Power Quality Improvement using STATCOM in Power System: A Review

Anand Antil*, Naveen Kaushik**
*M.Tech Scholar, Department of Electrical Engineering, Hindu College of Engineering, Sonipat
** Assistant Professor, Electrical Department, Hindu College of Engineering, Sonipat

Abstract

As the commercial and industrial customers are facing various power issues on the electrical distribution system which are popularly known as custom power products, so to get rid of these problems there are various new technologies has been developed. On the basis of their structures the custom power product has been classified into three different categories such as dynamic voltage regulation (DVR), distribution static compensator (STATCOM). Among these the STATCOM is a custom power product, which is a shunt connected power electronic based device and used to compensate the reactive power factor, which means it protect the electrical system from polluting load. There are several advantages of STATCOM thus due to this we can use the STATCOM in place of traditional VAR compensator. There are three main parts in STATCOM which are three phase voltage source inverter, injection transformer, DC LINK. The performance of STATCOM can be calculated by the controlling algorithm which is the extraction of current components. Thus for measuring the performance there are several algorithms have been developed which are based on the various theories and strategies.

Key Words:*Power quality, PCC, SVC, UPQC, STATCOM, Harmonics, Wind energy. Custom power devices.*

I. Introduction

In early 19th century when the electricity, when the commercial use of electricity has been started there are various issues has been occurred while electricity transmission like voltage fluctuation due to change in load and there are several power transmission limitations are present due to unbalance in reactive power. As now days electricity is the most important part of daily life so all these factors have higher impact on power supply due to globalization and privatization of electrical systems and energy transfer. Due to continuous development over the time there are several compact semiconductor devices has been developed which allow new power electronic configuration in power transmission and load flow control. Thus by these devices we can get reliable and efficient control over power transmission. Consequently the custom powers is for low voltage distribution and thus increase the quality and thus increase the reliability of supply which affect the sensitive load. There is very similarity between these devices and FACTS. The commonly used custom power devices are STATCOM, UPQC, DVR. Among these the STATCOM is a custom power product, which is a shunt connected power electronic based device and used to compensate the reactive power factor, which means it protect the electrical system from polluting load. [3]. The performance of STATCOM can be calculated by the controlling algorithm which is the extraction of current components. Thus for measuring the performance there are several algorithms have been developed on the basis of various theories and some of them are instantaneous reactive power (IRP) theory [4- 11 In this paper our main focus in on compensate the voltage fluctuation and the voltage interruptions. Thus we can analyze the dynamic performance by the simulation.

The main cause of these voltage sag are problem in utility systems or the problems in customer facilities or increase in load current, this will cause while starting the motor or transformer energizing. These are most common power

quality problem which occur in power transmission. While in commercial and industrial use the voltage sag are the most common problems and they cause various problems to machinery and even in production thus may cause economical losses. Thus here our main focus is on the disturbances caused from end to end user devices as the major power quality issue.

The harmonic current flow may cause the harmonic distortion and also cause the lower power factor and also cause some loss in form of heating in electrical equipment. These are several adverse effects of these distortions like vibration in machines which cause noise and adverse affect over sensitive equipments. Thus to overcome these all kind of problems the new power electronic devices has been developed like FACTS and custom power devices and thus provide the developed power system with the new control capabilities.

There are several new techniques have been introduced to prevent the power quality problems while transmission and distributing. In all these techniques D-STATCOM is one of the most emerging technology. Thus to control the electronic valves in DSTATCOM a novel PWM based scheme has been introduced. The D-STATCOM has ability to prevent the effect of reactivecurrent at low voltage and thus we can develop the voltage by interchanging the capacitors instead of batteries, thus the energies become store efficiently.

The rest of research paper is design as follows. The overall previous work is described in Section II. Section III describes problem formulation. performance parameter describe in section IV. Finally, Section V describes the conclusion of paper.

II. Literature Review

Numerous research works are already existed in literature which based on PQ problem compensating utilizing D-STATCOM. Some of them reviewed here.

Rakesh S. Kumbhareet.al (2015) present a novel scheme which is based upon STATCOM to improve the power quality in the grid connected wind generating systems with the non liner loads. Thus we can simulate the performance of STATCOM by implementing the two main controllers: Hysteresis current controller and PI controller. In this the STATCOM introduce the current in grid which will cancel the effect of reactive and harmonic parts of the induction generator current [1].

A. Yanushkevicet.al (2014) present a advanced approach for to enhance the power quality effectively, generally to flicker mitigation. In this approach the STATCOM has been introduced with the energy storage devices in its DC circuit. Further in this study its function has been discussed and also the effect of various parameters has also been studied [2].

Ilango K et.al (2014) present a novel approach for the application of STATCOM innovatively as i) compensator for reactive power ii) a interface unit among the grids and renewable energy [3].

Aarathi A. R et.al (2014) discuss about thee STATCOMs which are used for the extensive voltage support over the some past decades and to improve the quality of power and to stabilize the voltage. As there are some imitation of STATCOM while improving the system ability due to its restricted capabilities to deliver the original power. Thus there are super capacitors are employed to store the requisite amount of energy and they also have capability to quickly release it [3].

