCOM and other is without DSTATCOM. Both the systems are comprised of 3phase dynamic load. In both cases the fault of 0.3 to 0.5 is used for the power system.

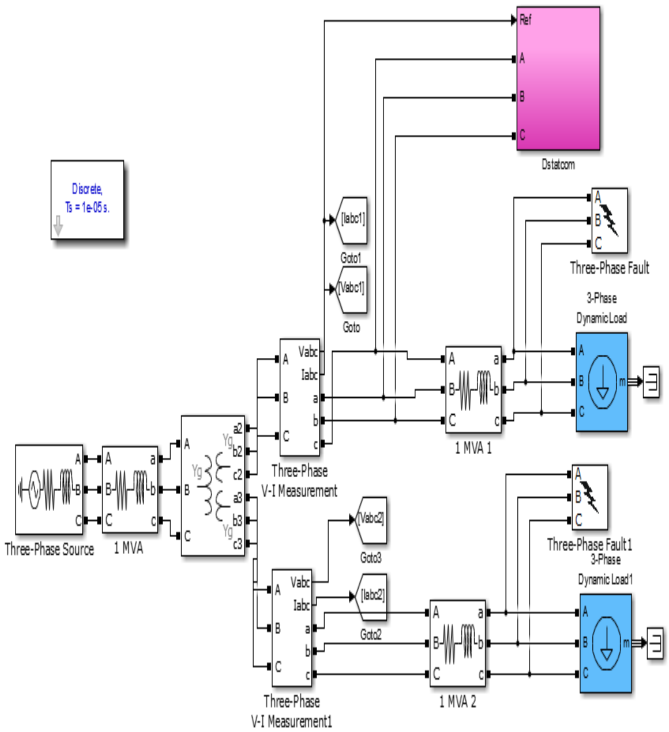

Figure 1 Simulation Model for test cases with DSTATCOM

The figure 2 shows the model with and without the DSTATCOM based power system model. The model depicts that the variations in voltage while DSTATCOM are less whereas the without DSTATCOM the variations are high. The curve that depicts the current without DSTATCOM suffers from a sudden fault which occurs between 0.3 and 0.5. However, the current with DSTATCOM has a balance as no fluctuations or faults have been noticed from the model.

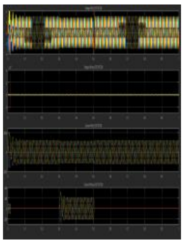

Figure 2 Model for voltage and current in both cases i.e. with DSTATCOM and without DSTATCOM

The figure 3 shows the model for total harmonic distortion in phase A, B and C respectively. The graph makes it clear that the phase A and phase C are highly suffered whereas the phase B has lower rate for the same.

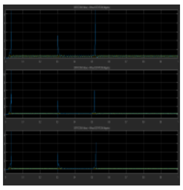

Figure 3 Total Harmonic Distortion in Phase A, B and C

Figure 4 represents the frequency analysis of the power signal without using DSTATCOM. The signal in figure 4 is acquired when DSTATCOM is not used with the system. The signal comprised of total 50 cycles and 2 cycles are selected for FFT. In this case peak value of the signal is identified and found that it remained high throughout the last cycle. The x axis of the graph calibrates the data in the time form at the instance of acquiring the signal. The time lies between 0 seconds to 1 second. The y axis depicts the value corresponding to the signal's peak and ranges from -200 to 200.

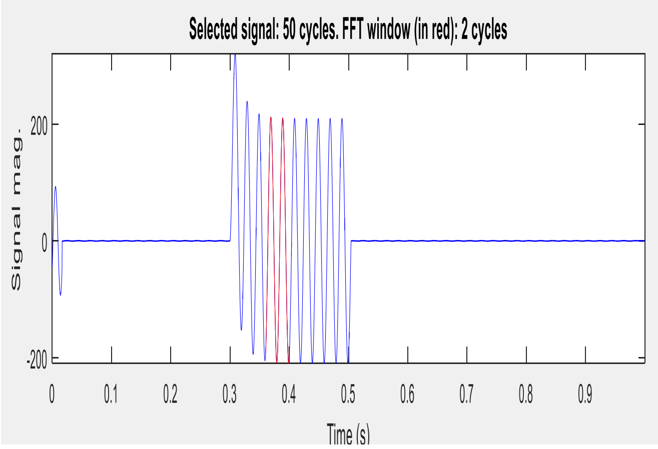

Figure 4 Signal Analyses with FFT

Figure 5 depicts the magnitude graph corresponding to the signal that is analyzed in previous step. In this the x axis shows the current value of frequency which is considered from 0 to 1000. The y axis depicts the data for signal related magnitude. As observed from the figure 4 that initially the signal has highest peak value similarly the graph below depicts that when the significance of the frequency is low the corresponding magnitude is high. But as the frequency is getting high the corresponding magnitude started falling and it becomes 0 at the end.

