International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 1, Jan-Feb-2021, ISSN (Online): 2395-566X

Literature Survey on Power Quality and Voltage Flicker Reduction using D-STATCOM

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***Abstract*- Now-a-days, the most important discussing topic in the world of powersystems is maintenance of power quality The power quality improvement is one of the interesting topics among researchers groups. And they all focused on power quality improvement in power system. In this literature survey paper we are study so many papers written by different researchers. Study and analysis of DSTATCOM and its uses and advantages in power system.**

***Keywords*- DSTATCOM, power quality improvement,UPF,pwm,power system**

I. INTRODUCTION

The most difficult thing is maintenance of the electrical power quality to make it stay within the acceptable limits. Many are downsides of poor and low power quality. It may result in higher power losses, abnormal and weird behavior of electrical equipment, and interference with the close communication lines, poor voltage profile, harmonics, sag and swells within the voltage & poor and low distortion issues.

The rise in applications of solid-states devices has boosted the tension on power system as it leads to generation of voltage and current harmonics and it also increases the reactive current. Nowadays, power electronic devices are used by the industries for many reasons like variable voltage, variable frequency and current control to receive accurate controllability, better and higher efficiency, faster response and most importantly to make the devices compact in size. The fundamental problem here is the non-sinusoidal current of power semiconductor technology devices e.g.rectifiers and inverters that not only contain the fundamental component but also the harmonic components.

The major problem encounters since the switching actions which these devices exhibit such as MOSFET, BJT, SCR, IGBT etc. Because of this switching action these devices acts as non-linear loads. Distortion and Displacement factors also turn out to be poor because these devicesattract the leading/lagging and non-sinewave current from the supply, thereby resulting in injection of harmonics in the distribution systems. The harmonic current then starts flowing through the line and source impedance and this causes distortion of voltages, excessive power loss and voltage drop.

II. RELATED WORK

As indicated by the ongoing force unsettling influence thinks about, Voltage hangs are viewed as the most continuous compose with serious effect on touchy burdens. There are various strategies to relieve voltage droops, yet a D-STATCOM is viewed as the most effective technique.

Several research papers and publications have addressed the improvement of power quality using D-STATCOM. A brief review of the work under taken so faris as follows:

Atma Ram Guptaet. al [8], The aim of this paper is to analyze unbalancedradial distribution systems (UBRDS) with the distributionstatic compensator (D-STATCOM). The main objectivesof this paper are D-STATCOM allocation in UBRDS withan objective of providing reactive power support toenhance voltage profile and reduce line losses of the distribution network, determination of optimal D-STATCOMrating subjected to minimization of total cost, andimpact of D-STATCOM placement on improving powerfactor and savings in cost of energy loss.
The analysis isconducted on a large industrial load model with light, medium and high loading scenarios. Further, the impact ofload growth is also considered for better planning of thepower distribution system. The results are obtained onstandard 25-bus UBRDS to check the feasibility of theproposed methodology.
N. Visaliet. al [9], Now-a-days, the most important discussing topic in the world of powersystems is maintenance of power quality. After generating voltage, the engineers inthe substations are struggling for transmitting as well as distributing of power to thereceiving end, since different loads at the ends of distribution are very sensitive tothe fluctuations in the

voltage, interruptions of voltage and harmonics. This papershows the improvement of Voltage Sag and THD using LCL Passive Filter alongwith the Distribution Static Compensator (D-STATCOM) which works with the principle of Voltage Source Converter (VSC).

Anju Balaet. al [10], This paper represents the Hardware implementation of three phase three level inverter based D STATCOM to reduce the THD. Inverter based D-STATCOM system using mc 3 phase IC. In this project mc3phac IC is used togenerate PWM pulses with alternate phases these PWM signalsare used to fire the IGBT. The system consists of mc3phase IC, IR2110 IC (IGBT drive IC), two voltage regulators (LM7805, LM7812). In this model IGBT is used to switch on and off inorder to generate the required three phase output signal. In thiswork we utilized the LabVIEW hardware NI-9171, voltagemeasurement module NI-9244 to acquire the real time data.

R.Rageshet. al [11], In this paper, the performance of aSingle D-STATCOM is evaluated for the purpose ofharmonics elimination, reactive powercompensation and load balancing. A control schemehas been proposed for D-STATCOM and itscharacteristics are investigated by digital simulation. A current controller on the single-phasebasis forms the innermost loop in the control hierarchy. The dc bus voltage controller and PCCvoltage controller are designed using a simplified model, neglecting the dynamics of the inner current control loop. The control of D-STATCOM isaccomplished by Space Vector Pulse Width Modulation (SVPWM) technique with potential ofsupplying reactive power, harmonics and unbalanced load compensation and it is used toprovide real component of load current, positive sequence and fundamental frequency. The Proportional–Integral (PI) controller is used tocompute current component to compensate losses inD-STATCOM to maintain dc-bus voltage of voltagesource converter (VSC).

