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Harmonics Mitigation Techniques in Renewable Energy Systems using Shunt Active Power Filter

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Abstract*: This paper depicts the methodology of improving power quality at load end is connected with renewable source of energy for power generation. The excessive of power physics devices in distribution system has evolved the matter of power quality. Shunt active power filter (SAPF) acts as a current supply and suppresses the harmonics by introducing the same amount of compensating opposite harmonics component along with common coupling. Simulation design of SAPF based on d-q model is implemented using MATLAB/simulink Toolbox. It explores the modelling of a Proportional Integral (PI) and fuzzy logic controller (FLC) based, SAPF for a 3 wire network to compensate current harmonics fed to a nonlinear load. The proposed model can be validated and its robustness will be checked through the simulation results. Simulation results illustrate that the logic based active filter out performs the PI based shunt active filter.

***Keywords* : Shunt Active Power Filter(SAPF), Renewable Energy System, Total Harmonic Distortion**

I. INTRODUCTION

Renewable energy is energy from sources that square measure naturally replenishing however flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Current power electronics prices would be much higher if the equipment was designed with the same robustness. Increase in such non-linearity cause's completely different undesirable features like low system potency and poor power factor issue. Hence it is important to beat these undesirable features. Traditionally, shunt passive filters, it consist of inductance capacitance filters or high passive filters are used to suppress the harmonics and power capacitors are employed to improve the power factor[1]. Active power filters unit of measurement presently seen as a viable completely different over the classical passive filters, to compensate harmonics and reactive power demand of the non-linear loads. The objective of the active filtering is to resolve these issues by combining with a much-reduced rating of the mandatory passive elements. An instantaneous reactive power unit compensator and harmonic suppressor system is planned while not the utilization of voltage sensors however needs complicated hardware for current reference generator.

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II. SURVEY OF METHODOLOGY

In this paper given attention on shunt active filter for power acquisition which offers reactive power compensation, harmonic compensation, flicker/imbalance compensation and voltage regulation. This paper deals with different power quality issues and from that harmonics is one of the important issues that affect on equipment connected in our system [2]. Due to leap downside of passive filter, active filter used for harmonic reduction. With the help of this techniques reference current area unit generated and that fe1d to PCC and so scale back the harmonic current in order that supply current to be pure sinusoidal. It means harmonics are reduced using shunt active power filter [3].

A power semiconductor device which was connected with power system components generate the reactive power and which was origin for the harmonics and it will create the distortion in output current and voltage waveform along with capacitor resonance failure problem, power factor problems etc. The detailed survey and investigation of Shunt active filter in this paper has done for harmonic suppression by using MATLAB/SIMULATION model with linear and non linear loads. Here in this paper, the propose model employed the simulation design aspects of shunt active power filter and its various control techniques such as hysteresis and PWM current control techniques for the enhancement of good power quality. With the help of d-q model the source harmonics has been balanced to a wider extend. Here the proposed APF is implemented using d-q model and hysteresis current control technique is adopted [4]. The output current waveform shown in simulation in this work is purely a sinusoidal by suppressing the current harmonics with SAPF.

In the load side of power system, the power quality has been enhanced by means of active power filters. The part comprised two sections. One is the simulation design while it tend to employ the hysteresis current control technique to measure the fundamental third harmonic at the load side. The other method is by using a power semiconductor device the PWM gate signal circuit to suppress the third harmonics at the load side [5]. The quality of power has been improved in ag greater extend with the simulation especially by mitigating the third harmonics at the load side.

Because the third harmonic is the vital concern as it, because it will increase the impact of harmonics drastically. Also the quality of power has been improved by means of hysteresis current control technique. The suppression within the deformation increase the potency of the system and performance of the parts [6].

