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DISTUBUTION SIDE SAG/SWELL PROBLEMS DIMINUTION BY USING A FUZZY BASED DVR

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ABSTRACT

This paper proposes the concept of problems regarding diminution a variations in voltage and its effect on non-linear loads. One of the series compensation device called as dynamic voltage restorer(DVR) is one of the most fashionable compensating device due to it have improved performance and low cost for compensating voltage quality problems and low cost. The concept of park's transformation technique is control technique for dynamic voltage restorer and also in this paper; we proposed the application of fuzzy logic controller for getting the better total harmonic distortion as compared to previous conventional proportional integral controller. And the results are verified by using the Matlab/Simulink.

KEYWORDS: DVR, fuzzy logic controller, PWM

I.INTRODUCTION:

Generally, the problem of Voltage swell is not a severe problem as like voltage sags because they are less common in distribution systems. To protect the system from all these power quality problems, we need a unique compensating device which can compensate all the power quality problems uniquely. As per the literature survey on the power electronic based converter, the flexible ac transmission system plays a key role. Based on the circuit configurations and control capability this facts devices are classified into four types, i.e. series converter, shunt converter, series-series converter, and series-shunt converter.

In the present scenario the production, distribution and production of electrical power is maintained continuously. For meeting this requirement we are going for concept of grid interfaced system. Due to this grid interfaced system, the electrical power system faces the problems regarding power quality such as variations in voltage and current levels and harmonics. Out of all these power quality problems, the variations in voltage i.e sag and swell conditions are easily occur due to fault, and utilization of sensitive loads. If these problems are maintained continuously then it causes the severe effect on the power system such as failure of the equipment, shunt down of power plant and also creates unbalances in currents. This problems also shows the effect on the distribution system such as consumer loads. The voltage reduction called as sag criteria is generally occurred at any instant of time, with change in amplitude from 10 – 90% of its rated value and a duration is less than a minute. And in other case, the voltage swell is defined as an increase in rms voltage at the power with variations in magnitudes between 1.1 and 1.8 up.

In this paper we are considering a facts based series converter called as dynamic voltage restorer.

II.OPERATION OF DYNAMIC VOLTAGE REGULATOR:

In order to protect the power system components from the general fault conditions such as voltage sags, the dynamic voltage restorer plays a key role as compared with the other compensating techniques. And also the efficiency of for this converter is high and provides reliable operation. The dynamic voltage restorer is a one of the type in series converter of FACTS devices. The main function of this series converter is to inject extra voltage to the transmission system for regulating the voltage across load. The location of dynamic voltage restorer is generally located in distribution side i.e. between distribution feeder and load. The schematic diagram of the dynamic voltage restorer is shown in figure 1. And the basic components used for constructing the dynamic voltage restorer are listed below.

The general configuration of the DVR is mainly consists of the following components such as,

i. an boosting transformer

ii. A filter for reducing harmonic

Iii. The battery energy Storage system

Iv. A Voltage Source Converter

v. DC charging circuit

vi. A control diagram for controlling DVR based on reference voltages and actual load voltages with the help of PWM technique. In this a general fuzzy controller is used for controlling the error value.

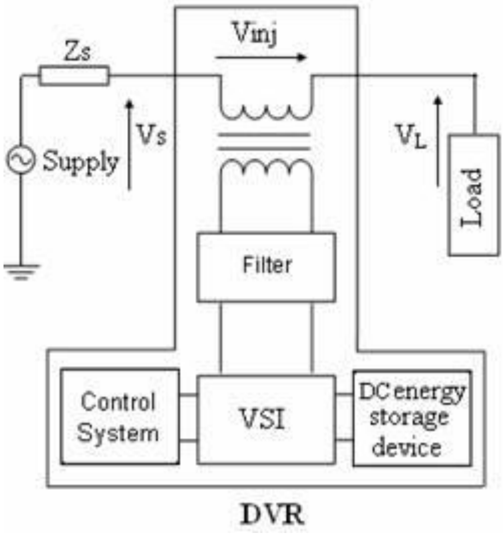

Fig 1: basic structure of dynamic voltage restorer.

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The operation of above circuit the DVR voltage is supplied voltage to line by using boosting transformer that is called V_{inj}. The aim of dynamic voltage restorer is used for compensate the changes in voltage dynamically. The voltage generated by a forced commutated converter is to inject the line through a series transformer called as boosting transformer.

The basic operation of dynamic voltage restorer can be explained in mainly three modes such as: one is protection mode, second one is standby mode, and third one is injection/boosting mode.

