POWER QUALITY ENHANCEMENT IN MICROGRID USING DSTATCOM

Bijo Baby , Bino Baby, Catherine Grace Jwala, Kavya S, Ajish P J, Muthoot Institute of Technology and Science, Kochi, Kerala

***Abstract*— The power quality issue got a new measurement because of the power system rebuilding and moving pattern towards distributed generation. To improve the performance of ac power systems, we need to manage reactive power in an effective way. To conquer the issues of power quality, FACTS devices are present. A D-STATCOM is one of the FACTS device makes it productive answers for enhancing the power quality distribution system. So as to diminish the power quality issues, the D-STATCOM exhibitions are enhanced. A D-STATCOM injects a current into the system to provide for the reactive component of the load current, reduces losses in the feeder and the voltage source inverter. The proposed scheme allows D-STATCOM to tackle power quality issues by providing power factor correction, harmonic elimination load balancing and voltage regulation based on the load requirement. The proposed topology reflects new trends of consumers toward electronic polluting loads and integration of renewable sources which in fact may lead to the scope of a reliable and sustainable supply.**

***Keywords*—D-STATCOM, STATCOM, FACTS, Power Quality, Power Factor**

I.INTRODUCTION

Both electric utilizes and end users of electrical power are becoming increasingly concerned about the quality of electric power. The term power quality has become one of the most important word in the power industry. The issue in electricity power sector delivery is not confined to only energy efficiency and environment but more importantly on quality and reliability of supply or power quality and supply quality. The power quality is primarily exaggerated due to current harmonics introduced by nonlinear loads into the distribution network. Power quality may also define as the degree to which both the utilization and delivery of electric power effects the performance. As the consumption of reactive power increase it results in poor voltage quality.The development in fast and reliable semiconductors devices (GTO and IGBT) allowed new power electronic configurations to be introduced to the tasks of power transmission and load flow management.

Static synchronous compensator (STATCOM) is predominantly recognized as a reliable reactive power controller substituting customary VAR compensators, similar to the thyristor-exchanged capacitor (TSC) and thyristor controlled reactor (TCR). This gadget enrich with reactive power compensation, dynamic power oscillation damping, flicker attenuation, voltage regulation. STATCOM is a part of Flexible AC Transmission Systems (FACTS) family that is related in shunt with the power system. By controlling the magnitude of the STATCOM voltage, the reactive power associations between the STATCOM and the transmission line control the amount of shunt compensation in the power system. The STATCOM is a power electronics gadget relies upon the law of injection or absorption of current at the point of common coupling (PCC) to the power network. The advantage of the STATCOM is that the compensating current does not rely upon the voltage level of the PCC and hence the compensating current isn't limited as the voltage drops. The valuable thought process in picking a STATCOM as an option of a SVC are overall prevalent operational highlights, quicker execution, lesser size, cost minimization and the capacity to give both dynamic and reactive power, this manner giving adaptable voltage control to power quality improvement. The execution of the DSTATCOM relies upon the control algorithm for example the extraction of the current segments. For this reason there are many control plans which are accounted for in the literature and some of these are instantaneous reactive power (IRP) theory, instantaneous compensation, instantaneous symmetrical components, synchronous reference frame (SRF) theory, calculation dependent on per phase premise, and plan dependent on neural system. Among these control plans instantaneous reactive power theory and synchronous rotating reference frame are most widely used. The reasons for power quality issues are by and large perplexing and hard to distinguish. Actually, the ideal AC line supply by the utility system should be a pure sine wave of fundamental frequency (50/60Hz). Different control quality issues, their characterization techniques and conceivable causes are talked about above and which are in charge of the absence of value control which influences the client from numerous points of view. We can subsequently presume that the absence of value power can cause loss of generation, harm of gear or apparatuses or can even be negative to human wellbeing. It is in this way basic that an exclusive requirementof intensity quality is kept up.This paper demonstrate the power electronic based power conditioning using devices like DSTATCOM can used improve the quality of power supplied from the micro grid.