III. IMPLEMENTATION OF SAPF ON RENEWABLE ENERGY SYSTEM

MATLAB (matrix laboratory) may be numerical computing and fourth-generation programming language. Developed by science Works, MATLAB permit matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing Simulink is wide employed in management control theory and digital signal process for multi domain simulation and Model-Based style. With Simulink, we will move on the far side idealized linear models to explore a lot realistic nonlinear models, factorization in fraction, air resistance ,gear slippage solid stops, and therefore alternative things that describe real world phenomena. A filter is known as passive filter is collectively with the elements of inductors and capacitors and resistors in actual practice which will not require any operational amplifier. While comparing to other explanatory devices, passive filters are economical one. Its arrangement will be either in the series or parallel manner.

The implementation of the passive filter arrangement is only depends upon the harmonic source type incorporated with the system. Initially, at its fundamental frequency, it will generate the harmonic current to resonate. The LC Circuits which need filtering are adjusted to the harmonic orders by attenuated by this resonant technique. The rigorous harmonic currents are prevented by means of passing upstream to the source of power which will lead to the maximized widespread problem. The implementation of an active filter is only when orders of harmonic currents are changeable. In case of variable speed drive system the demand of varying harmonics from the power system are the apparent. Its arrangement will be either in the series or parallel manner. The arrangement of active filter will be provided only depends on the category of harmonic power source available in the power system and its consequences will be variety of filter solutions which will lead to the robust overall system enhancement.

Implementation of Passive Filter

The Simulink model of the passive filter is illustrated in the figure 3. In this the capacitance and inductance are connected as the passive filter. The harmonics which is induced due to the connection of non-linear load is reduced by means of the filter. The voltage and the current characteristics are obtained as the output.

