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Literature Review of "Modelling And Simulation of Dynamic Voltage Restorer For Power System Distribution Networks"

KEYWORDS

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ABSTRACT *This paper addresses the detailed review of research works on the solution of power sag problems on distribution networks and have been summarized with aspect to DVR technology and its different controllers. The DVR (Dynamic Voltage Restorer) is a power custom device that provides three-phase controllable voltage source whose voltage vector adds to the source voltage during sag event, to restore the load voltage to pre-sag conditions.The DVR is a commercially available, popular device to eliminate voltage sags and swells in the distribution lines.It's basic function is to inject the voltage difference (difference between the pre-sag and sag voltage) to the power line and maintains the presage voltage condition in the load side.*

The different topologies can be used to provide the dc supply to DVR. Different control strategies are available depending on the compensation technique used for compensation.An adequate modeling, analysis and simulation of DVR using MATLAB, A PI controller and discrete PWM pulse generator was used in this model. Extensive simulation results are included to illustrate the operating principles of a DVR.

LITERATURE REVIEW:-

O. Anaya-Lara et. al. present the simulation of dynamic voltage restorer and suggests four different methods to inject the voltage using DVR, which are categorized such as presage compensation, phase advance method, voltage tolerance method and in phase voltage injection method. In presage compensation method injected DVR voltage is the difference between the sag and pre-fault voltage. In order to minimize the real power injected by DVR, phase advance method is used. For a small percentage of the voltage sag which does not affect the system then voltage tolerance method with minimum energy injection. **[1]**.

S.F. Torabi et. al. deals with modeling and simulation technique of a Dynamic Voltage Restore (DVR). The DVR is a dynamic solution to protect sensitive loads against voltage sags and swells. The DVR can be implemented to protect a group of medium voltage or low voltage consumers. The new configuration of DVR has been proposed using improved d-q-0 controller technique. This study presents compensation of sags and swells voltage during single line to ground (SLG) fault and three-phase fault. Simulation results carried out by Matlab/Simulink verify the performance of the proposed method **[2]**.

V.K. Ramachandaramurthy et. al. represents additional supervisory control method during voltage sag and swell. The scheme must set the DVR to operate without exceeding its rating so that it maintain load voltage within acceptable limits and sensible point is set to 0.9 pu voltage level as a compensation for voltage sag, likewise the compensating swell to 1 pu is not most effective solution. If 1.1 pu is sufficient. And this paper also explains how to calculate injected DVR voltage according to its rating and compensation set point.Inphase and presage compensation techniques are dependent on the magnitude of the retained supply voltage and the load power factor.**[3]**.

John Godask Nielsen et. al. represent the different topologies can be used to provide the dc supply to DVR .John Godsk Nielsen and Frede Blaabjerg proposed four different topologies in order to provide dc supply. Comparisons are made between those topologies that can be realized with minimum amount of energy storage, which can be summarized as follow. In first case DVR is performed without any energy storage system. A passive convertor is used because only unidirectional power flow is necessary. The convertor may either place at the load side or placed at the source side. And in other case the DVR is performed with the energy storage system. The energy is stored either in the dc link capacitor or in the form of constant dc link. Experimental test using a 10KVA DVR shows that the no. of energy storage concept is feasible but an improved performance can be achieved for compensating voltage sag using stored energy topology.**[4]**.

Jose M. Lozano et. al. presents a concept for the use of matrix converter which consists of nine bidirectional switches arranged in three groups each being associated with an output line.This matrix converter is used in DVR based on a matrix converter without energy storage device is proposed to cope with voltage fluctuation Direct Space Vector Pulse Width Modulation (DSVPWM) techniques used for unbalanced and distorted voltage supply.Among the exiting DVR topologies with energy storage in ac form, various different types of switching power converters have been employed,being the matrix converter an attractive solution due to its operating advantages.**[5]**.

Michael John Newman et. al. suggest that it would be advantageous if the series connected inverter of a DVR could also be used to compensate for any steady state load voltage harmonics, since this would increase the power quality value added benefit to the grid system in order to add voltage harmonics compensation scheme has a net real power flow of zero to minimize the net real power flow, narrow bend resonant based controllers are used to compensate for each selected har-

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monics with no proportional term. Resonant controllers are used instead of synchronous frame d-q integral control at each frequency **[6]**.

Amr Elnady et. al. introduce the robust control technique to add more functionality to the DVR. They develop the adaptive perceptron based control algorithm in order to discriminate and mitigate a power quality problem. According to that sampled signal is transferred to the classifier. As a rule based classification module to recognize disturbances like harmonics unbalanced and balanced voltage sags and swells. And DVR takes the action according to the disturbance occurs in the system. In conventional algorithm used for DVR used for DVR the response of the voltage injection algorithm in response to well defined sag return to 1 pu network voltage but in many practical cases a return to 1 pu is not necessary **[7]**.

Ahmed Hossam-Eldin et. al. represent there are many devices which may be used to compensate the voltage sag such as tap changer, Uninterrupted Power Supply (UPS), Static var Compensator (STATCOM), dynamic voltage restorer (DVR). He has make the comparison between those devices and conclude that UPS cannot be used because it carries the entire load without any contribution from the grid. Due to the bulky construction of tap changer it is rarely used, STATCOM is installed to support those have poor power factor and often poor regulation. The DVR is most economical device for voltage sag mitigation in distribution system **[8]**.

