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Improvement of Power Quality using DVR by Different Control Techniques

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***Abstract**: Power quality has been an issue in electrical power systems. Disturbances occur in power quality which effects machines, some electric devices and severe cause will get very serious damages. For normal and efficient operation it's necessary to compensate and acknowledge every type of the disturbances at earlier time of the power system. Many sorts of Custom Power Devices (CPD's) are used to resolve these issues .Here at present, one in every of those devices, Dynamic Voltage restorer (DVR) is conferred. In power distribution systems this is often best and effective device employed. During this project new structure and control methodology of multifunctional DVRs for voltage quality correction are mentioned. Proportional Integral Controller and Fuzzy Logic Controller are used for the PQ improvement. The performance of the device and Total Harmonic Distortion is compared with each other. The performance of the device like voltage swell, sag is projected.*

***Keywords**: Power Quality (PQ), Custom Power Devices (CPD's), Dynamic Voltage Restorer (DVR), Proportional Integral Controller, Fuzzy Logic Controller, Voltage sag, Voltage Source Inverter, Voltage swell.*

I. INTRODUCTION

In distribution systems Power Quality (PQ) and Reliability are attracting an increasing interest in modern world and became a section for some modern industrial and also industrial applications. Various starts of refined industrial drives, manufacturing and designing systems exactness electronic equipments are in present time demand high quality of power and reliability offers Distribution networks. PQ issues include a large vary of phenomena. Few methods are distinguished like Voltage dip/swell, flickering, sudden harmonic distortions, few interruptions and impulse transients. Those type of disturbances are answerable for issues starting from errors or any malfunctions which causes for loss for manufacturing capability and sudden shut down happens. Voltage sags/swells will occur a lot of oftentimes than the other PQ development. These sags/swells are the foremost necessary PQ issues within the distribution system.

Voltage dip or voltage sag is outlined by decrease of RMS voltage level within the 10%--90% of it's nominal voltage, durations of ½ cycles to one minute the frequency has done. Here IEC (International Electro-technical Commission) that defines that voltage dip when the sudden fall of the voltage at some extent within system, also by voltage recovers done when a small duration, were from half acycle to the some few seconds. Here Voltage sags typically relates to faults however they'll even generated it by the emerging of significant loads or beginning of huge motors will which might be drawn six to ten times of its total full load current when during the motor starts. Sag durations are divided into 3 classes, instant, normal momentary is coincidence with some utility. It occurs because motors start.

Voltage Swell is outlined RMS Voltage level increase up to 110%-180% of the Nominal voltage, here ability of power Frequency at the durations of ½ cycles to 1 min. it's division for short period of changes in the voltage change phenomena, that is one among the overall classes of Power Quality issues. "momentary overvoltage" term is employed as a equivalent word for swell. Here Swells occurs from the rise of the temporary voltage at the single L-G fault during the healthy phases. These also can be causes by shift off for energizing very large electrical device bank and are characterised its magnitude (RMS value) and length. The voltage swell severity may be operate of fault location, grounding and system electric resistance [1].

The PQ is strictly associated with the economic drawbacks which relates to equipment and may so be evaluation considers according to the customer purpose. The solutions which dedicates the customers with the sensitive loads are a quick response of voltage regulation is needed. It must follows the characteristics of the voltage dips/swells each in industrial and domestic distributions in power systems. Aboard the variation in magnitudes, voltage sags/swells may also be in the middle of a modification in point [2]. This development is thought as point jump before onset and through the events of voltage dip/swell will be calculated for an argument of the complicated voltage). To resolve this drawback, Custom Power Devices (CPD's) used. For one in every of these devices Dynamic Voltage Restoer (DVR), that the best and very effective CPD's utilized in power distribution networks.[3].These consists of lower value, size will be small and its quick dynamic response for the disturbance in system. In distribution and then also transmission systems the application of static power unit have been noticed.

