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A Fuzzy Logic based DSTATCOM for Diesel Generation System for Load Compensation

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Abstract

The main objective of this paper is to enhance the power quality for grid interfaced Diesel Generation system under some non-linear load conditions using a DSTATCOM. For obtaining effective compensation characteristics the damping controller such as DSTATCOM is designed based on model control theory. In this paper a Fuzzy based DSTATCOM controller is designed and the results are compared with the conventional controllers. This Diesel Generation system is simulated in Matlab/Simulink for both conventional PI and Fuzzy controllers. The fuzzy controller reduces the damping and improves the total harmonic distortions than the PI controller. From the simulation results we can conclude that the Fuzzy based controller can effectively improve the THD than the PI controller and enhances the power quality.

Keywords: Diesel Generation System, Dstatcom, Fuzzy Controller, Harmonics

1. Introduction

The power quality improvement method such as FACTS controllers are classified into four main categories. DVR is one of the series connected device which is used for injecting the voltage with specified magnitude and phase shift at point of common coupling[1]. Then DSTATCOM is a one of the Shunt-connected device which helps for compensating the harmonic currents.

2. Configuration of DSTATCOM

Figure 1 shows the configuration of Distributed Static Compensator. The main purpose of this DSTATCOM converter control technique[2,3] is used to compensate the deviations in power system for improving power quality. In this paper grid interfaced wind turbine based DSTATCOM control scheme is proposed for improving the reliability of electrical power

In general, in order to maintain voltage regulation, power factor correction, and harmonics compensation and load leveling the DSTATCOM can be utilized[4].

As from the Figure 1, the DSTATCOM is a combination of voltage source converter which is used for controlling and compensating the error signal and the energy storage system is for discharging or delivering the energy required for compensation. And finally the control technique is for controlling the voltage source converter[5]. The control diagram for this DSTATCOM is designed using model control theory as shown in Figure 2.

The control diagram for this DSTATCOM is as shown in Figure 3. In this controller the commands for current are obtained from the line to line current or voltage signals and by the parks transformation technique. In this the PLL block is used for getting the phase shift which is required for this parks transformation technique[6]. The PI controller used in this control diagram is for controlling the dc link capacitor voltage ratings. Finally the gating signals required for this DSTATCOM is obtained by the PWM technique. The reference signal required for this technique is generated by the reference current commands[7,8].

With the help of supply current in-phase (*i*sadr, *i*sbdr and *i*scdr) and quadrature phase components (*i*saqr, *i*sbqr

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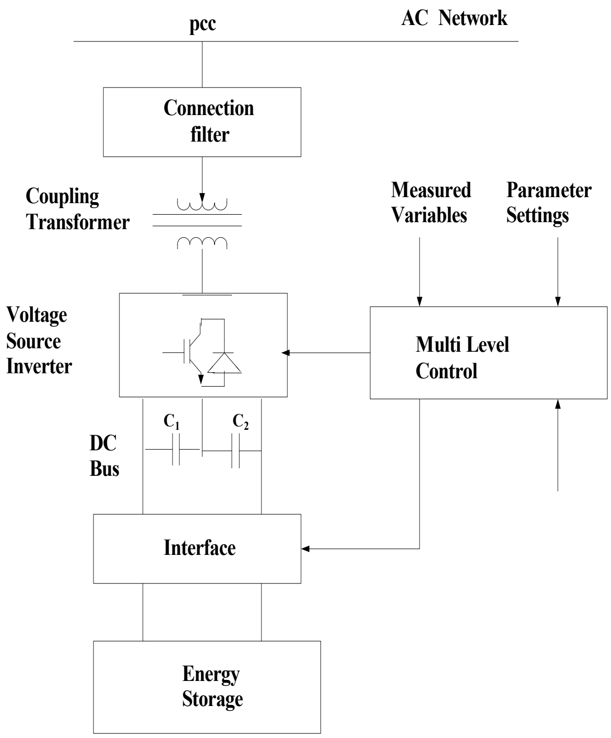

Figure 1. Configuration of DSTATCOM.

