International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 8, August-2018

Comparative Analysis of Power Quality improvement with PQ Theory & DC Link Control Scheme of Non-Linear Load by using Shunt Active Power Filter

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Abstract— This paper highlights the harmonics problems which is created by non-linear load and retrieval technique for controlling the current hysteresis controller is used. The harmonic problem causes the effects of equipment damage and Electromagnetic Interference effects in the power system. The expanded hardness of harmonic pollution in power system has attracted the concentration of system engineers to develop a powerful solution to the power quality problems. These equipments known as active filter (AF's), are also called active power line conditioners (APLC's). To reduce this problem Shunt Active power filter (SAPF) has more suitable because of its excellent performance of harmonic mitigation, In this paper Different control methods of Active power filter in addition to different harmonic extraction methods are presented and discussed, The simulation result of shunt active filter using PQ theory and DC Link Scheme is carried out using MATLAB/SIMULINK toolbox

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Keywords— APF, APLC'S, AF, PQ theory, SAPF, MATLAB

I. INTRODUCTION

Along with the development of power electronic technology, the application of power electronic equipment in power system is zooming up, thus creates more serious harmonic pollution to electric system. Solid state control of AC power with the help of thyristor and semiconductors are widely employed to feed controlled electric power to loads, such as static power converters have deteriorated power quality in power transmission and distribution systems. These power converters utilizing switching devices are being increasingly used in domestic as well as in the industrial applications ranging from few watts to Megawatts. Some applications that are increasingly being dominated by power electronics are variable speed motor drives, switched-mode power supplies, efficient control of heating and lighting, efficient interface for photovoltaic, modern domestic appliances, fuel cell and high voltage DC system for efficient transmission of power. The increased hardness of harmonic pollution in power system has attracted the concentration of system engineers to develop a powerful solution to the power quality problems. These equipments known as active filters (AF's) is also called active power conditioners (APLC's).line

In addition to the various advantages offered by these power electronic converters they offer highly non-linear characteristics and suffer from the problems of drawing non-sinusoidal current and reactive power from the AC mains. Current harmonics generated by these non-linear loads are propagated throughout the network include further distortion to the ideal sinusoidal voltage waveform. As a consequence, recently the issue of power quality has become important. Harmonic currents passing through the system impedance causes a voltage drop for each harmonic and results in voltage harmonics appearing at the load bus and leads to other power quality problems. These problems led to implementation of standards and guidelines IEEE-519 for controlling harmonics on the power system along with the recommended limits. Active Power Filters (APFs) are seen as a important option over the passive filters and static var compensators to mitigate harmonics and reactive power of non-linear loads. Active Power Filter can effectively solve the problem of harmonic pollution and compensate the reactive power simultaneously. The objectives of the active filtering are to solve the control algorithms are proposed various power quality problems by combining the advantages of regulated systems with much reduced rating of the necessary passive components.