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It could be shown in a series compensation of device, PQ issues majorly occurs faults are like voltage sags(dips), swells,, Unbalance and Distortion of harmonics occurs so because to protect the very sensitive loads we use the Voltage Source Converters (VSC) [4].

II. DVR

The basic principle of Dynamic Voltage Restorer to inject the Voltage.DVR been a static power unit equipment that which has been application in an exceedingly kind of the Transmission and also Distribution systems. Here series in the compensation device,hwhich protects very sensitive electrical Loads from PQ disturbances like voltage dips, voltage swells, Distortion and Unbalance about the power electronic Controllers which uses the Voltage Source Converters (VSC). Here DVR stands at NorthAmerica (1996) - 12.47 kilovolt system that were of situated in Anderson, South Carolina.usually here,the DVR's are which applies to save difficult loads of semiconductor, utilities side and also food process. Now Today, DVR is one amongest foremost effectively done PQ devices resolution voltage dip issues. How ever, installation difficulties and value have to be restricted for its future scope wherever there's demand obvious to constant stable in voltage supply. On other method DVR which compensates the not balance in supply voltage for various kinds phases. Here also, DVR are sometimes install on difficult feeder that gives the active power were via DC Energy storage and therefore without DC storage the needed reactive power which in process [2].

The basic principle of the DVR which injects a needed voltage magnitude and frequency, it restores the voltage at load side in form similar where the waveform and amplitude even one in method of voltage at source which distorts. similarly,the solid state power electronic switches like Gate Turn Off Thyristor exceedingly Pulse Width Modulated (PWM) for the inverter structure. Here DVR can generates and absorbs by severally controllable reactive and real power which is at load side. In some situations DVR forms solid state DC to AC switching power device . serial and synchronicity to Transmission and distribution line voltages DVR injects collection of 3-phase AC output voltages. Schematic representation of DVR as shown in Fig 1 [4].

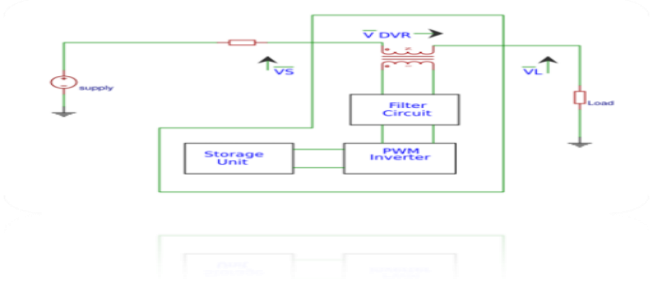

Fig 1: Schematic representation of a DVR

1. Passive/Harmonic filter

Usually, a filter consists of inductor capacitor and inductor. When voltage supply device create any unwanted harmonic components it eliminates.

2. Energy storage systems/Storage devices

The active demand of the load can be fulfilled. Different and systems may be used for this concept like flywheel, Lead Acid Batteries, Super conducting magnetic energy storage systems (SMES).

III. PI CONTROLLER

The input of PI controller known an error signal which obtains through reference in RMS value and Voltage of its terminal voltage which measured. For this error to propose by the PI Controller therefore output that angle that which to provides PWM signal generator. This has generates IGBT gates pulses of voltage source converter (VSC).The demerits of PI controller inoccurence to react to the abrupt changes within error signal, the amendment of the increase and fall of error.In various methods, here the protection method of system which opposes voltage collapse that to normal response which at the load side to falls demand at once in the voltage of system falls. Here the property of DVRs would be trending which keeps utility where once the incipient voltagerequirements presents. Here as a solutions, falls the for innate ability for which abunds damaging then which rises the happening of a cascading interruptions. Here for the transmission type we notice, the DVR would be expance voltage changing if for the load which be a constant power kind [5]. Here circuit model of DVR Test system is as shown in Fig 2.