1. **Protection mode:** if in any situation the load current is increased more than its permissible value, due to fault condition or short circuit on load side, the dynamic voltage regulator will be isolated from the by the use of bypassing switches S1 and S2.
2. **Standby Mode: (VDVR= 0):** in case of this standby mode the boosting transformer secondary winding is short circuited, with this the DVR is unable to inject any compensating values.
3. **Injection/Boost Mode: (VDVR>0):** In this case of injection mode the transformer called as injection transformer, the DVR have the capability of injecting voltage for compensating the power quality problems.

In-phase compensation method for dynamic voltage restorer:

This In-phase compensation method is the straight forward method. This in phase method provides that the injected voltage is maintained in phase with the supply voltage irrespective of the load current and pre-fault conditions. Generally, the phase angles between the pre-sag and load voltages are different but also it has the capability of maintaining the power quality by compensating the load voltage.

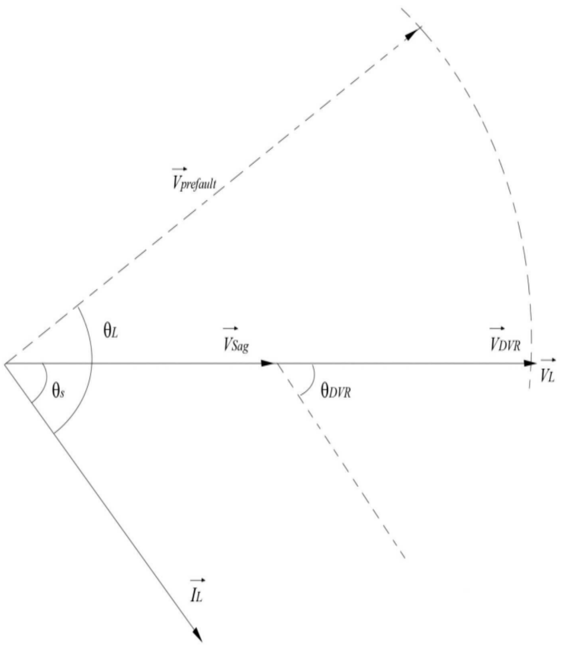

Fig 2: In-phase compensation method

The main function of dynamic voltage restorer is to protect the sensitive load on consumer side and power system components during fault conditions. The location of DVR is identified based on the sensitive loads. If a fault occurs on the transmission line, then the DVR placed in series with the transmission line. If there is any presence of fault in the transmission system, then it causes the changes in load voltage. Due to these changes the load may be affected. So, for compensating this problem the dynamic voltage restorer injects the extra voltage through the power electronic converter which is anti-phase voltage to the voltage during fault. The basic controlling diagram for generating appropriate pulses to three phase converter is as shown in figure 4.

III.CONTROL STRATEGY FOR DVR

Fig. 4 shows the control block diagram technique for controlling the dynamic voltage restorer. In this case the source voltage at place of point of common coupling and load voltage are considered for obtaining gate triggering pulses to converter.

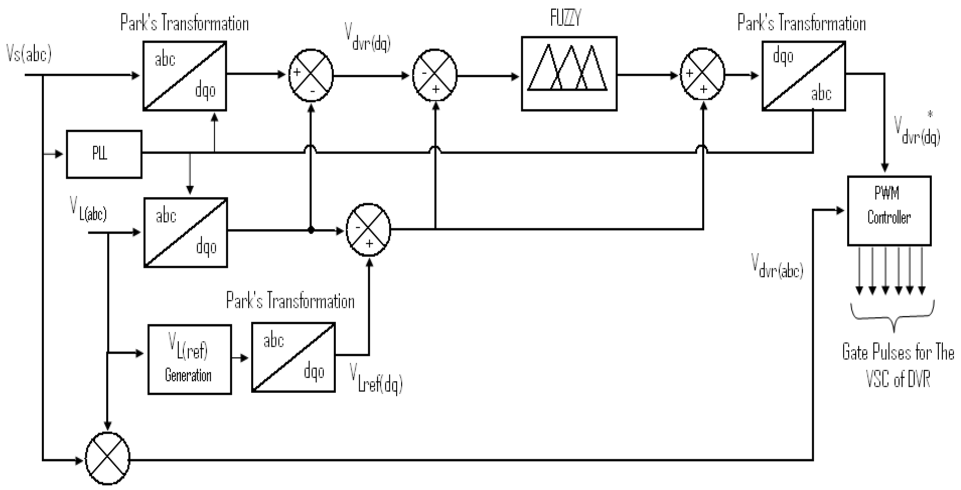

Fig 3: Control Block Diagram for DVR

Basically, the three phase load voltages are transformed to the two phase rotating reference frame using parks transformation technique. And also the source voltage at the point of common coupling is converter to direct and quadrature axis components using parks transformation. These source and load voltages are compared and applied to PI controller. The error obtained is used for generating gate firing signals to the voltage source converter.