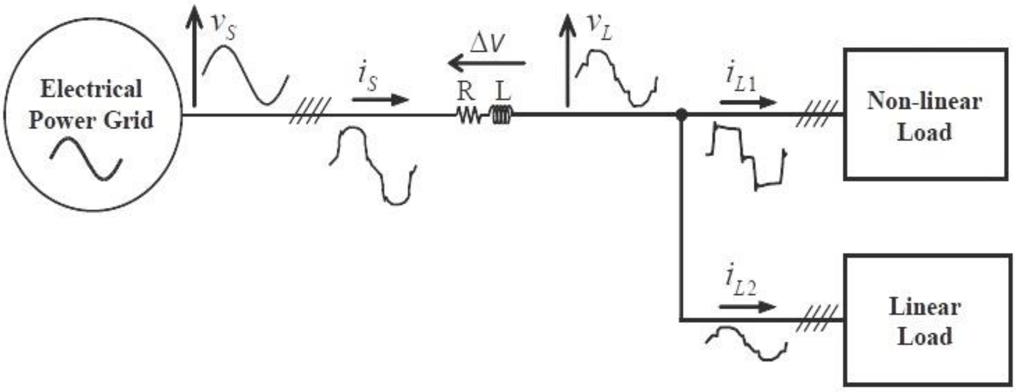

Figure.1.1: Single line block diagram of a system with non-linear loads

Active power filters are used as an alternative over the passive filters for reducing harmonics and reactive power of the non-linear loads of the system. The main purpose of active power filtering is to solve these problems by combining with a much-reduced grading of the necessary passive elements. In this work Shunt active power filters have been proposed as a powerful tool for power quality improvement and reactive power compensation power quality improvement of the power system. The different solutions topologies and control strategies are presented. The use of Shunt Active Power Filter for harmonic current and reactive power compensation is studied. Different control methods of Shunt Active Power Filter are presented and discussed. Shunt Active Power Filter system connected to DC-link capacitor, not only improves the power quality of a system feeding a typical non-linear load but also compensates for the reactive power requirement of the load. The final objective is to analyse and compare the system performance in each case i.e. without filter, with Shunt Active Power Filter alone and with Shunt Active Power Filter including DC link voltage hysteresis current control.

POWER QUALITY

The Power Quality which is defined as “any occurrence manifested in voltage, current, or frequency deviations that results in damage, upset, failure, or mis-operation of end-use equipment”. Almost all Power Quality issues are closely related with Power Electronics in almost every aspect of commercial, domestic and industrial application. Equipment using power electronic devices are residential appliances like Televisions, Personal Computers etc. business and office equipment like photo-copiers, printers etc. industrial equipment like programmable logic controllers (PLCs), adjustable speed drives (ASDs), rectifiers, inverters, CNC tools etc. The Power Quality problem can be detected from one of the following several symptoms depending on the type of issue involved:

- Lamp flicker
- Frequent blackouts
- Sensitive-equipment frequent dropouts
- Locations
- Communications interference
- Overheated elements and equipment.

Power electronics are the most important cause of harmonics. Harmonics are produced by rectifiers, Adjustable Speed Drives, soft starters, electronic ballast for discharge lamps, switched-mode power supplies, and HVAC. Equipment presents different levels of sensitivity to power quality issues, depending on the type of both the equipment and the disturbance. Furthermore, the effect on the power quality of electric power systems due to the presence of power electronics depends on the type of power electronics utilization. The maximum acceptable values of harmonic are specified in IEEE-519 standard in terms of Total Harmonic Distortion.

IMPORTANCE OF POWER QUALITY

- Power quality is basically defined by the parameters that express reactive power, load unbalance and harmonic pollution.
- The best ideal electrical supply would be a sinusoidal voltage waveform with constant magnitude and frequency. But in such conditions due to the presence of non-zero impedance of the supply system the large difference of loads may be encountered and of other phenomena such as outages and transients the reality is frequently different.
- If the power quality of the system is good, then any load connected to it will run adequately and efficiently. Installation during cost will be minimal.
- If the power quality of the system installation will also be reduce. Installation running cost and carbon footprint will be high and operation may not be is bad, then loads connected to it will breakdown or will have a reduced life time and the efficiency of electrical possible at all.