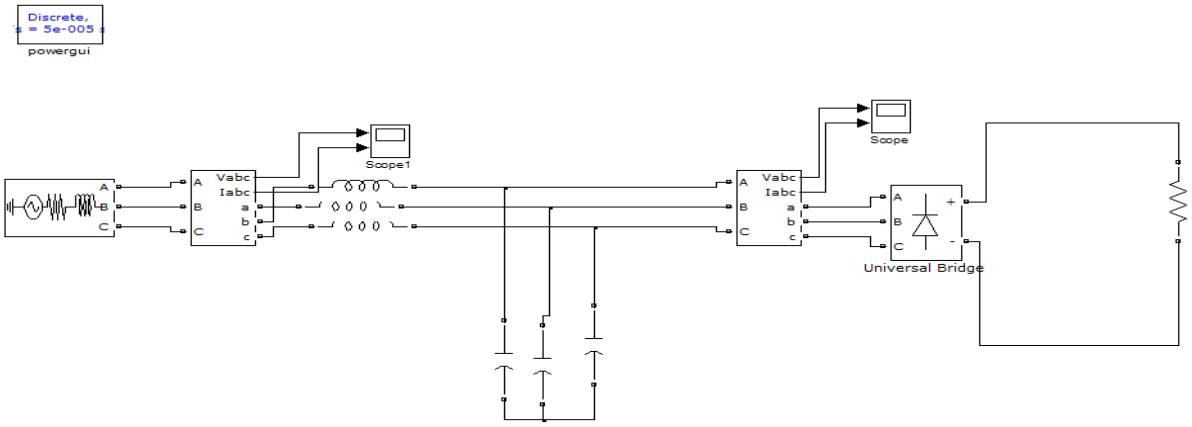

Fig.1 Simulink Model of Passive Filter

A. Implementation of Active Filter

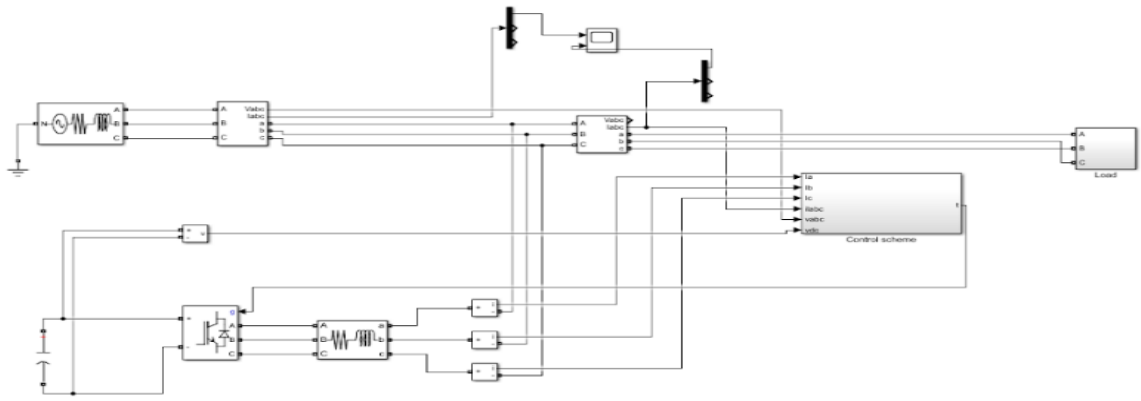

Fig.2 Simulink Model of Active Filter

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The Simulink model for the active filter is illustrated in the figure 2. The harmonics which is induced due to the connection of non- linear load is reduced by means of control scheme. The voltage and current characteristics are obtained as output. The resistance and capacitance values of the filter used in this active model can be calculated by the empirical relationship between the filter circuits. The characteristics of both active and passive filters are comparatively indicate the robustness of the proposed active filter.

B. Implementation of Shunt Active Power Filter (SAPF)

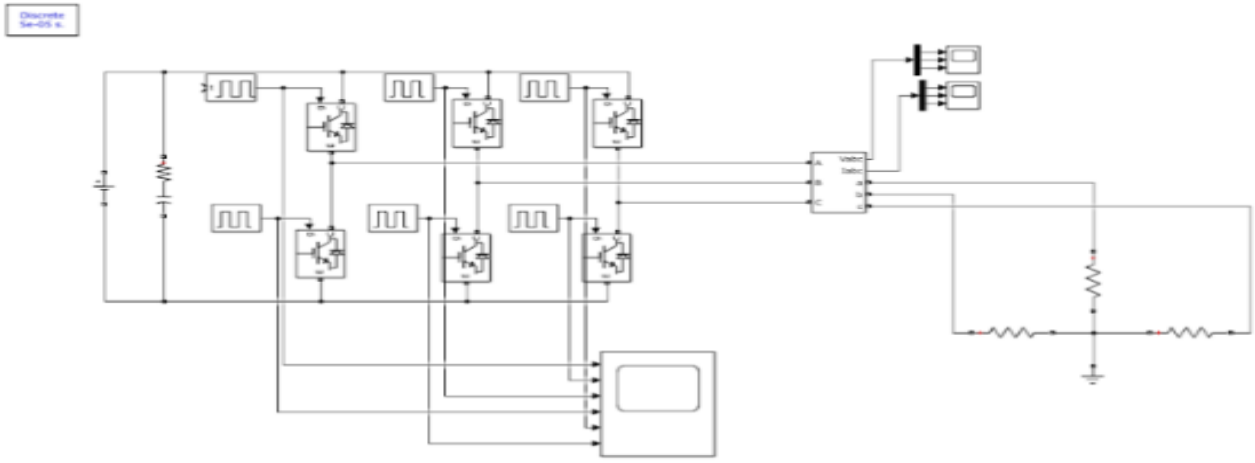

Fig.2 Simulink Model of Shunt Active Power Filter

IV. RESULTS AND DISCUSSIONS

This chapter can investigate the results of the planned model. Simulation results are the most important part as it helps to validate the model of a Project. From the results the effectiveness of the proposed method The figure 4 shows the representation of output voltage and output current of the passive filter. When it is subjected to non-linear load it produces harmonics which can be minimized by means of passive filter which is shown