B. Murugananthamet. al [12],The depleted conventional energy sources and awareness approaching Green gas emissions, have forced the countries towardsthe integration of Distributed Energy Resources (DER) in the secondary distribution network. While integrating DER in the Distribution Network (DN) the performance of the network varies with respect to the seasonal variation of source and load. In addition to this the DN experiences unbalanced load in each phase, variable peak demand and continuously varying load profile creating disproportion load flow between real and reactive power. With the variation in generation and load, dip in power factor and variation in reactive power flow is observed in the underground lines. This paper addresses the impact of real and reactive power allocation for the seasonal variation of source and load demand on IEEE 37 node test feeder. Solar PV is integrated at remote locations of the feeder and load flow analysis is performed for different load profiles. Time series simulations are performed to analyze the dynamic behavior of the network. The nodal voltage solutions and power flow solutions are explored with and without Distribution static compensator (D-STATCOM). Switching sequence of the D-STATCOM for different seasons is computed and the reactive power reallocation is done for the DN. The improvement in voltage profile and power factor at various nodes with D-STATCOM has been demonstrated.

Reza Sirjaniet. al[13],With the growth and development of power grids, optimal utilization of electric networks is very important.Because of the high cost of construction and development of power networks, mitigation of existing issues, suchas excessive power losses, voltage profile problems, voltage instabilities, reliability problems and etc. isinevitable. To obviate these problems, Distribution Synchronous Static Compensator (D-STACTOM) as a shuntcompensator device can be used in electric distribution networks. Optimal location and size of D-STATCOM, should be determined on the basis of economic viability, required quality, reliability and availability. In recent years, several papers have concentrated on the techniques used for finding optimal location and size of the D-STATCOMunits considering different aspects. However, to date, no review paper has been published in thisfield.

This paper presents an up to date survey of the literature on the optimal allocation of D-STATCOM indistribution networks. The existing research works have been classified into five categories including analyticalmethods, artificial neural network-based approaches, metaheuristic methods, sensitivity approaches, and acombination of sensitivity approaches and metaheuristic methods. Moreover, it was found that in D-STATCOM al location problem, the objectives may be alleviation of power loss, mitigation of voltage deviations, improvement of reliability metrics and enhancement of voltage stability.

All methods, objectives and constrainshave been compared and discussed in details. Eventually, an overall review on the reviewed works has beenprovided and some directions for future research were suggested.

Venkatraman Kandadaiet. al [14],This paper presents an implementation and performanceanalysis of a three-phase distribution static compensator(D-STATCOM) for various compensations in a systemwith static and dynamic loads. Under static loading condition, D-STATCOM is used for reactive power compensation, harmonic elimination and load balancing. During dynamicloading condition, induction machine is considered asa dynamic load by operating it as motor/generator and the dynamicreactive power support capability of D-STATCOM isexplored.

Synchronous reference frame theory is utilized forreference signal generation and hysteresis pulse width modulationswitching is employed for firing pulse generation, which are implemented in field-programmable gate array (FPGA). All the tasks in FPGA are realized as independentmodules to build the system with the capability to reconfigurethe hardware for any other application with similarrequirements.

The proposed FPGA implementation utilizes reduced amount of reconfigurable resources and works with-out a dedicated personal computer. The experimental results prove that the implemented control technique makes the supplycurrent sinusoidal and the supply power factor close to unity.

Soumya Mishra et. al [15], A common practice of obtaining the values forfilter parameters and gains of proportional plus integral (PI) controller is to use a linear model of the distributed staticcompensator (D-STATCOM). The values so obtainedproduces perfect harmonic cancellation (PHC) and unitypower factor (UPF) for balanced and sinusoidal supplyvoltages based photovoltaic fed D-STATCOM (PV-D-STATCOM).

However when supply voltages are distorted; PV-D-STATCOM may not produce PHC along with UPF dueto non-linear behavior of the passive filter parameters.Hence; there should be an optimal calculation for filterparameters and PI controller gains; so that the PV-D-STATCOMcan deliver optimal performance underdistorted supply voltages. This paper presents a newalgorithm based on teaching-learning behavior inside aclassroom; to optimize the gains of PI controller and filterparameters. Through simulation results; it is observed thatthe optimization based control algorithm performs quitesatisfactorily under sinusoidal as well as distorted supplyvoltage conditions. The proposed teaching-learningoptimization based PV-D-STATCOM is compared withgrenade explosion method (GEM) and found to convergefaster than GEM to reach the global optimum solution.

III. PROBLEM FORMULATION

On the basis of above literature survey, some following problems have been identified, which is being discussed in this section.

1. Power Quality Problems:
Poor PQ problems ultimately results in economic loss of the power system network. PQ mainly concerns to maintain voltage and current profile i.e. any deviation in these parameterscan cause severe damage to the electrical utility and end consumers. An overview of manyPQ problems along with their causes and consequences are presented.

