ENHANCEMENT OF QUALITY IN A TRANSMISSION GRID USING UPQC WITH FUZZY AND NEURON FUZZY LOGIC CONTROLLER

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ABSTRACT

Non-linear tons are normally affected by power quality (PQ) problems. Harmonic currents make system resonance, capacitor overloading, and decrease in efficiency. Voltage sags are usually happening power quality difficulties in electrical systems. The unified power quality conditioner (UPQC) is one of the FACTS controllers used for modifying the effect of voltage sags.The series compensator in the UPQC is for quadrature type of voltage inoculation. So that at steady state the series compensator not ever ingests active power. The proposed method introduces a low power rating series compensator that injects the voltage which perfectly recompenses the power quality problem of the system. The addition of fuzzy logic controller with the conservative UPQC decreases the voltage sag levels in the output voltage and also develops the power factor. The control circuit is aimed using fuzzy logic controller and simulated using MATLAB/SIMULINK.

Keywords: Minimum active power injection, unified power quality conditioner (UPQC),power quality (PQ) and voltage sag.

1. INTRODUCTION

In the present generation, PQ has become one of the most significant problems. Due to the use of different types of sensitive electronic equipments, PQ issues have drawn substantial attention from both utilities and users. The main PQ deviations are happened by short-circuits, harmonic distortions, notching, voltage sags, voltage flickers, voltages wells and transients due to switching of load.

The Unified Power Quality Conditioner (UPQC) is one of the FACTS devices used for mitigating the effect of voltage sags [I].Unified Power Quality Conditioner (UPQC) is a device expected to solve almost all power problems that is similar to a Unified Power Flow Conditioner (UPFC). It consists of both series and shunt active power filters which compensate the distortions of both source voltages and load currents. UPQC is used for harmonic elimination and simultaneous compensation of voltage and current, and it improves the power quality offered by the harmonic sensitive loads The UPQC employing this type of quadrature voltage injection in series is termed as UPQC-Q. waveform of current will change. Due to this non-sinusoidal voltage drop occur across the various network foundations connected to the system resulting in partial waveform spread throughout the system.There are different types of PQ disturbances in an electrical power system. A recent research by PQ experts found that 50% of all PQ problems are related to grounding, ground bonds, and impartial to ground voltages, ground loops, ground current or other ground related issues. Some of the power quality issues are voltage sag, voltage swel**l,**

2. POWER QUALITY ISSUES

When we are using a non-linear bulk in a power system, the fundamental sinusoidal waveform of current will change. Due to this non-sinusoidal voltage drop occur across the various network foundations connected to the system resulting in partial waveform spread throughout the system.

There are different types of PQ disturbances in an electrical power system. A recent research by PQ experts found that 50% of all PQ problems are related to grounding, ground bonds, and impartial to ground voltages, ground loops, ground current or other ground related issues. Some of the power quality issues are voltage sag, voltage swell,harmonics, voltage flicker etc.

3. POWER QUALITY IMPROVEMENT

The FACTS devices are power electronic based controllers. FACTS devices are mainly used for regulating the voltage and schedule power flow through the lines. The harmonic currents in the power networks are mainly caused by non-linear loads used in that power networks and decreases the PQ. Thus voltage distortions are caused due to these harmonic currents at the Point of Common Coupling (PCC).This results the malfunctioning of equipments in the system. To eliminate such problems, passive power filters have been used. Passive power filters can cause annoying resonance and amplify harmonic currents.

To daze the drawback of passive power filters, active power filters has been used [5].According to their system configuration, active power filters can be classified as series and parallel active power filters [6]. The combination of series and parallel active power filters are called the Unified Power Quality Compensator (UPQC) [7]. In addition with harmonic elimination, UPQCs are used for compensation of the reactive power, unbalanced load current, source voltage sags, source voltage unbalance, and power factor correction [4]. The UPQC-Q introduces a quadrature injection method which controls voltage sags and offers economical compensation.