Mohit Bajaj et.al (2016) present a study in which he discuss about the D-STATCOM is case of the distributed supply voltage has been performed to enhance the quality of power in supply system. Thus the results we get after the simulation confirmed the compensation approach based on the synchronous detection method and also present a new approach in *a-b-c* reference frame. [4]

Mohammed Abdul et.al (2016) present the design and implementation process of distribution type voltage source convertor (VSC) based static DSTATCOM has been carried out. Thus the present method can be used to enhance the power quality problems like voltage sag and swell by employing the D-STATCOM in distribution system [5].

D. Prakash et.al (2016) presented. a distribution static compensator (D-STATCOM) which is one of the power custom device which makes is productive in solving the power quality issues in distribution system. So as to diminish the PQ issues, the D-STATCOM exhibitions are enhanced. [6]

MasoudFarhoodnea et.al (2016) present study in which he shows the use of D-STATCOM in a distribution system by employing the firefly algorithm to enhance the quality of power [7].

T.Bharath Kumar et.al (2014) present the novel approach for the wing energy production and its integration with the current transmitting units are growing worldwide. Thus the power thus generated from wind is time varying in nature and thus produce the stability issues [9].

Soumya Mishra *et al.* present low ranked photovoltaic fed enhance D-STATCOM to recompense the harmonics and reactive power. Thus in this system we use the load active power with the least power rating of the PV source for the ideal load rating as contrasted with the standard L or LCL filters [10]

M.R.Qader has depicted an innovated systematic scheme which is based on the optimal control and tracking with PI controller, which is used to control the entire follow of load and voltage sags, thus by eliminating the harmonic current distortion and prefer a steady state behavior.

S.M.Abd-Elazim*et al.* have projected a met heuristic technique, the Cuckoo Search (CS) algorithm, which is designed on the basis of life cycle of birds for the ptimal design of STATCOM in a multi-machine surroundingsThe performance of the CS depend STATCOM was contrasted with Genetic Algorithm (GA) based [11]

Abdul Balikci*et al* present the control algorithm which is based on the series decomposition of load current and the reimbursement of the negative series elements [12].

Bhim Singh *et al.* present a study where he explained about the modeling and execution of the three phase D-STATCOM which consist of STF based IRPT control algorithm use for the power quality enhancement. Thus here a adaptive fuzzy logic controller has been employed to control the DC bus voltage of the VSC based D-STATCOM thus to alter the response and to decrease the influence of unbalance loading situations and the supply voltage variations [13].

III. Problem Formulation&Challenges

The main aim of determining the optimum D-STATCOM placement is to enhance the power quality of the system thus by decreasing the entire installation cost. Thus here the multi optimization problem has been introduced in which the real function contains the three sub functions and thus these three constraints are as follows:

- Harmonic distortion
- Sag / Under voltage
- Interruptions
- Voltage Spike
- Transients
- Noise
- Swell / Over voltage

IV. POWER QUALITY ISSUES

A. Power quality standards

a. IEC standard

Common guidelines for measurement and rules for power quality of wind turbines are specified in IEC standard 61400.Both manufacturer and buyer utilized this standard for better power quality requirement [4].

The standard norms are specified.

1. IEC 61400-13: Wind turbine – measurement system used to determine the behavior of power.

2. IEC 61400-3-7: making the assessment for the emission limits of the varying load.

3. IEC 61400-12: Wind turbine performance. The data sheets along with the electrical characteristics of the wind turbine facilitate the basics for the utility assessments. [4].

B.Power Quality issues

a. Voltage Fluctuation

Better torque and wind velocity are the source of voltage discrepancy. The voltage variation occurs by variation in wind speed and its disparity directly linked with real and reactive power deviation. Thus we can classify the voltage fluctuation as voltage dip, voltage swell, short interruption and long duration voltage variation. The amplitude of voltage fluctuation depend and power factor of wind turbine [4]. The dynamic variation in network caused by wind turbine is described by voltage flicker.IEC standard 61400-4-15 specifies flicker meter which is used to determine flicker directly.

b. Harmonics

Harmonics are referred as sinusoidal voltage, and current consist of frequency which is product of the frequency at which the system is designed to work. Thus the main sources of harmonics are power devices. Thus at the point of common coupling the harmonic current and voltage must be limited. To ensure the harmonic voltage at desire limit, each source of harmonic current permit only partial contribution as per IEC standard 61400-36.The harmonic current is generated at low distortion point in wind turbine. Thus the two main parameters for the measurement of harmonic content are total harmonic distortion and total demand distortion.

c. Self excitation of WTGS

thus the wind turbine generator has contain the compensating capacitor which is used for the efficient storing of energy. The capacitor which is connected with asynchronous generator gives reactive power compensation.

d. Consequence of issues

The voltage variation, voltage flickering effect and inducement of harmonics create much effect in wind turbine which is connected with grid .These power quality issues will affect the sensitive equipment and also it will affect the sensitivity of the grid.Voltage fluctuation, flicker, harmonics and frequency causes the dysfunction of the various equipments which are necessary.

V. Conclusion

Power quality has turned into dominant situation of late. This paper has examined the performance of various FACTS devices during various power quality conditions. From this study we can suggest that the Static Compensator can carry out better performance than other custom devices. Various Control techniques are adopted for enhancing the performance of the entire network while using custom power device. Unified power quality conditioner can do well according to power quality maintained at PCC. But only defect is cost effective. Static VAR compensator can support only for stabilization of voltage. But it fails to give reactive power support.

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