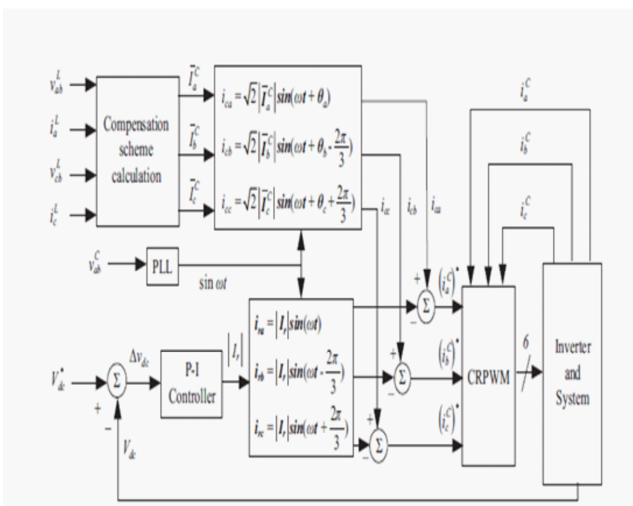

Figure 2. Control Diagram for DSTATCOM Controller.

and *i*scqr), then computed the three-phase instantaneous reference supply currents (*i*sar, *i*sbr and *i*scr).

$$I_{sar} = i_{sadr} + i_{saqr},\ i_{sbr} = i_{sbdr} + i_{sbqr} \qquad i_{scr} = i_{scdr} + i_{scqr}$$

The reference currents generated by the DSTATCOM is helps to provide the triggering pulses with the help of hysteresis controller.

3. Diesel Generator Set using DSTATCOM

For distributing the power to some crucial equipment in remote areas the electrical energy produced by diesel engine-based unit plays an effective role. This type of distribution energy storage systems are loaded with unbalanced loads and non-linear loads. Due to this load variation causes the variations in power system parameters.

Figure 4 shows the schematic diagram for diesel energy system serves the different loads such as linear loads, non-linear loads etc.

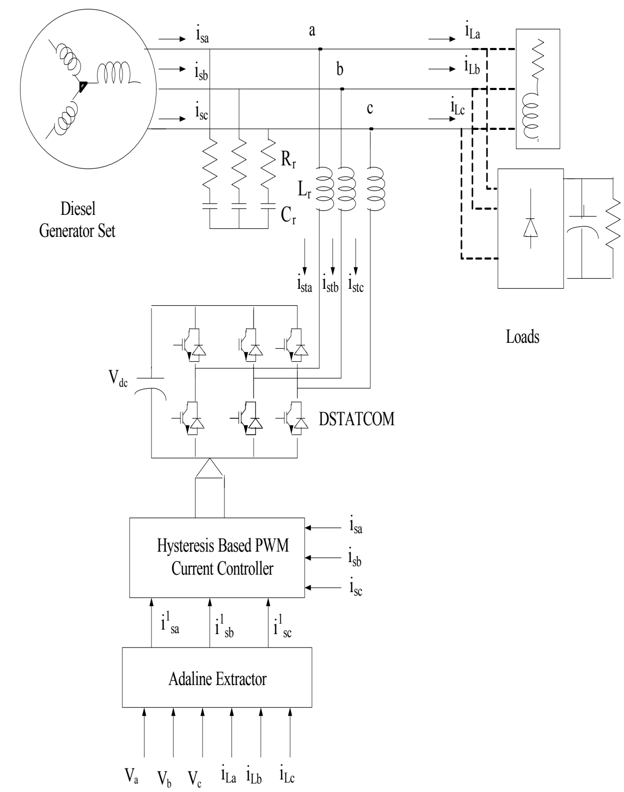

Figure 3. Configuration of diesel energy system based statcom controller.

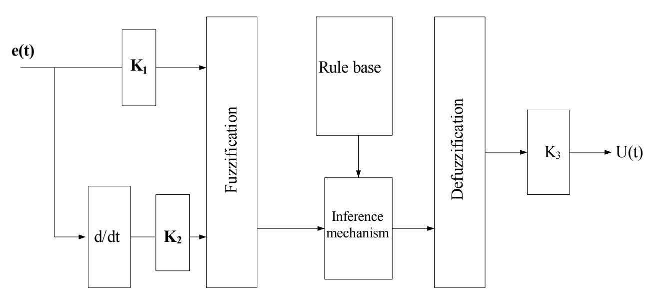

Figure 4. Block diagram of Fuzzy Logic Controller.

4. Fuzzy Logic Controller

Fuzzy controllers are directly using the fuzzy rules[9]. The fuzzy inference engine system is a soft computational system which is used for analyzing the input variables in terms of logical variables i.e 0 and 1. Logic involved in the fuzzy is dealing the concepts that which cannot be expressed as true or false. This fuzzy controller is as shown in Figure 4.

Three stages of Fuzzy controllers are output stage, processing stage, input stage. The input stage senses the input, processing stage generates result for each, and output stage combines the results and shows a final output value[10]. For low cost implementation fuzzy logic is preferred.

5. Simulation Diagram and Waveforms

The experimental setup for the diesel generation system along with statcom controller is shown in Figure 5. Power System Block set and Simulink are used to modeling of the control diagram for main power circuit .Three-phase AC source represents the grid source and connected at the load end. DSTATCOM is a combination of voltage source converter fed capacitive reactor or distributed energy source.