This paper proposed a new minimum active power injection method that can overcome the limitations of the conventional UPQC scheme [3]. The proposed method allows the low power rating series compensator that injects the deficient voltage, which allows economical compensation. If voltage sags cannot be fully compensated by reactive power injection because of limitations in the series compensator rating and the phase difference between the input and output voltage, economical compensation is possible by using the proposed minimum active power injection scheme

4. DESIGNING OF UPQC AND TUNING OF FUZZY LOGIC CONTROLLER

The structure of a complete fuzzy control system is composed from the following blocs: Fuzzification, Knowledge base, Inference engine, Defuzzification. The fuzzification module converts the crisp values of the control inputs into fuzzy values. A fuzzy variable has which are defined by linguistic variables (fuzzy sets or subsets) such as low, Medium, high, big, slow where each is defined by a gradually varying membership function. In fuzzy set terminology, all the possible values that a variable can assume are named universe of discourse, and the fuzzy sets (characterized by membership function) cover whole universe of discourse. The shape fuzzy sets can be triangular, trapezoidale, etc To verify the performance of UPQC the system was simulated using Simulink Power System Blockset in Matlab. The aforementioned analysis and design was done in continuous domain. However, to investigate the behaviour of the system with digital based controller in future experimental work, the UPQC system was simulated in discrete domain. All the compensators are implemented using equivalent discrete blocks. Fig.5 Simulink Model of UPQC with Fuzzy Controller The compensator output depends on input and its evolution. The chosen configuration has seven inputs three each for reference load voltage and source current respectively, and one for output of error (PI) controller. The tuning of fuzzy logic controller for outputting fundamental reference currents. The signals thus obtained are compared in a hysteresis band current controller to give switching signals. Fuzzy membership functions between 6 inputs as three phase currents and three phase voltages from input and two outputs as output voltage and current shown in below Fig.6. Fuzzy rules are written between error and change of error for one particular quantity based on that that given voltage or current as its output, like that 49 rules are framed. Similarly for other inputs of fuzzy editor framed out the rules. After better tuning the fuzzy membership functions at particular incidence that fuzzy gives an optimum solution.

5. UNIFIED POWER QUALITY COMPENSATOR

The Unified Power Quality Compensator (UPQC) consists of two Voltage Source Converters (VSC), one is shunt connected to the power system, and another is series connected to the load. The two converters are connected by common DC bus, as shown in Fig.1. [9].During the voltage dip, the controllable voltage, both magnitude and phase angle, is injected by the UPQC to keep the load terminal voltage and the required energy at the DC bus is delivered by the shunt connected VSC, which excerpts the energy from the power system.

As the power drawn by the shunt connected VSC is kept equal to the power delivered to the series connected Scathe energy storage device at the DC bus is not necessary in the UPQC. The power coming from the power system will begreatly reduced during the voltage dip. The shunt connected VSC must be designed to operate correctly with reduced or even unbalanced input voltage.

The block diagram of UPQC is shown in Fig.2. A source gives the AC supply to the rectifier. The input side having one inductive filters. It is used to improve the input power factor. Inverter is used to convert DC voltage to AC voltage. Transformer is used for step down/step up purpose.

It is also used for isolation. Rectifier converts AC supply to DC supply. DC supply having some ripples. It is filtered with the help of capacitor filter. Multi-level inverter generates AC output voltage. The control of output voltage is done using pulse width modulation. economical compensation is possible by using the proposed minimum active power injection scheme.