Park's transformation:

The park's transformation is helps the three phase voltage that is V_{abc} to two phase voltage that is V_{dq0}. This helps to reduce the calculation part. As show in Fig. 4 control diagram for getting gate pulse for the vsc of dvr by using synchronous reference frame theory used for reference signal estimation.

$$\begin{bmatrix} V_{Lq} \\ V_{Ld} \\ V_{L0} \end{bmatrix} = \frac{2}{3} \begin{bmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ \sin\theta & \sin\left(\theta - \frac{2\pi}{3}\right) & \sin\left(\theta + \frac{2\pi}{3}\right) \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} V_{Laref} \\ V_{Lbref} \\ V_{Lcref} \end{bmatrix}$$

Similarly, reference load voltages (V_{La}^*, V_{Lb}^*, V_{Lc}^*) and voltages at the PCC that is supply voltage are also converted to the rotating reference frame. The equation of supply voltage is below.

$$V_a = \left[V_d * \sin\theta + V_q * \cos\theta + V_0\right]$$

$$V_b = \left[V_d * \sin\left(\theta - \frac{2\pi}{3}\right) + V_q * \cos\left(\theta - \frac{2\pi}{3}\right) + V_0\right]$$

$$V_c = \left[V_d * \sin\left(\theta + \frac{2\pi}{3}\right) + V_q * \cos\left(\theta + \frac{2\pi}{3}\right) + V_0\right]$$

Above three phase supply voltage V_{abc} are converted to two phase supply voltage V_{dq0} by using park's transformation. Converted voltage equation are shown below

$$V_d = \frac{2}{3} * \left[V_a * \sin\theta + V_b * \sin\left(\theta - \frac{2\pi}{3}\right) + V_c * \sin\left(\theta + \frac{2\pi}{3}\right)\right]$$

$$V_q = \frac{2}{3} * \left[V_a * \cos\theta + V_b * \cos\left(\theta - \frac{2\pi}{3}\right) + V_c * \cos\left(\theta + \frac{2\pi}{3}\right)\right]$$

$$V_0 = \frac{1}{3} * \left[V_a + V_b + V_c\right]$$

IV.FUZZY LOGIC CONTROLLER:

In the previous section, we discussed a control strategy based PI controller. But in case of PI controller, it has high settling time and have large steady state error. In order to rectify this problems we go for fuzzy logic controller. Generally, the fuzzy logic controller is one of the most important software based technique in adaptive methods.

As compared with previous controllers, the fuzzy has low settling time low steady state errors. The operation of fuzzy controller has explained in four steps.

1. Fuzzification
2. Membership function
3. Rule-base formation
4. Defuzzification.

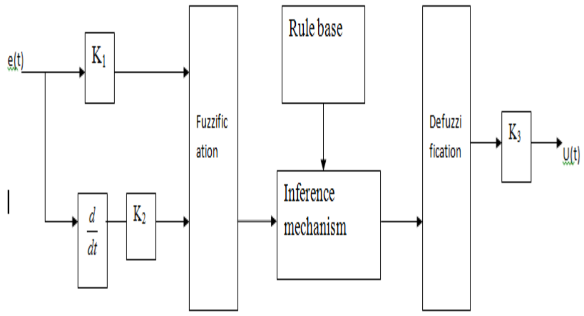

Fig 4: basic structure of fuzzy logic controller

In this paper we considered the membership function as a type in triangular membership function and method for Defuzzification here we considered as centroid. The error which is obtained from the comparison of reference and actual values is given to fuzzy inference engine. In this paper we consider as a single input and single output fuzzy inference system. The number of variables for input and output is assumed as 3. The number of rules we formed as 9.

V.SIMULATION DIAGRAM AND RESULT

The simulation diagram for the DVR is obtained by using figure 1 and it shows in figure 4. The simulation diagram for the dynamic voltage restorer is shown in figure 6. This diagram shows the connection of dynamic voltage restorer to a transmission system and the controlling diagram for series converter. In this case study, we considered as voltage sag condition during the time between 0.2 sec to 0.3 sec and the voltage swell condition is considered between the time 0.4sec to 0.5 sec. it also observed that the DVR is successfully compensated this conditions. The simulation results for the input voltage during voltage sag and swell conditions, compensated load voltage and also we shown the load current and injected DVR voltage as shown in figure 7. In this paper, we also compare the results for both the case of PI and Fuzzy logic controller applications and shown the total harmonic distortions.