1.1 Voltage SAG/DIP:

The voltage sag or dip can be stated as decrease in nominal voltage level by 10-90% for shortduration for half cycle to one minute as shown in fig.2.1. Sometime, voltage sag last for longduration such prolonged low voltage profile referred as ‘under-voltage’. Voltage sag isfurther divided in three categories: instantaneous, momentary and temporary sagsrespectively.Voltage sag are mainly caused due to occurrence of faults in power system, overloading ofthe electrical network and starting current drawn by heavy electrical loads like motors andrefrigerators.Voltage sag in power system network results in failure of relays and contactor, dim light andfluctuating power.

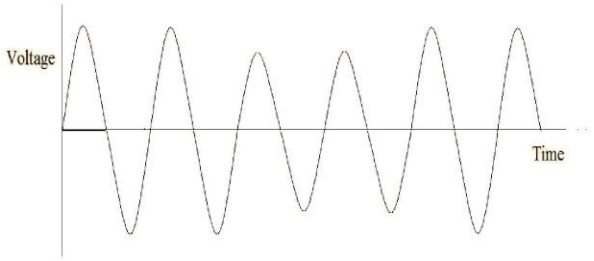

Fig 1. Voltage sag/dip.

1.2 Voltage Swell:
Voltage swell can be stated as voltage rise by 10-80% of normal value for duration of halfcycle to one minute as shown in fig.2.2. Likewise voltage sag, prolonged high voltage profileis referred as ‘over-voltage’. Voltage swell is subdivided as:

- Instantaneous swell
- Momentary swell
- Temporary swell

Voltage swell is mainly caused by disconnection of large load, Single Line to Ground fault (SLG) results in voltage rise in unfaulted phases and loose connection of neutral wire.Voltage swells results in breakdown of insulation, overheating of electrical equipment anddamage to electronic equipment.

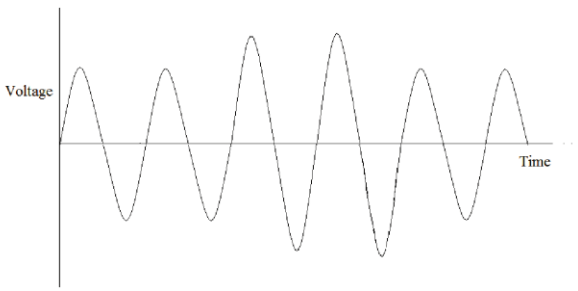

Fig 2. Voltage Swell.

2. Voltage Interruption:
Voltage interruption can be stated as reduction in RMS voltage by below 0.1 pu of nominal orcomplete failure of

supply voltage. It can be further divided into two classes based oninterruption time period:

2.1 Short Interruption: If the interruption duration occurs for few milli-seconds then it is termed as shortinterruption. This is due to malfunctioning of switching devices which may affect thedata stored in sensitive devices like PLCs.

2.2 Long Interruption: If the interruption duration occurs for range between few milli-seconds to severalseconds then it is termed as long interruption as shown in fig.2.3.

The main cause is disconnection of electrical power system for maintenance and faults inelectrical network which may result in complete stoppage of supply.

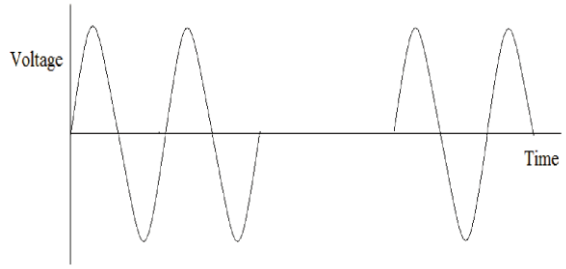

Fig 3. Voltage signal with long interruption.

3. Waveform Distortion:
Distortion means change in original waveform shape as shown in fig.2.4. In a power systemnetwork, the voltage and current waveform should be sinusoidal in nature. A Waveformdistortion is mainly due to harmonics; A harmonic is an integral multiple of fundamental frequency of electrical quantities.This is due to presence of non-linear loads which results in over heating of electrical equipment. Hence its reduction is desirable.

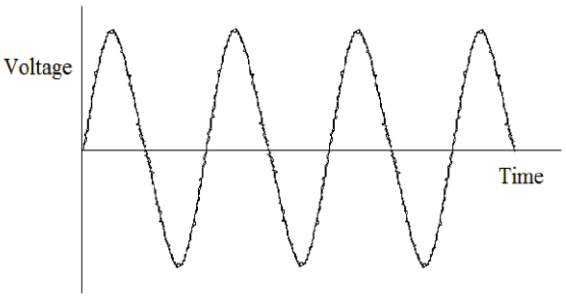

Fig 4. Distorted voltage waveform.

IV. CONCLUSION

Here in this work we have come to the conclusion that D-STATCOM is better as compare to SVC and STATCOM based systems. It is also noted that D-STATCOM discussed during this work contains lower harmonics compared with SVC and STATCOM.

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