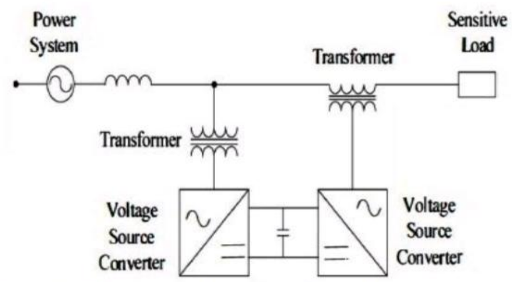

Fig.1. Unified Power Quality Compensator

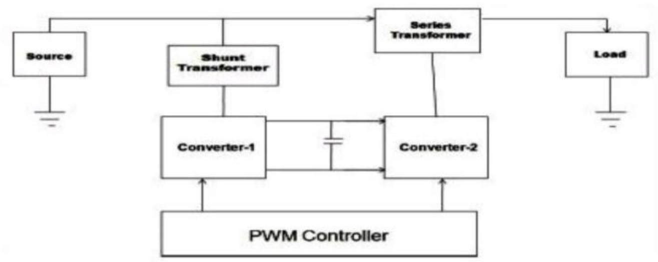

Fig.2. Block diagram of UPQC

6. FUZZY LOGIC CONTROLLER

Fuzzy logic is the portion of artificial intelligence or machine learning which interprets the human act. Computers caninterpret only true or false values but a human being can reason the grade of truthiness or degree of wrongness. Fuzzy models interpret the human actions and are also called intelligent systems. Fuzzification is the process of changing a real scalar value into a fuzzy value. This is achieved with the different types of fusiliers. Fuzzy logic is a rule-based system. These rules are stored in the knowledge base of the system. The input to the fuzzy system is a scalar value that is fuzzified.

7. SIMULATION RESULTS

Simulations of the proposed method have been carried out by using the simulation tool MATLAB/SIMULINK. The simulation is done without and with Fuzzy logic controller.The output wave forms without fuzzy logic controller and with fuzzy logic controller are compared and the results are discussed. The addition of fuzzy logic controller with the conventional UPQC reduces the voltage sag levels in the output voltage.

7.1 Without Fuzzy Logic Controller

The output voltage and output current with interruption is shown in Fig.4. Here the interruption occurs for a period 0.05 sec. After that, due to the power quality disturbances, the output waveforms have been distorted. The circuit diagram of UPQC without fuzzy logic controller is shown in Fig.3.