II.PROBLEM IDENTIFICATION IN MICROGRID

A.Introduction to Micro Grid

A Micro-grid is an aggregation of electrical/heat loads and small capacity on-site micro-sources operating as a single-controllable unit at the distribution voltage level. Conceptually, Micro-grids should not be thought of as conventional distribution networks with additional local generation. In a Microgrid the microsources have sufficientcapacity to supply all the local loads. Microgrids can operate both in synchronisms with the utility (grid-connected mode) and in autonomous power islands (stand-alone mode). The operating philosophy is that under normal condition the Microgrid would operate in the grid-connected mode but in case of any disturbance in the utility, it would seamlessly disconnect from the utility at the Point of Common Coupling (PCC) and continue to operate as an island. A typical model of a microgrid is shown in figure [II.1]

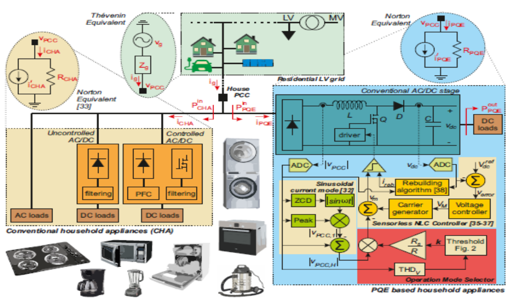


Figure II.1 A typical model of microgrid

B.Analyzing Problem in Micro-Grid

The harmonic limits in the electrical grids to ensure an efficient and proper operation of the subsystem and equipment connected to the grid. Exceeding voltage or current harmonic limits reduces the overall efficiency and might produce critical faults. The effects of harmonics in residential area are attenuated applying local or wide area mitigation approaches. The compensation capability and availability using DERs is limited by their nominal rating. For maintaining power quality, active and reactive power balance must be maintained with in the micro grid on a short term basis. To ensure accurate synchronization of the modulation signals with the grid,the harmonics injected to compensate the distortion effect. Relative large imbalances between load and generation to be managed (significant load participation required, need for new technologies, review of the boundaries of micro grids). To analyze the power quality issues in micro-grid a model of the micro-grid along with distributed energy resources, housing loads and back up batteries are simulated in the Simulink platform of MATLAB. Figure [II.2] shows the simulated model of a micro-grid.

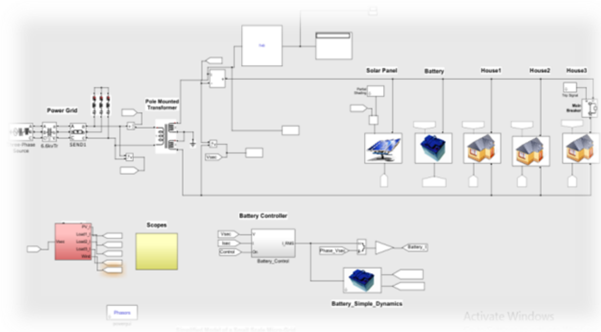


Fig: II.2 Simulated model of a micro-grid

Figure II.3 gives the FFT analysis of the grid current and it shows the effect of harmonics in the source waveform of the grid with a total harmonic distortion of 308.81%.

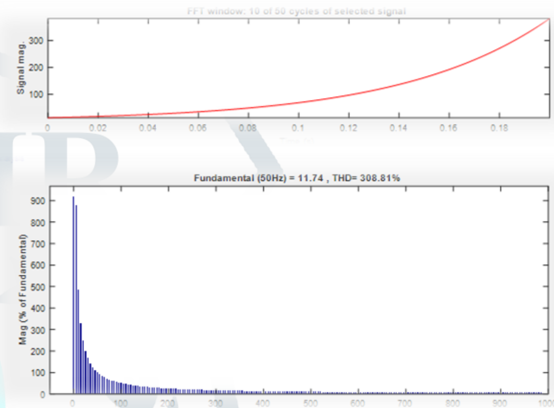


Fig: II.3 FFT analysis of grid current

III.OPERATION PRINCIPLES

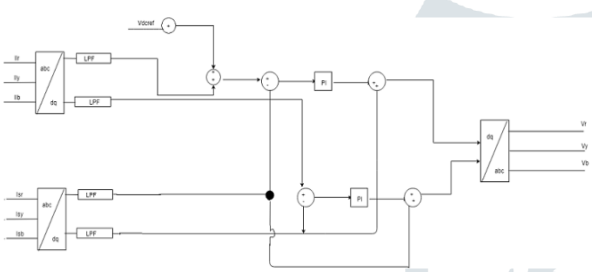
The control strategy that we have been selected for the power quality enhancement is using a FACT device called DSTATCOM.