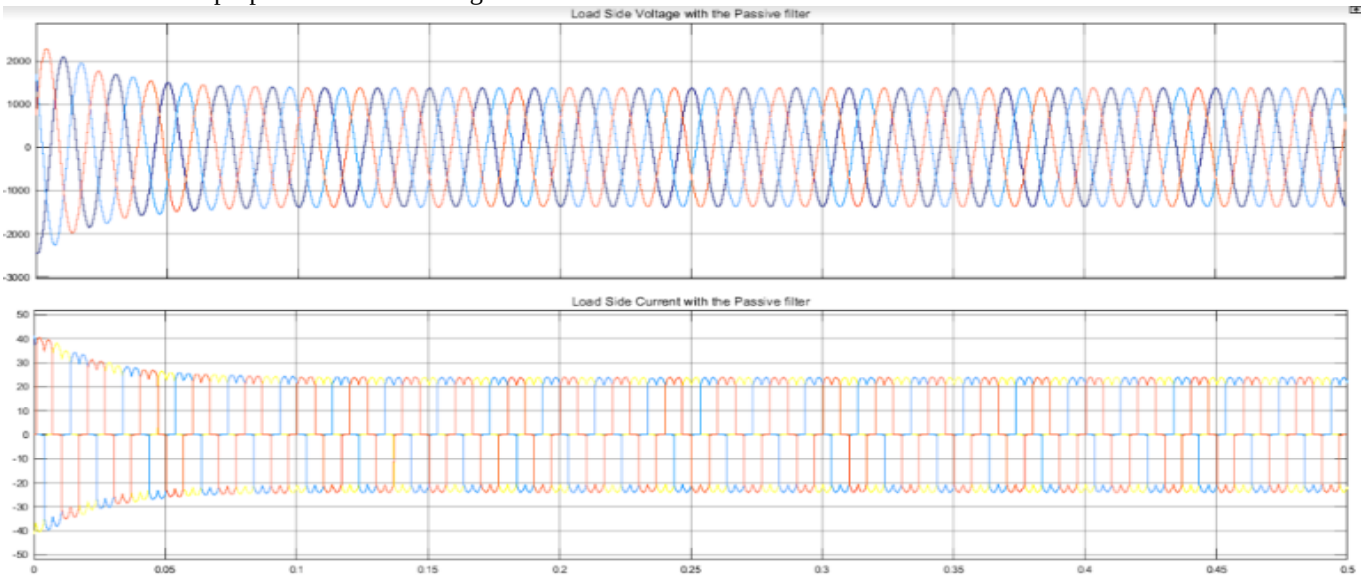

Fig.3 Output characteristics of Passive Filter

The figure 5 shows the represents the output voltage and output current of the Active power filter. When it is subjected to non-linear load it produces harmonics which can be minimized by means of active filter.

The graph shown in figure 6 explains the output voltage and the output current of the voltage source converter respectively.