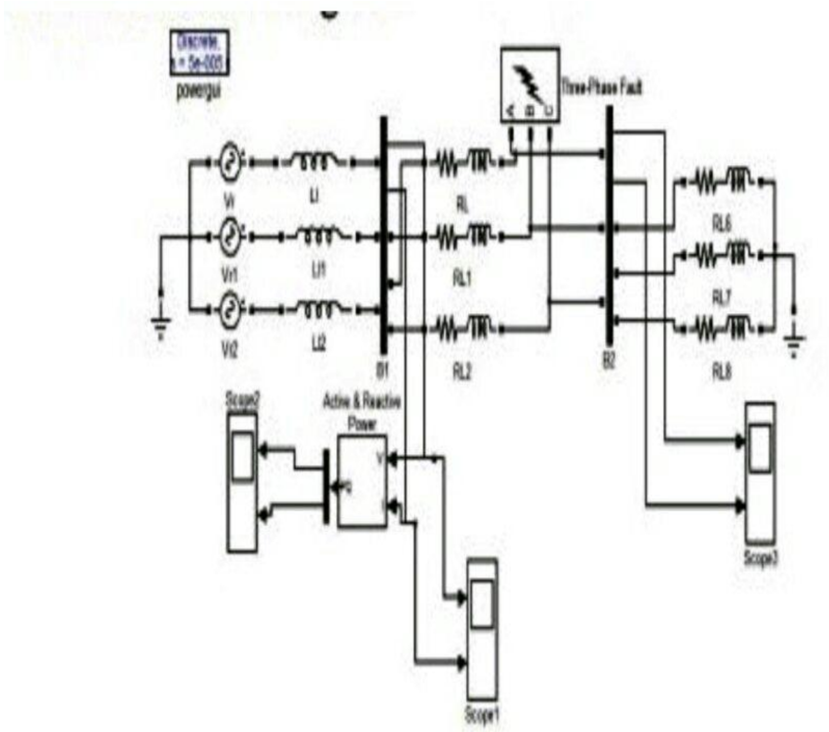

Fig.3. Circuit diagram without fuzzy logic controller

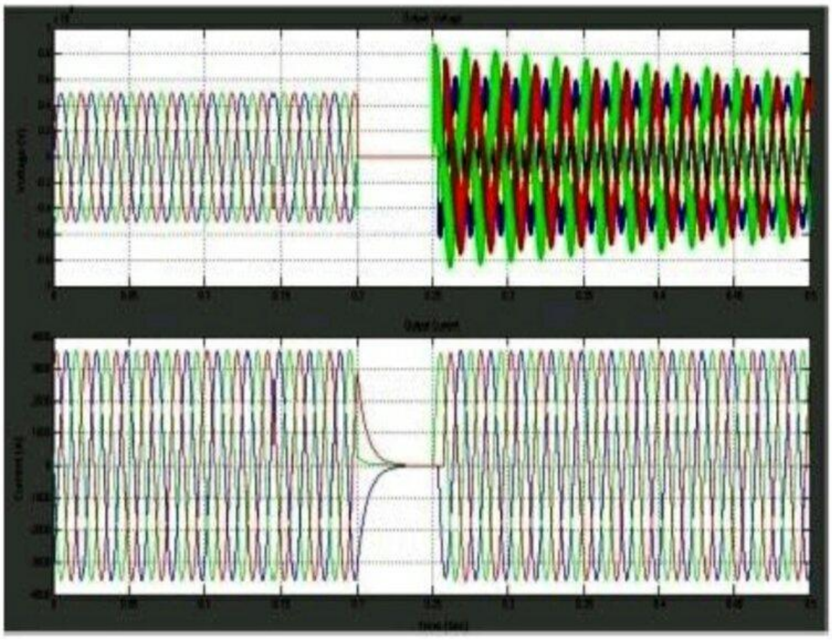

Fig.4. Output voltage and output current with interruption

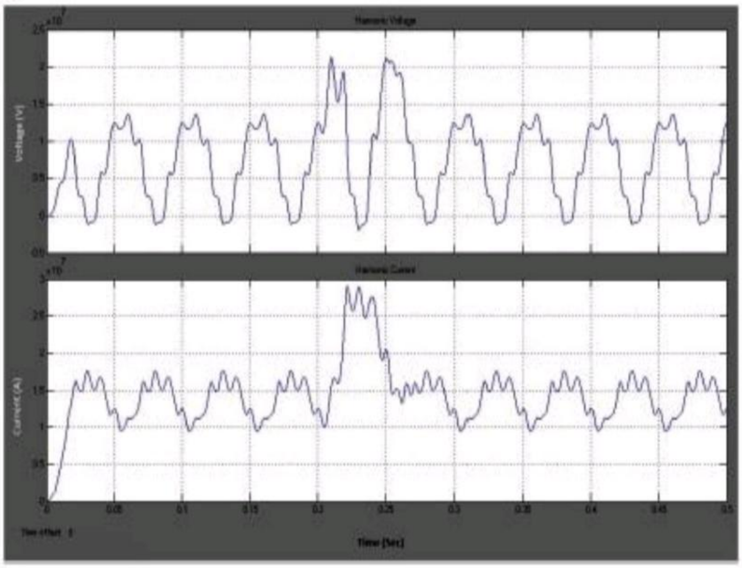

Fig.5. Harmonic waveforms of voltage and current

7.2 With Fuzzy Logic Controller

The circuit diagram of UP QC with the addition of fuzzy logic controller is shown in Fig. 6 and Fig. 7 shows a subsystem for the fuzzy logic controller.