The simulation diagram for the proposed diesel generation system with statcom controller is shown in Figure 5.

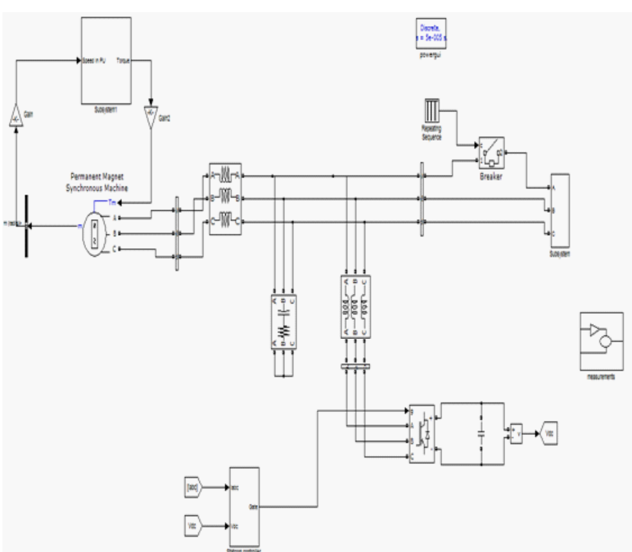

Figure 5. Experimental Setup for proposed system in Matlab/Simulink.

Figure 6 shows the simulation result for output current, source currents, voltages and compensated currents of the proposed system.

The simulation result for RMS value of the line current is shown in Figure 7. And the line voltage RMS voltage is shown in Figure 8.

6. Comparison of % THD Values

TYPE	Vs	I_s	I_L
PI	24.75	24.66	94.37
FUZZY	24.75	24.60	87.69

This table shows the comparison of total harmonic distortions under both conventional PI and Fuzzy based

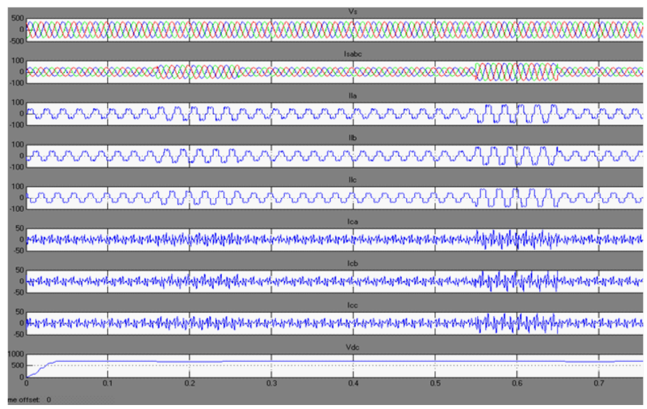

Figure 6. Simulation results Non-Linear R-Load.

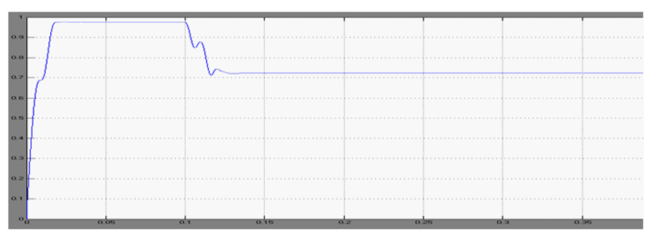

Figure 7. PCC Voltage without DSTATCOM during LG fault.

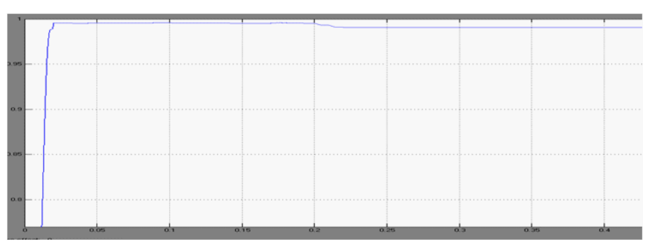

Figure 8. PCC Voltage with DSTATCOM during LG fault.

Diesel Energy Systems. From this table we conclude that the proposed get better compensation with Fuzzy system as compared with the PI controller.

7. Conclusion

This paper proposed Fuzzy logic based static compensator for compensating the power quality problems in the distribution systems. The distribution static compensator is one of the type in most flexible device which is operated under voltage or current controlled modes, the current control mode is used for compensating voltage variations, unbalances and the voltage control modes is for voltage stabilizers. It has the capability for controlling the unbalances and variations in input currents. It is observed that with the help of these compensator the factor of total harmonic distributor is reduced. This paper is extended with the help of fuzzy logic controller. The main of this fuzzy controller is to reduce the settling time and also provides better control action. And also this fuzzy controller provides less total harmonic distortion as compared with the other conventional controllers.

8. References

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