D. MhindaVilathgamuwa et. al. proposed a new concept of the DVR where two or more DVRs in different feeders connected to the common DC link. One of the DVR compensates for voltage sag and the other replenish the DC link energy storage. The limiting factor of the proposed system is that the amount of real power transfer that one line can transfer to the dc link energy storage is depends on load power factor. The control strategy is one of the important parts of the DVR operation. The injected voltage of the DVR depends on the accuracy and dynamic behavior of the pulse width modulated(PWM) voltage synthesis scheme and control system adopted [**9**].

Kasuni Perera et. al. suggest a control strategy for single phase voltage sag based on in- phase compensation technique in which DVR initially tracks the phase angle of the supply voltage and produce reference voltage signal with the rated voltage magnitude. If any phase jump occurred at the supply voltage, phase angle of the reference voltage signal is adjusted slowly to track the phase difference between the reference and measured voltage injected by the DVR. Therefore with this technique the load will no experience any phase jump or dip **[10]**.

Tariq Masood et. al. principal objective of this paper is to investigate the behavior of STATCOM against SVC controller by setting up new control parameters. Essentially, STATCOM, and SVC linear operating ranges of the V-I and V-Q as well as their functional compensation capabilities have been addressed to meet operational requirement with certain degree of sustainability and reliability. Hereby, the other operating parameters likewise transient stability, response time, capability to exchange real Power and Power Losses have also been addressed in STATCOM against SVC control models. In addition to that, STATCOM-Controller's pragmatic response has been identified and determined reliability level to maintain full capacitive output current at low system voltage.**[11]**.

Mahmoud A. El-Gammal1 et. al. represent the Dynamic Voltage Restorer (DVR) is fast, flexible and efficient solution to voltage sag problem. The DVR is a power electronic based device that provides three-phase controllable voltage source, whose voltage vector (magnitude and angle) adds to the source voltage during sag event, to restore the load voltage to pre-sag conditions. The DVR is designed for protecting the whole plant with loads in the range of some MVA. The DVR can restore the load voltage within few milliseconds. Several configurations and control methods are proposed for the DVR. In this paper, an overview of the DVR, its functions, configurations, components, compensating strategies and control methods are reviewed along with the device capabilities and limitations **[12]**.

Dong-Jun Won et. al. presents a new definition of voltage sag duration which takes into consideration of the voltage tolerance characteristics of individual electrical equipment. The magnitude and the duration of voltage sag are important parameters which characterize the voltage sag event. The conventional voltage sag characterizing method can over estimate the voltage sag in case of non-rectangular sag. Furthermore it does not take the voltage tolerance characteristics of each equipment into account. Therefore the proposed method in this paper utilizes the minimum voltage(**Vmin**) of voltage tolerance curve of each equipment.**[13].**

John Godsk Nielsen et. al. represent the DVR is a series connected device, which primarily can protect sensitive electric consumers against voltage dips and surges in the medium and low voltage distribution grid. The thesis first gives an introduction to relevant power quality issues for a DVR and power electronic controllers for voltage dip mitigation. Thereafter the operation and the elements in a DVR are described. The advantages and disadvantages are treated by inserting the DVR in either the medium voltage distribution system or in the low voltage distribution system. Different topologies for a DVR are investigated on a converter and system level and the protection issues are treated. The design of a DVR is treated and two prototype DVRs are designed and specified. The first DVR is a low voltage DVR (LV-DVR) rated for 10 KVA for insertion in a 400 V low voltage grid and the second DVR is a high voltage DVR (HV-DVR) rated for 200 KVA for insertion in a 10 KV medium voltage distribution system.**[14]**.

Mehmet Tumay,Ahmet Teke,et.al. represents modeling and analysis of a Dynamic Voltage Restorer (DVR) with sinusoidal pulse width modulation (SPWM) based controller by using the Matlab/ Simulink. The proposed control scheme is simple to design and allows flexibility in cost or robustness constraints. In addition, the performance of the designed DVR is examined under different sag conditions. DVR has become a cost effective solution to voltage for the protection of sensitive loads from voltage sags. The DVR is fast, flexible and efficient solution to voltage sag problems.DVR consists of energy storage unit, PWM inverter,filter and infection transformer. DVR is categorized into threeoperation mode: protection mode, standby mode and injection mode. **[15].**

Bingsen Wang, Giri Venkataramanan,et.al. represents the DVR as a means of series compensation for mitigation of voltage sags for improving power quality at sensitive load conditions. The detailed design of a closed regulator to maintain load voltage within acceptable levels in a DVR using transformer coupled H-bridge converters.DVRs deals with a voltage source converter realized using two level converters,which are well suited for 480V systems. While in high power applications such as at distribution voltage levels, a multilevel converter is a more attractive solution,whose application in a DVR has not been well addressed **[16].**

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CONCLUSION:-

This paper has presented the main objectives for the utilization of the studied equipment to mitigate the voltage sag and voltage swell. In order to protect critical loads from more sever fault in distribution network the series connected voltage source converter known as Dynamic Voltage Restorer is more suitable and satisfactory. It is reliable, cost effective solution for compensation of voltage in comparison with other power electronic and FACTS devices.

The facility available in MATLAB/SIMULINK was used to carry out extensive simulation study. PI controller is used to get the compensating signal for Sinusoidal Pulse Width Modulation Technique. The simulation results show the performance of DVR under fault condition that causes voltage sag and voltage swell.

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