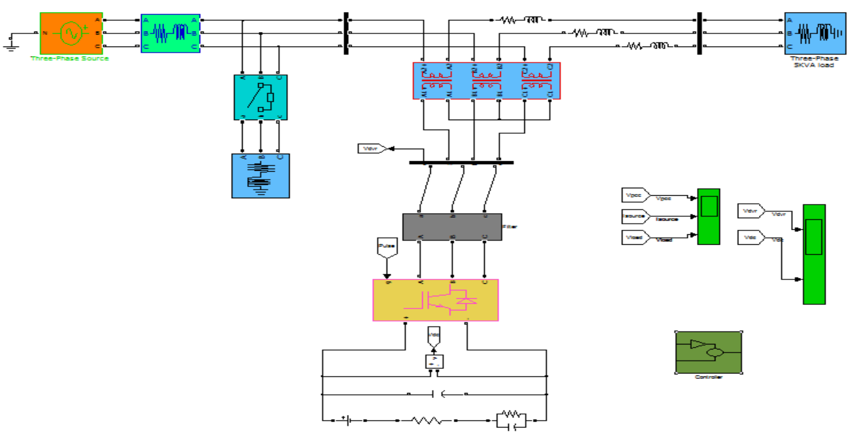

Fig 5: Simulation Diagram for dynamic voltage restorer

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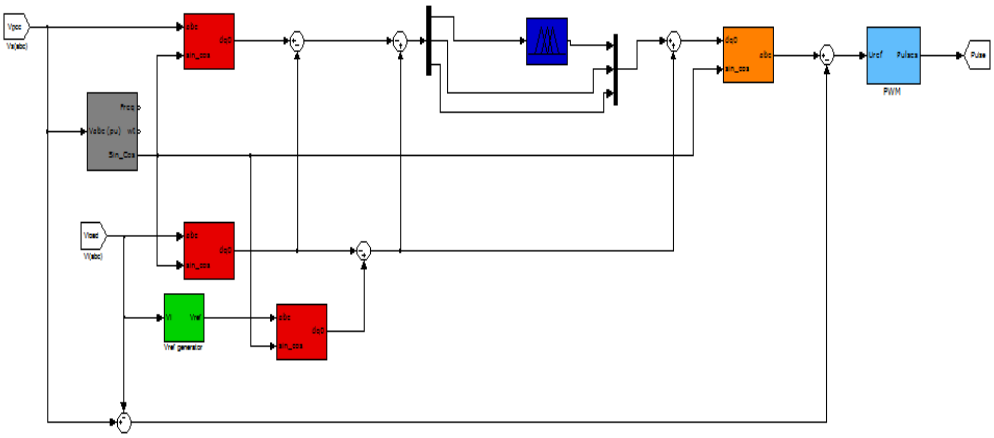
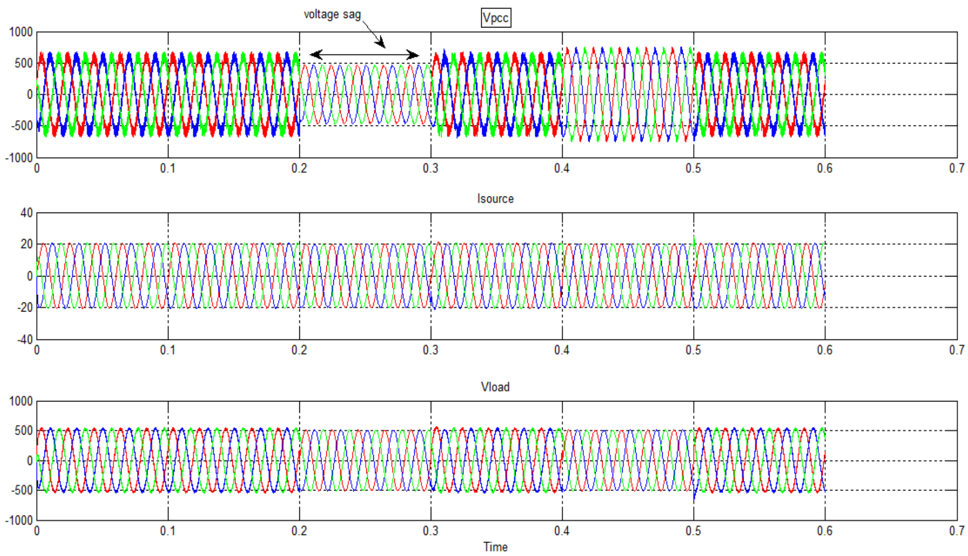