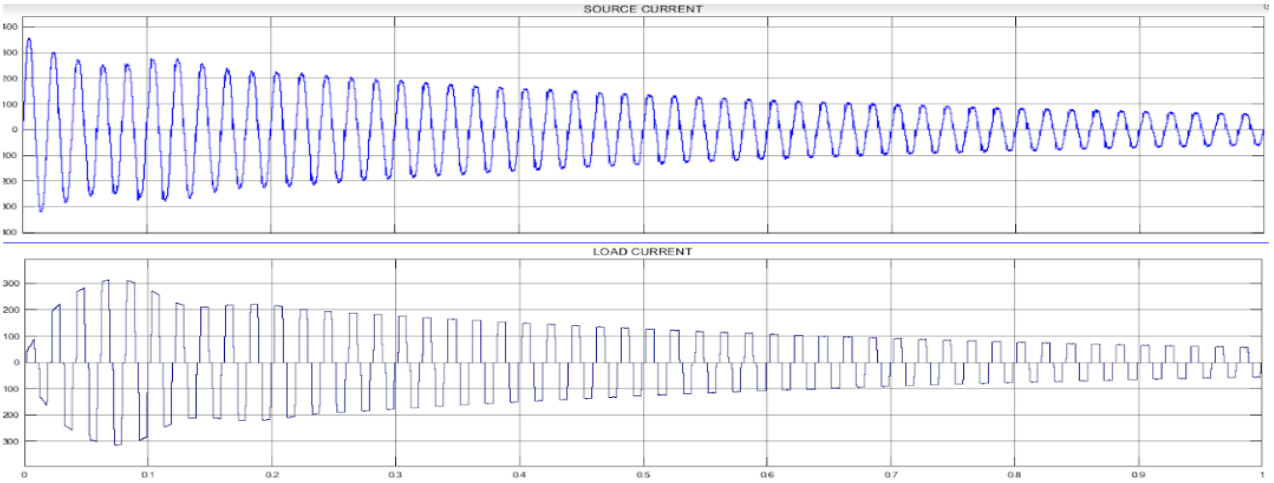

Fig.5 Output characteristics of Active Filter

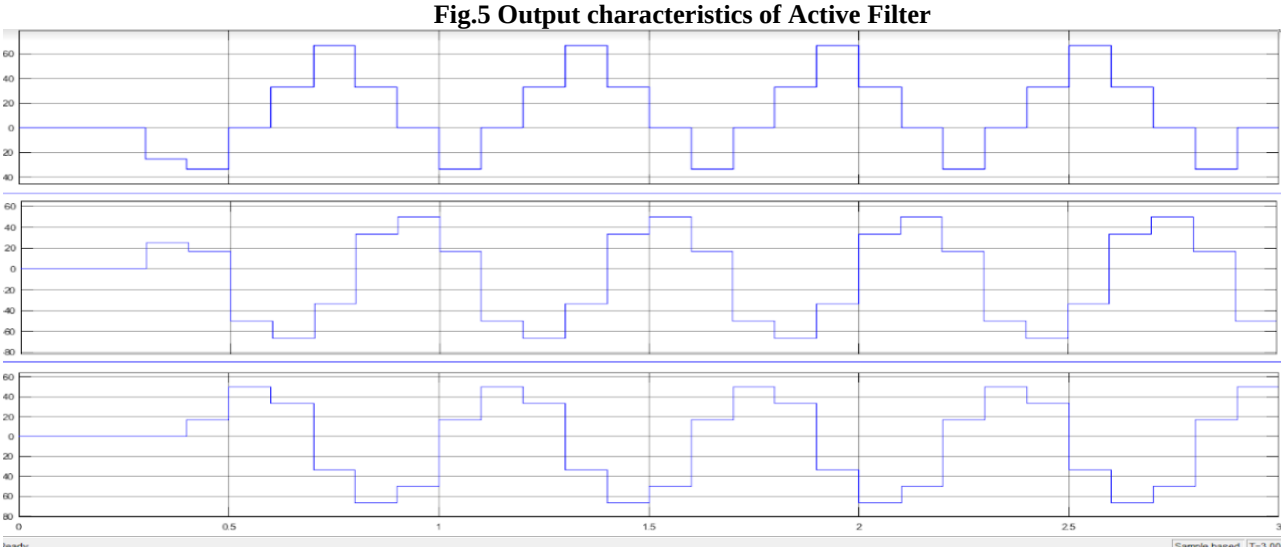

Fig.5 Output characteristics of Shunt Active Power Filter

V. CONCLUSION

The concept of implementation of the reduction of harmonics using shunt active filter has been proposed and validated through MATLAB/Simulink simulations. The Perfect Harmonic Cancellation method is used as the control scheme in order to provide the compensating current for the cancellation of harmonics produced due to the non -linear load.

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