A.Operating Principle of DSTATCOM

DSTATCOM is basically a device used to control reactive power source which provides the required amount of reactive power generation and absorption by means of VSC. The VSC converts the dc voltage across the storage device into an ac voltage source. The VSC consists of a dc capacitor, IGBT with back to back diode making a bridge.DSTATCOM is an adjustable voltage source behind a reactance. The voltages are in phase and coupled with the ac system through a reactance of the coupling transformer. DSTATCOM absorbs or generates the reactive power in synchronization with the load to stabilize the voltage level of the power system. DSTATCOM is the most important controller for distribution networks. It has been widely used to precisely regulate system voltage, improve voltage profile, reduce voltage harmonics, reduce transient voltage disturbances and load compensation.

B. Control Method

Generation of correct PWM firing is the most significant part of DSTATCOM control and includes a great impact on the compensation objectives, transient furthermore as steady state performance. The control strategy that has been selected in this paper for DSTATCOM is regulation of ac bus voltage and dc link voltage. This compensation theme is multifunctional and can be effectively used for load equalization and harmonic suppression additionally to power factor correction and dynamic voltage regulation. Three phase ac load current, statcom current and grid voltage is perceived and the active and reactive components of these fed to two PI controllers. Figure III.1 shows the diagram of control strategy.



IV. SIMULATION VALIDATION

The simulation results of power system with the compensation strategy is developed in the simulink platform of MATLAB. The model consists of a power system , a non-linear , a harmonic generator and the DSTATCOM. The DSTATCOM consis of a voltage source inverter, dc capacitor source and the controller. Figure IV.1 shows the model of the power system compensated using DSTATCOM.

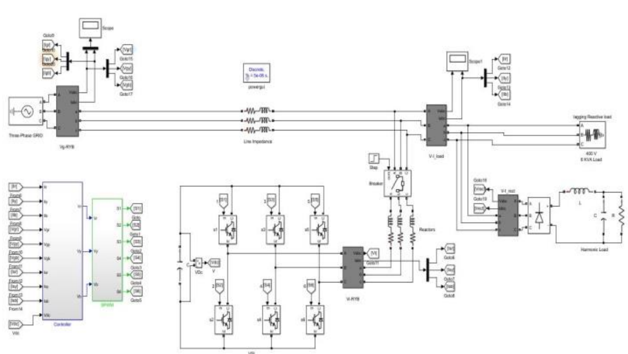


Fig: IV.1 Simulated model of power system with compensation

Figure IV.2 shows the source waveform of the power system without any harmonic distortion. FFT analysis of the source waveform is shown in figure IV.3

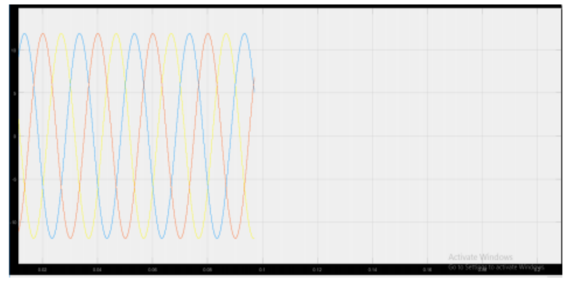


Fig: IV.2 Source Waveform

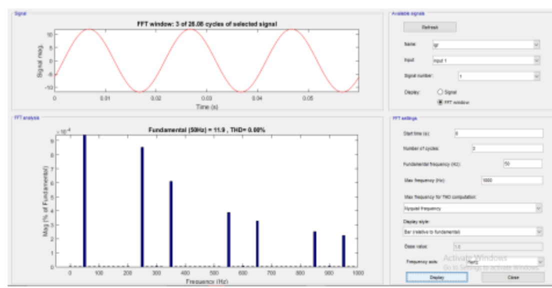


Fig: IV. 3 FFT analysis of source

And the figure IV.4 shows the waveform of the grid current after the harmonic load is being injected to the system. And the FFT analysis of the load current after the harmonic load is being injected is shown in the figure IV.5