Fig 6: Simulation Diagram for gate pulse for vsc of dvr



. Fig 7: Simulation results for voltage sag and load voltage

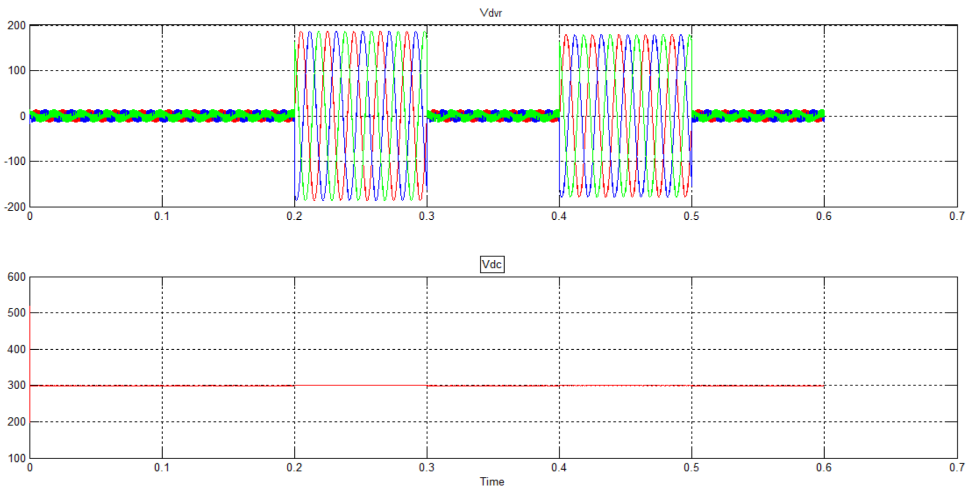


Fig 8: Simulation results for voltage swell and dc voltage

Show in below fig FFT analysis of load voltage that is V_{load}. The total harmonic distortion of the load voltage is 0.58% as shown in Fig. 9 by using fuzzy controller. It is only one signal valve and it tack 10 cycles out of 30 cycles the start time is 0.1.

The below table indicate The total harmonic distortion is comparisons between proportional–integral controller and fuzzy controller as shown in below table

Parameters	proportional–integral controller	fuzzy controller
V_{pcc}	5.21	2.83
I_{source}	1.41	0.42
V_{load}	1.39	0.58

Table 1: THD comparisons of PI and FUZZY

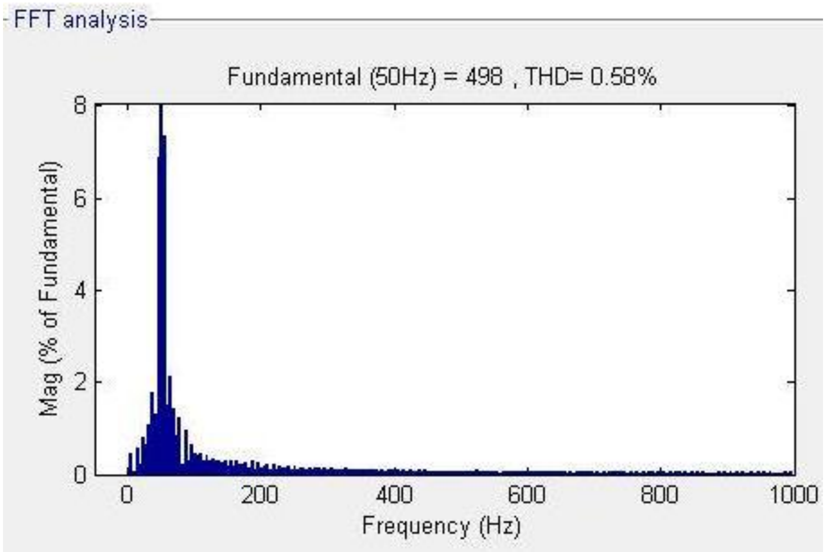


Fig 9: FFT analysis of load voltage

VI.CONCLUSION

This paper proposed a concept of operation of dynamic voltage restorer with the new control strategy along with the in phase compensation technique for counterbalance the power quality problems The proposed a concept of operation of dynamic voltage restorer with the new control strategy along with, in phase compensation technique for compensating the power quality problems. It has been observed from the results that the total harmonic distortion (THD) of load voltage by using proportional integral controller (PI controller) is 1.39% is drastically reduced to 0.58% by applying FUZZY logic controller shows the better performance as compared to proportional integral controller (PI controller)

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