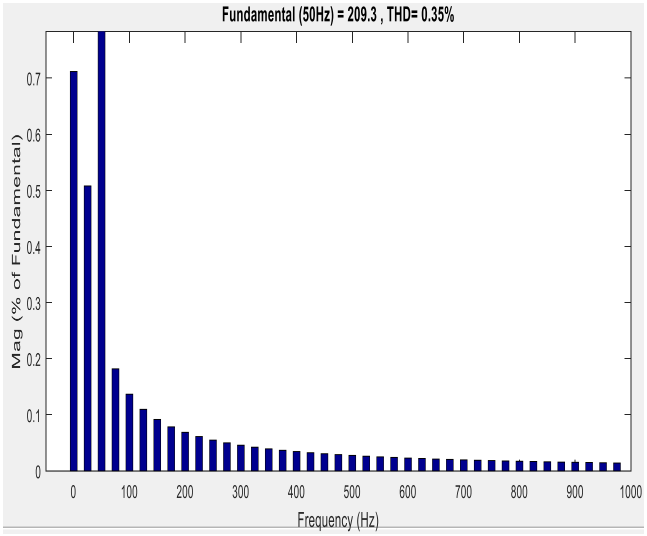

Figure 5 Magnitude and Frequency of analyzed signal

The figure 6 represents the investigation of the selected signal after applying DSTATCOM. The graph calibrates the data in the terms of time and peak values. The graph shows that the signal has less fluctuation. The FFT window depicts that the fluctuations occurs between 0.3 and 0.4 seconds. Only 2 cycles has been considered for representing the effect of FFT.

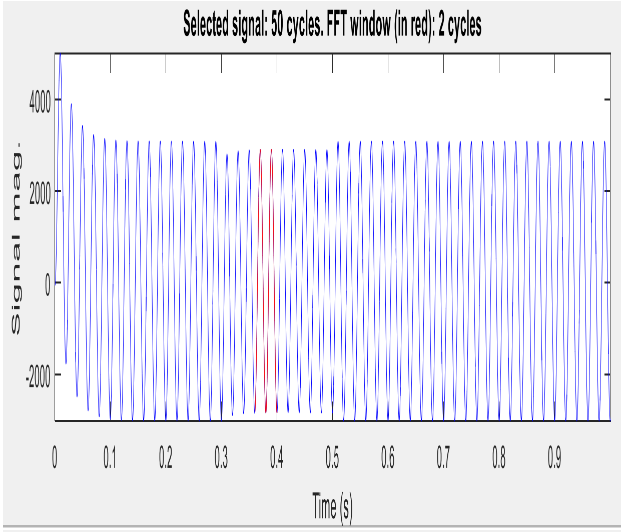

Figure 6 Signal Analyses with FFT

The graph in figure 7 depicts the graphical format of above analyzed signal with DSTATCOM. The graph comprised of signal frequency that is plotted at x axis and signal's magnitude on other axis of the graph. The graph is drawn by taking the observed signal in account of figure 7. In this graph it is depicted that magnitude is reducing constantly with the increase in the frequency. But the magnitude did not become NIL till the last frequency notation i.e. 1000.

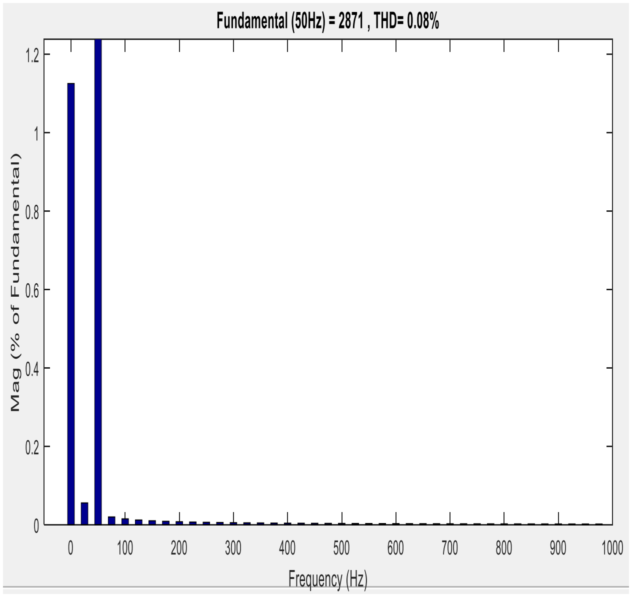

Figure 7 Magnitude and Frequency of analyzed signal with DSTATCOM

VI. CONCLUSION

In distributed system the issue of quality of power exists for the reason of the use of devices based on power electronics as well as, non-linear and inductive loads etc. The quality of power for the system can only be enhanced by using STATCOM i.e. Static Compensator. This study provides a solution for compensation of reactive power and balancing the load corresponding to dynamic loads by using DSTATCOM in generating station. For doing the simulation 3Phase loads are used for balancing the loads in dynamic system. Results of this paper show that harmonic distortion is reduced up to a certain extent.

For amendments can be done by applying more proficient mechanisms such as Fuzzy Logic sets along with DSTATCOM.

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