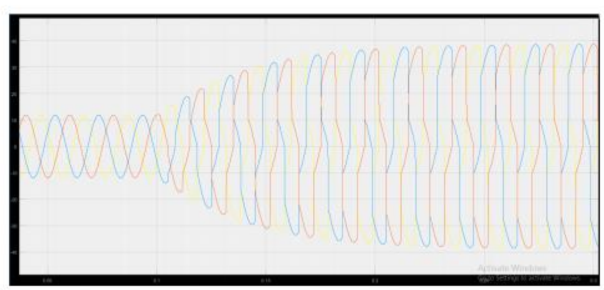


Fig: IV.4 Grid current after harmonic load injection

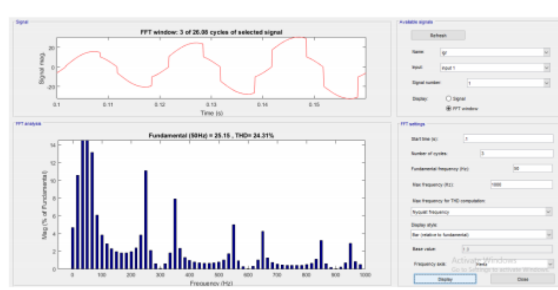


Fig:IV.5 FFT analysis after harmonic injection

When the DSTATCOM get connected to the power system, the statcom starts to compensate the voltage imbalances and harmonics generated in the power system after the injection of the harmonic load in to the system. Figure IV.6 shows the waveform of grid current after it get compensated by the DSTATCOM and figureIV.7 shows the FFT analysis of the grid current after compensted by DSTATCOM.

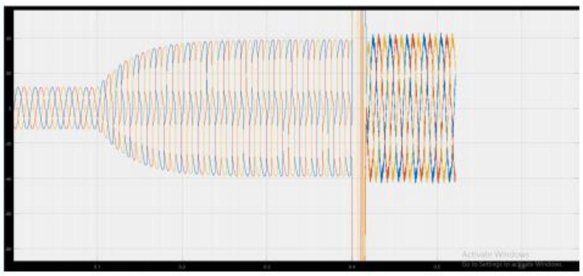


Fig:IV.6 Grid current after compensation

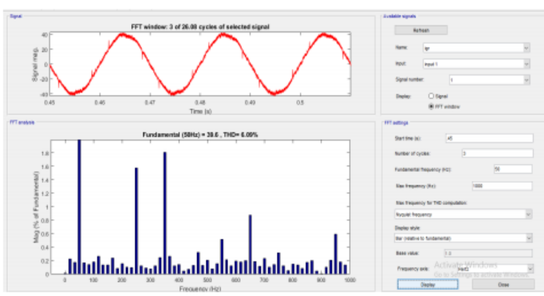


Fig:IV.7 FFT analysis of grid current after compensation

The compensation using DSTATCOM for various firing angles of the harmonic load is analyzed and the respective is plotted in a graph shown in figure IV.8. From the graph it is clear that as the firing angle changes the THD changes as the output of the rectifier varies.

Alpha(firing angle)	Before Compensation %	After compensation %
30	59.76	11.34
40	64.92	29.41
50	70.15	45.25
60	75.67	11.98
70	91.76	9.31
80	99.67	8.19
90	107.6	7.04
100	114.9	6.07
110	119.23	5.23
120	114.69	4.52
130	87.33	3.9
140	31.08	3.58

Table:IV.1 Various Firing angle and compensation

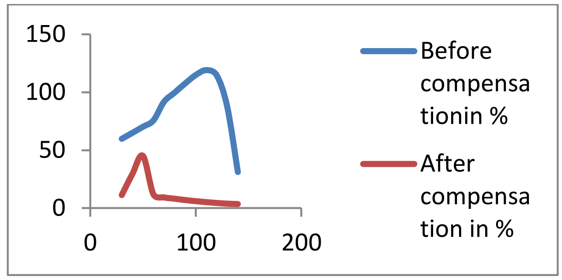


Fig: IV.8 Compensation with varying firing angle

V. CONCLUSION

Power balance, power quality and protection are crucial for future microgrids. In order to avoid the power quality issues and other issues related with the microgrid is being regulated using the DSTATCOM . D-STATCOM is able for correction to power factor,

load balancing and regulation in the voltage profile this , we have studied and analysed the operation and performance of D-STATCOM at unbalanced non linear load condition.This proposed model is implemented using MATLAB SIMULINK software and the obtained resultant waveforms are evaluated and system stability effectiveness and power system performance have been established.

VI. REFERNCES

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