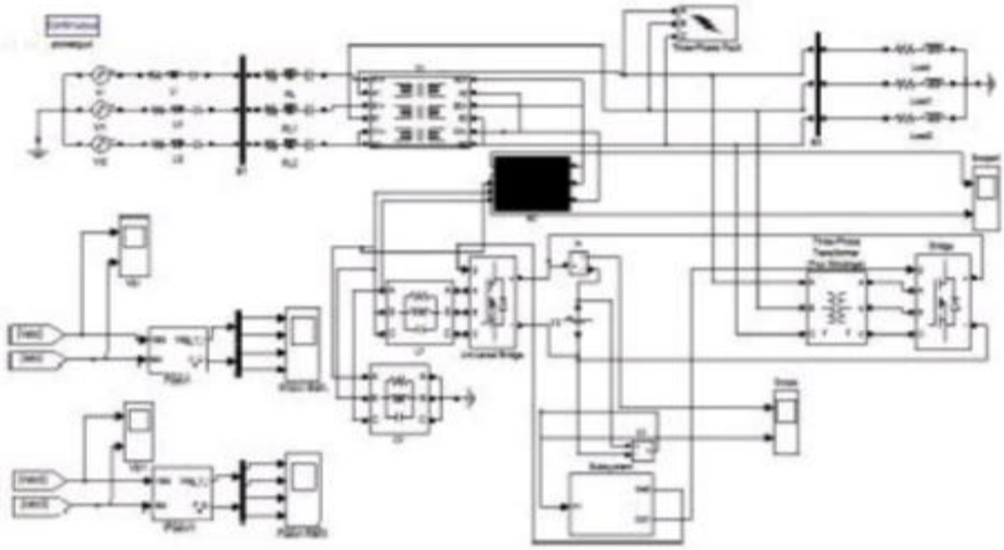

Fig.6. Circuit diagram with fuzzy logic controller

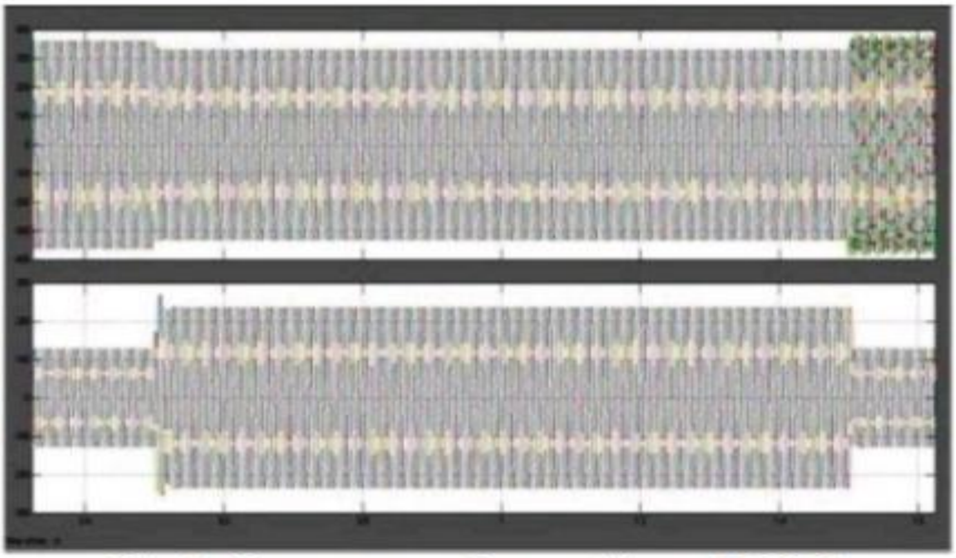

Fig.7. Output waveform without UPQC

7.3 Fuzzy Logic Controller/Subsystem

Fig. 6 Circuit diagram with fuzzy logic controller/subsystem. The output waveform without UPQC is shown in Fig. 7. Here the power quality disturbances occur for a period of 1sec. before the implementation of UP QC.When we have introduced UPQC and fuzzy, here the power quality disturbances have been mitigated and the output waveforms obtained is shown in Fig. 7.

8. CONCLUSION

This paper has presented a new control method for UPQC using minimum active power injection technique. The conventional UPQC cannot mitigate the voltage sag effectively. The limitations of the conventional UPQC are rectified by the proposed minimum active power injection method. A new control technique and mathematical models were framed and then simulated by MA TLAB/SIMULINK. The experimental results were presented using fuzzy logic controller to verify the performance of the proposed new control technique.

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