POWER QUALITY PROBLEM EVALUATIONS

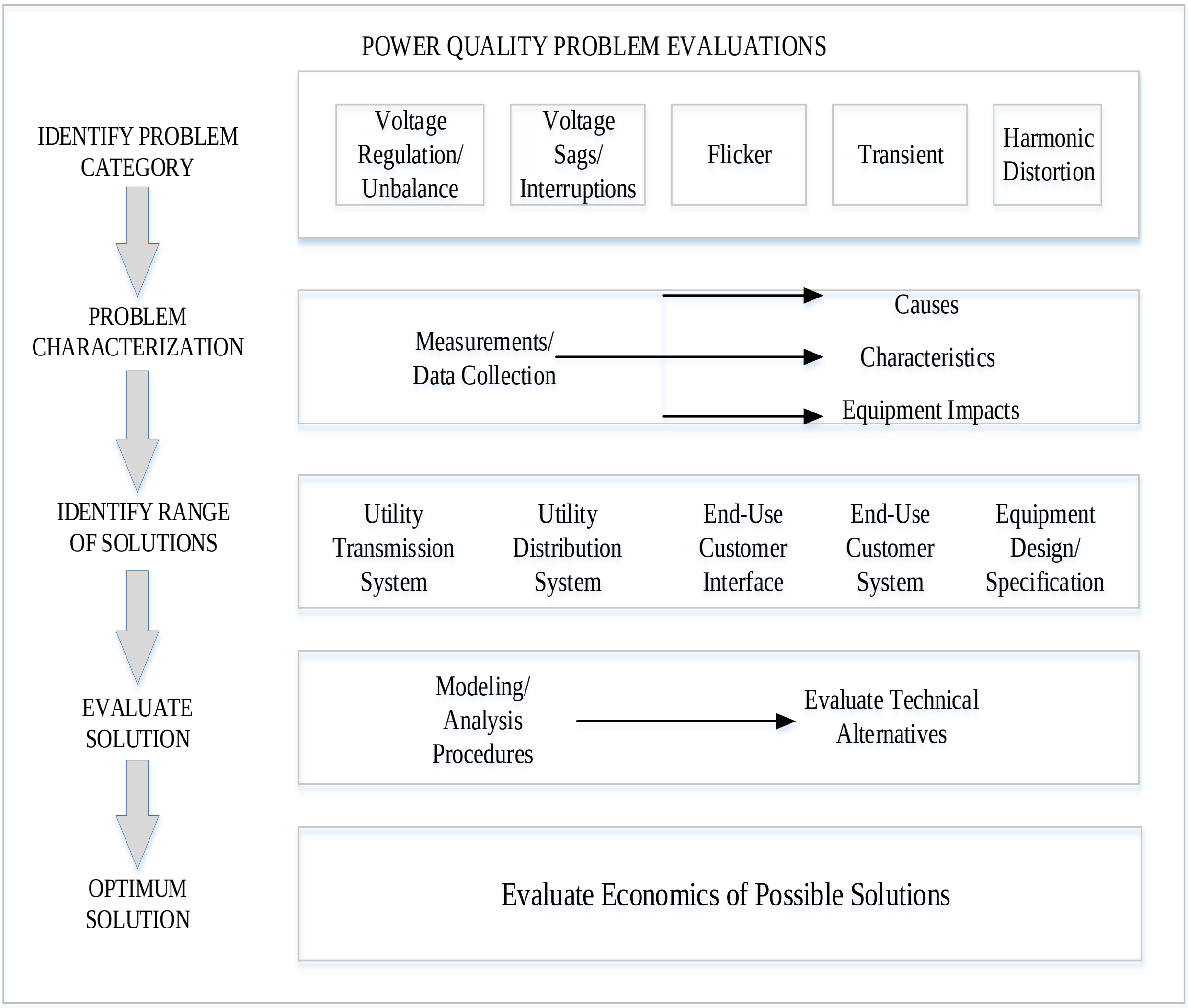

Figure 1.2 Basic steps involved in a power quality evaluation

Power quality problems surrounds of different types of phenomena each of these phenomena may have a collection of different causes and different solutions that can be used in the system. Figure 1.2 shows some common steps that are required in a power quality investigation of the system along with the major that must be addressed at each step.

II. LITERATURE REVIEWS

Jiang et al. (2017) investigates the Supply current control method of Shunt Active Power Filter with the use of three phase three wire parallel type active power filter for detecting source current control method to achieve the compensation current and the double loop closed control which improves the compensation accuracy. The Author also used DC link voltage reference according to operating space of the grid voltage. Based on the relationship between DC link voltage and power loss, and Active Power Filter compensation

Suhendar et al. (2017) proposed A shunt active power filter based on P-Q theory with multilevel inverters for Harmonic current compensation. A dual level H-bridge inverter (DLHI) and clamp diode multilevel inverter (CDMII as inverters was used. They also proposed active power filter was applied to 3-phase power system with 220V voltage and 50 Hz frequency. The simulation model was constructed by using Simulink MATLAB.

