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A REVIEW TO THE MITIGATION OF POWER QUALITY EVENTS

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ABSTRACT
The quality of electrical power is an important contributing factor to the development of any country. Power quality is highly newsworthy issue as it has attained considerable attention in the last few decades due to large penetration of power electronic based loads or microprocessor based controlled loads. In order to avoid the unexpected disruptions and damage in the power system it becomes necessary to overcome power quality issues and to have reliable power performance. Mitigation of power quality event helps the power system to overcome the power quality issues to a great extent. To enhance the quality of power and to reduce the issues related to it mitigation of power quality events is preferred. Mitigation of power quality event not only provides the control over the power related problems but also maintains it. Here we are going to have a review of some of the power quality events that cause the power quality issues and also find the appropriate device that helps in solving the power quality issues

I. INTRODUCTION

Nowadays, Power quality is identified as one of the very serious issues in electric power transmission and distribution, because of its bad impact on electricity suppliers, manufacturers and users. Generally, we can define power quality as the deviation of voltage, current and frequency from its standard values in a power system. The voltage disturbances mainly encompass the voltage sags, swells, harmonics, unbalances, and flickers. These disturbances can cause the malfunction of voltage-sensitive loads in factories, buildings, and hospitals and sever process disruptions resulting in substantial economic and/or data losses. voltage sags or voltage dips are considered to be the most severe disturbances when industrial equipment is considered. Some of the industrial loads are very sensitive that these are unable to handle a very low deviation in voltage. Voltage sags can cause brutal damage in these loads. Voltage sag is a momentary decrease in the rms ac voltage (10%–90% of the nominal voltage) at the power frequency of duration from 0.5 cycles to a few seconds. Voltage swell is defined as a short duration increase in rms supply with an increase in voltage ranging from 1.1 p.u. to 1.8 p.u. of nominal supply. The main reasons for voltage swells are switching large capacitors or the removal of large loads [10].

Now, the voltage support at the load end is very much required and it can be achieved by injecting the reactive power at the load point of common coupling.

Some of the useful conventional method is to utilize the mechanically switched capacitors which are connected in shunt. The reactive power can be injected by mechanical switching the capacitors as per the requirement of the system. But the disadvantage is that some of the highspeed transients cannot be compensated by this method and also some voltage sags are not compensated because the limited time period of mechanical switching. Also, transformer tap changing can be used but tap changing under load is very complex and costly. Here, power electronics technology had played an important role in power flow control and utilization of electrical energy; also, for the electrical power system, the FACTS devices are more often utilized because of its extraordinary performances and these devices have the ability to mitigate power quality problems such as voltage sag, swell, harmonics etc. For example, the FACTS for transmission systems, the term custom power pertains to use of power electronics controllers especially in distribution systems in order to mitigate various power quality problems. FACTS devices can boost the power transfer capabilities and improve the stability, the custom power ensures that the customers get pre-specified power quality and reliability of the power supply. The pre-specified power quality may include the following specifications of the parameters: low phase unbalance, low flicker at load point, no power interruptions, low total harmonic distortions, overvoltage and undervoltage within specified limits etc.

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There are many types of Custom Power devices. Such as: Active Power Filters (APF), Battery Energy Storage Systems (BESS), Distribution static synchronous compensators (DSTATCOM), Distribution Series Capacitors (DSC), Dynamic Voltage Restorer (DVR), Surge Arresters (SA), Super conducting Magnetic Energy storage (SMES), Static Electronic Tap Changers (SETC), Solid-State Transfer Switches (SSTS), Solid State Fault Current Limiter (SSFCL), Static VAR Compensator (SVC), Thyristor Switched Capacitors (TSC) and Uninterruptible Power Supplies (UPS) [11].

II. LITERATURE SURVEY

Mitigation of Voltage Sag and Swell Using Dynamic Voltage Restorer-

In this paper, the usefulness of including DVR in distribution system for the purpose of voltage sag and swell mitigation is described. Dynamic voltage restorer (DVR) is a series connected power electronic based device that can quickly mitigate the voltage sags in the system and restore the load voltage to the prefault value. The DVR presented here is based on the concept of dqo transformation.