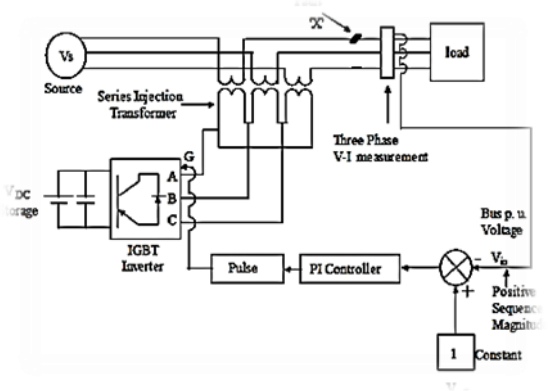

Fig 2: Circuit Model of DVR Test System

IV. FUZZY LOGIC CONTROLLER

In Fuzzy Logic Controller, system which determines the number of linguistic rules as basic control basic control. Since numerical of variables which are converts into the linguistic variables, and system need mathematical modeling. The Fuzzy Logic which has being proposing for controller inverting action. The FLC has 2 real time inputs which named as error and also other variable error rate and the mostly only single output have named activating signal were for every part for measured at each sample point. The input signals for which are done fuzzified and also represents fuzzy value sets the notations as the membership functions in the system [6]. The outlined 'If …. Then ….' rules which produces output (actuating) the signal to control PWM inverter.here these type of signals are Defuzzified for that analog Control signals and also done by comparing carrier signal..Fig 3 shows proposed methodology [7].

Fuzzy method is realises by the method Mamdani. This method been used the both relationship. between its inputs and outputs which obtained. The set of rules for FLC controller are seen in table. Here 25 rules are done in Fuzzy controller [7]. Here The Minimum operator gives output membership function to each and every rule. Table I shows rules of fuzzy controller.

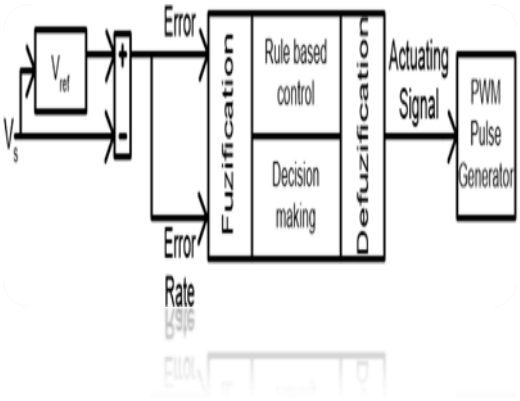

Fig 3: Block diagram of proposed control system

Table I. Fuzzy Rules

The set of rules for FLC controller are shown in Table 1.

Error/error rate	NB	NM	Z	PM	PB
NB	NB	NB	NB	NM	Z
NM	NB	NB	NM	Z	PM
Z	NB	NM	Z	PM	PB
PM	NM	Z	PM	PB	PB
PB	Z	PM	PB	PB	PB

V. SIMULATION REULTS

4.1. Results for linear load:

a) Without compensation

For linear loads here without compensation the output load SLG as shown in Fig 4.1.1

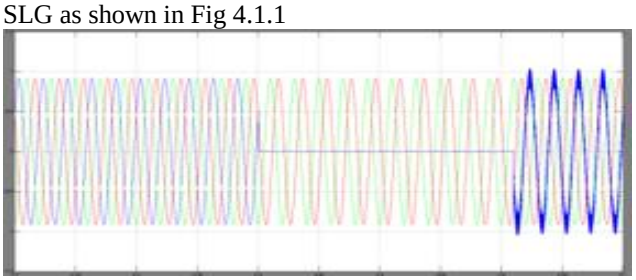

Fig 4.1.1 Output load voltage of SLG

b) Using PI Controller:

For linear loads here with compensation for PI controller the output load SLG as shown in Fig 4.1.2