Rajmohan et al. (2016) observed Reactive Power Compensation and harmonic mitigation for attaining an efficient grid connected PV system with suppression of current harmonics by Shunt Active Power Filter (SAPF) as grid connected inverter. Various optimization algorithms are used for obtaining optimized control parameters of PI controller. The performance of this presented method is compared in minimizing Total Harmonic Distortion (THD) to increasing the energy efficiency of the system

Mousavi and Asadi (2015) proposed A Sliding mode control method of DC-link capacitor voltage used in active filter. Author presented control method compensates the source current without measurements of the loads and active filter currents. They also shows the compensation signals obtained by regulating the source current. The performance of the proposed dc-link controller and current control scheme were verified through a simulation with MATLAB.

Sarasvathi and Rajalakshmi (2013) execution, the Performance of Shunt active power filter is for various types of non-linear loads. Among the various control schemes available for shunt active power filter, indirect current control scheme is used here. PI controller and fuzzy logic controller are used to analyze its performance for various types of nonlinear loads. (R, DC motor, Induction motor). The output parameters are Total Harmonic Distortion and power factor. The results are obtained with the conventional PI controller and fuzzy controller. The proposed method offer an efficient control method under the various load conditions results in power factor improvement and Total Harmonic Distortion reduction. In this paper Simulation of the proposed controller (PI and fuzzy logic controller) of a shunt active power filter has been carried out in MATLAB/SIMULINK and the aim is to reduce the total harmonic distortion and improve the power factor.

Mohan and Amuthan (2012) show that a comparative study of current harmonic compensation using passive power filter, Shunt active power filter and hybrid filter is made. A simple PI DC bus voltage controller with reduced energy storage capacitor is employed in the active power filter. A fixed non linear load is simulated with various harmonic filters in MATLAB/SIMULINK environment.

Hossein et al. (2012) investigates the current control strategy in three-phase parallel active filter, with the Instantaneous Power Theory, to improve power quality through compensating harmonics and reactive power required by a nonlinear load, are presented. The pattern of PWM for converter switching is based on hysteresis band. The advantages of this approach are that compensation is only based on measured load current and supply voltage and don't need to know the harmonics and reactive power required by load.

III. PROPOSED METHODOLOGY

EXPERIMENT METHODOLOGY

This dissertation report presents a “Investigations on power quality Improvement with p-q Theory and DC Link Scheme of non-linear load using shunt active power filter” based on MATLAB to suppress the harmonics due to non-linear loads and for the compensation of the reactive power so as to improve the power quality.

Figure 3.1 shows the overview of the total research procedure and the experiment methodology that was adapted.