Transformerless Dynamic Voltage Restorer for Voltage Sag Mitigation-

This paper discusses a transformerless dynamic voltage restorer based on three-single phase Voltage Source Inverters (VSI). Since the DVR does not have an injection transformer, it has lower loss, lower cost and it is less bulky. The DVR control is implemented using Synchronous Reference Frame (SRF) theory.

Voltage Swell and Overvoltage Compensation with Unidirectional Power Flow Controlled Dynamic Voltage Restorer-

This paper illustrates the inability of the minimum energy injection scheme to solve Voltage swell and overvoltage compensation problems in a diode-bridge rectifier supported transformerless-coupled dynamic voltage restorer (DVR) during unbalanced situations. Therefore, this paper proposes a novel unidirectional power flow control algorithm with DVR maximum compensation limit consideration, which can effectively suppress problems of continuous rising in dc-link voltage. Progressive phase rotating method is applied to prevent compensated load voltage distortion or discontinuity.

A Novel Configuration for a Cascade Inverter-Based Dynamic Voltage Restorer with Reduced Energy Storage Requirements-

This paper introduces a new configuration for a cascade (H-bridge) converter-based dynamic voltage regulator in which the basic cascade converter is supplemented with a shunt thyristor-switched inductor. The proposed topology is shown to possess the ability of mitigating a severe and long duration voltage sag with a significantly smaller energy demand from the cascade converter.

Design and Experimentation of a Dynamic Voltage Restorer Capable of Significantly Reducing an Energy-Storage Element-

This paper deals with a dynamic voltage restorer (DVR), or a voltage-sag compensator, which consists of a set of series and shunt converters connected back-to-back, three series transformers, and a dc capacitor installed on the common dc link. The DVR is characterized by installing the series converter on the source side and the shunt converter on the load side. This system configuration allows the use of an extremely small dc capacitor intended for smoothing the common dc-link voltage. This paper provides a design procedure of the dc capacitor under a voltage-sag condition and proposes a control method for the series converter, which is capable of reducing the voltage ratings of both the series converter and the series transformers.

Voltage Sag Detection Technique for a Dynamic Voltage Restorer-

This paper presents and verifies a novel voltage sag detection technique for use in conjunction with the main control system of a DVR. In all cases it is necessary for the DVR control system to not only detect the start and end of a voltage sag but also to determine the sag depth and any associated phase shift

An Enhanced Voltage Sag Compensation Scheme for Dynamic Voltage Restorer-
The work presented in this paper proposes an enhanced sag compensation method to extend the DVR compensation time. It optimizes the gradient of dc link voltage (by regulating the amount of active power injected by DVR. In the proposed method, the controller restores both phase and amplitude of the load voltage to the presag value and then initiates a transition toward minimum active power (MAP). mode. The overall operation sequence and implementation of the proposed compensation method is discussed in the following subsections.

Mitigation of voltage sags and voltage swells by dynamic voltage restorer-
This paper deals with modelling and simulation of a Dynamic Voltage Restore (DVR) for mitigation of voltage sags and voltage swells. The control of the compensation voltages in DVR based on d-q-O algorithm is discussed.

Power Quality: Overview and Monitoring, Second International Conference on Industrial and Information Systems-
PQ events include a wide range of voltage/current disturbances with time scales ranging from tens of nanoseconds to steady-state. Each PQ evens has unique characteristics and features which are usually detected and used for PQ monitoring. PQ monitoring instruments can vary from a simple true r.m.s. meter to advanced techniques that employ artificial intelligence such as ANNs, Fuzzy Logic, Genetic algorithms, etc. This paper presents an overview of the characteristics, effects and causes of PQ events and addresses recent trends in PQ monitoring.

Mitigation of Voltage disturbances Using Dynamic Voltage Restorer Based on Direct Converters-
In this paper, two new topologies are proposed for three-phase dynamic voltage restorers (DVRs). These topologies are based on direct converters. The proposed topologies do not require dc-link energy storage elements. As a result, they have less volume, weight, and cost. They can also compensate long-time voltage sags and swells. The proposed DVRs can compensate several types of disturbances, such as voltage sags, swells, unbalances, harmonics, and flickers.