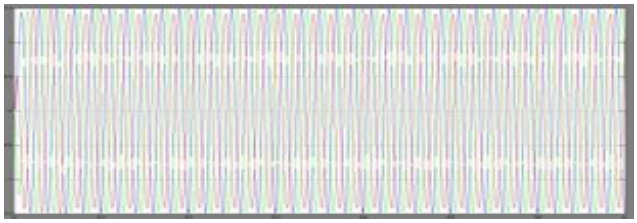

Fig 4.1.2 Output load voltage of SLG

c) Using Fuzzy Logic Controller:

For linear loads here with compensation for Fuzzy Logic Controller the output load SLG as shown in Figure 4.1.3

Fig 4.1.3 Output load voltage of SLG

4.2 Results for non linear loads:

a) Without compensation

For non linear loads here without compensation for the output load SLG as shown in Fig 4.2.1

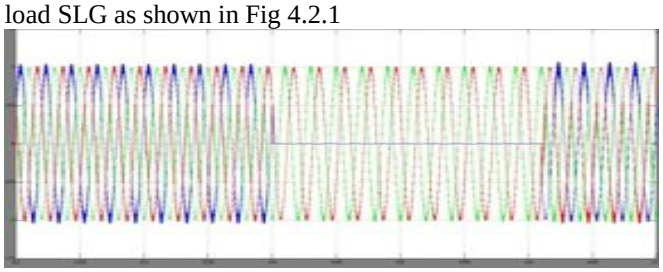

Fig 4.2.1 Output load voltage of SLG

b) Using PI Controller:

For non linear loads here with compensation for PI controller the output load SLG as shown in Fig 4.2.2

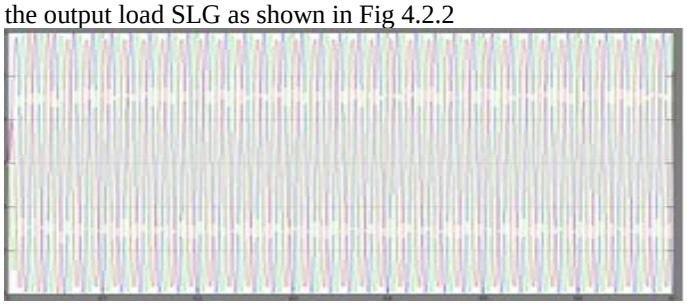

Fig 4.2.2 Output load voltage of SLG

c) Using Fuzzy Logic Controller:

For non linear loads here with compensation for Fuzzy Logic Controller the output load SLG as shown in Fig 4.2.3

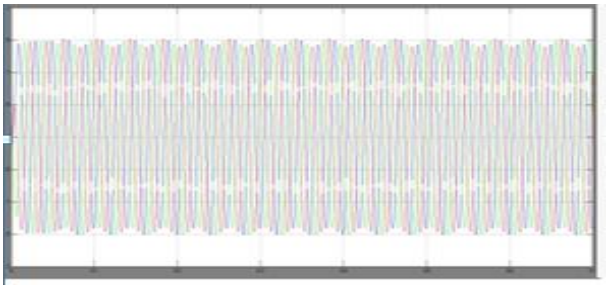

Fig 4.2.3 Output load voltage of SLG

VI. CONCLUSION

DVR is simulated and modeled by MATLAB/SIMULINK. and the performance has been done for Linear loads and Non Linear loads. DVR regulates the voltage under unbalancing of load and condition of load. using two controller's viz. PI controller and Fuzzy logic controller.. THD of two controllers are compared. We can conclude that DVR reduce the harmonics and load voltage gets very effectively and smooth. PI and FUZZY controllers were used to get better result for reducing the harmonics. Hence, among the two controllers a Fuzzy logic controller gives best results. Here the different types of loads for comparison of THD levels with or without dynamic voltage restorer under SLG fault are shown in the Table II.

Table II. Comparison of THD

Variables	Without Compensation	PI controller	Fuzzy logic controller
Linear Load	11.21	5.65	3.95
Nonlinear loads	20.95	7.10	3.46

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