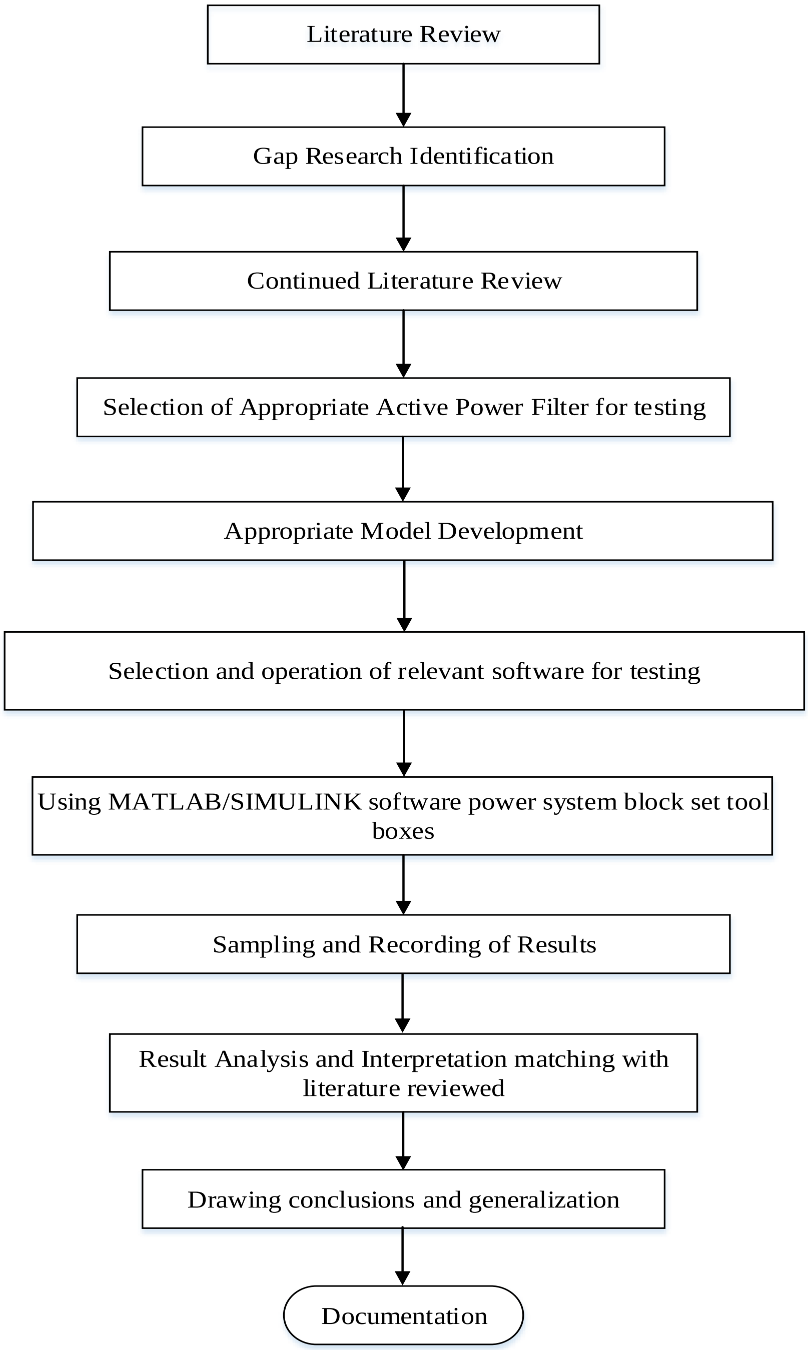

Figure.3.1 : Flowchart for Research.

SOFTWARE USED

MATLAB i.e. the matrix laboratory is the software used, and is now widely used for the simulation for almost all type of power systems. The MATLAB/SIMULINK developed by Math Works, which a tools of simulation modeling, and analyze multiple dynamic systems. It is a graphical block diagram based tools and a customized set of block library. It refers integration with the rest of the MATLAB/SIMULINK environment and can either drive MATLAB or be scripted from it. The Simulink is mostly used for the control technique and Model based Design.

IV. CONCLUSION & FUTURE SCOPE

CONCLUSION

In this research work, a study of currents harmonics and their consequences on the electrical systems has been discussed. Different proposed solutions for the problem of harmonics generation, the literature studies shows that the shunt active power filter represents an effective solution for the compensation of harmonics produced by the non-linear loads of the power system. The investigation of shunt active power filter for power quality improvement and various simulations result are carried out to analyze of the system performance. Hysteresis controller based shunt active power filter are implemented for harmonic and reactive power compensation of the non-linear load. A program has been developed to simulate which is based on shunt active power filter in MATLAB.

SCOPE FOR THE FUTURE WORK

1. Further development of SIMULINK model can be done using different control schemes such as fuzzy logic control and PI or sliding mode control and then comparison can be done for all the control schemes.
2. Experimental investigations can be done on shunt active power filter and hybrid filter by developing a prototype model in the laboratory to verify the simulation results.
3. The prototype model can also be implemented using different control schemes.
4. The prototype model can be practically implemented on various loads in industrial and commercial purposes such as drives.

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