An Overview of Various Control Techniques of DVR-
In this paper, the overview of DVR is presented and also different control strategies are offered. The DVR can inject three phase control voltage to make the load voltage constant at its nominal value.

Predictive Voltage Control of Transformerless Dynamic Voltage Restorer-
This paper presents a predictive voltage control scheme for effective control of transformerless

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dynamic voltage restorer (TDVR). This control scheme utilizes discrete model of voltage source inverter (VSI) and interfacing filter for generation of switching strategy of inverter switches. Predictive voltage control algorithm based TDVR tracks reference voltage effectively and maintains load voltages sinusoidal during various voltage disturbances as well as load conditions.

III. PRPOSED SCHEME

Dynamic voltage restoration (DVR) is a method of overcoming voltage sags that occur in electrical power distribution. These are a problem because spikes consume power and sags reduce efficiency of some devices. DVR saves energy through voltage injections that can affect the phase and wave-shape of the power being supplied. Devices used for DVR include static var devices, which are series compensation devices that use voltage source converters (VSC). The first such system in North America was installed in 1996 - a 12.47 kV system located in Anderson, South Carolina. The basic principle of dynamic voltage restoration is to inject a voltage of the magnitude and frequency necessary to restore the load side voltage to the desired amplitude and waveform, even when the source voltage is unbalanced or distorted. Generally, devices for dynamic voltage restoration employ gate turn off thyristors (GTO), solid state power electronic switches in a pulse-width modulated (PWM) inverter structure. The DVR can generate or absorb independently controllable real and reactive power at the load side. In other words, the DVR is a solid-state DC to AC switching power converter that injects a set of three phase AC output voltages in series and synchronicity with the distribution and transmission line voltages.

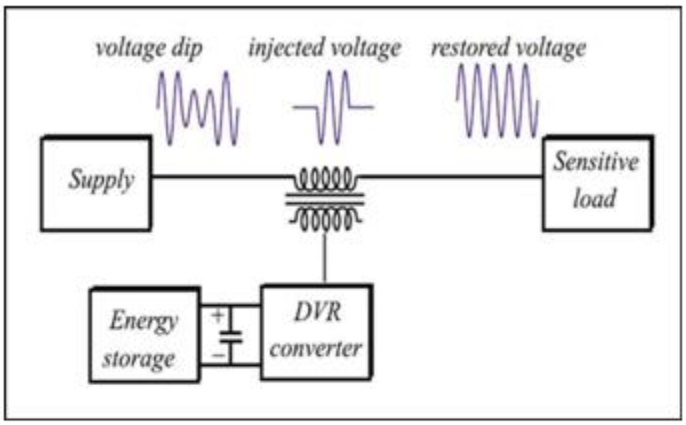

Fig. no. 1 Schematic diagram of dynamic voltage restorer

IV. MERIT OF DVR OVER OTHER CUSTOM POWER DEVICES

- The SVC pre-dates the DVR, but the DVR is still favoured because the SVC has no capability to control the active power flow.
- The DVR is small in size and price is less compared to DSTATCOM and other custom power devices.
- The DVR has more energy capacity compared to the UPS and SMES. DVR has many advantages over UPS, like less cost, higher capacity, low losses, injects only the missing part of the supply voltage and less maintenance.
- Economic comparisons of SSTS and DVR has been investigated and it reveals that SSTS provides better solution in terms of expected savings, cost of solution per KVA, annual operating cost and a higher benefit/cost ratio if, a secondary undisturbed or independent feeder is present otherwise 5. DVR is considered to be the most cost-effective solution, because SSTS does not regulate voltage neither generate/absorb reactive powers. Its only purpose is to deactivate a faulty feeder in favour of a healthy one.

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V. CONCLUSION

Thus, by studying all the above references we can conclude that there are many ways to mitigate the power quality events but Dynamic Voltage Restorers are identified to be cost effective solution for protecting sensitive loads from voltage related power quality issues. Also, there are various control techniques to use this power conditioning equipment to solve the power quality problems.

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