Reduction In Harmonic Distortion Of The System Using Active Power Filter In Matlab/Simulink.

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ABSTRACT

A different type of load draws non-sinusoidal current from the mains, degrading the power quality by causing harmonic distortion. These nonlinear loads appear to be prime sources of harmonic distortion in a power system. In addition, the harmonic currents produced by nonlinear loads can interact adversely with a wide range of power system equipment, most notably capacitors, transformers, and motors, causing additional losses, overheating, and overloading and interferences. The aim of this paper is to review an active power filter that commonly used to mitigate harmonics. Thus, to solve this harmonics problems The system is verified by simulation using Matlab/Simulink simulation package. The paper starts with a brief overview of harmonic distortion problems and their impacts on electric power quality, how the active power filter mitigate this problems and the verifying using Matlab software. The proposed filter minimizes the harmonic distortion is within an acceptable range.

KEYWORDS*: Active power filter, current harmonic, load, Matlab, non-linear load, power quality, Total harmonic distortion.*

I. INTRODUCTION

Industrial electronic devices and non linear loads are the major cause of harmonic generation. As the current drawn from the supply no longer remains sinusoidal, thus the resultant waveform is made up of a number of different waveforms of different frequencies, harmonics are a major cause of power supply pollution lowering the power factor and increasing the electrical losses, which may causes a premature equipment failure and higher rating requirement for equipment[10], in a non linear load current and applied voltage are not proportional to each other, when sinusoidal voltage is applied to a nonlinear resistor, we get the resulting current distorted, few percent of increase in a voltage may cause the current to double and take on a different waveshape. This is the main source of harmonic distortion in a power system.[1] modern electrical system is with number of power electronic devices those are nothing but a non linear load which may causes a disturbance in a mains ac current, due to which power system may suffers from adverse effect therefore it has become necessary to reduce harmonic distortion for utilities as well as users[7]. Harmonic distortion in power distribution systems can be suppressed using various techniques such as, by using passive and active filter. Passive filter causes resonance problem, thus affecting the stability of the power distribution systems. Where as an active power filter is to utilize power electronics technologies to produce specific currents components that cancel the harmonic currents components caused by the nonlinear load[2].

1.1.IEEE standard for Harmonic:

The limit on harmonic voltage and current based on IEEE standard 519-1992 [11]. It should be emphasized that the philosophy behind this standard seeks to limit the harmonic injection from individual customers so that they do not create unacceptable voltage distortion under normal system characteristics and to limit overall harmonic distortion in the voltage supplied by the utility. Harmonic filters are applied at different points where power pollution due to harmonics is observed above the desirable limits as recommended by IEEE 519 standard[10].

1.1.Advantages of active filter over passive filter:-

1) Active filter do not resonate with the system where as passive filters resonate with system.
2) They can work independently of the system impedance characteristics and therefore they can be used in very difficult circumstances where passive filters can not operate successfully because of parallel resonance problems[2].
3) They can address more than one harmonic at a time and fight with other power quality problems also
4) They can be programmed to correct harmonics as well as power factor.

1.2.Comparision of passive filter and active filter:

	Passive filter	**Active filter**
Harmonic control by order	Very difficult	Possible via parameters
Harmonic current control	Requires filter for each frequency	Simultaneously monitors many frequencies
Dimension	Large	Small
Weight	High	Low
Influences of a frequency variation	Reduced effectiveness	No effect

Table 1.

1.3.Active Power filter:

Active filter uses harmonic reduction techniques to improve the quality of power, by injecting equal current or voltage distortion into the network but in opposite magnitude, which automatically cancels the actual distortion presented in the circuit. Active Power filters utilize fast-switching insulated gate bipolar transistors (IGBTs) bridge, which produces an output current of the preferred shape such that whenever they are injected into the AC lines, it cancels the original load-generated harmonics. The most important part of the active power filter is the controller part. The improvement of the performance and stability of the filter gate vary as the different control strategies applied to the Active power filter, Therefore control strategies plays an important role in improving the performance and stability of the system. Usually active harmonic filter are designed with two types of control scheme.

1) They performs fast Fourier transforms to calculate the amplitude and phase angle of each harmonic order. The power devices are directed to produce a current of equal amplitude but opposite phase angle for specific harmonic orders.
2) In this method of control is often referred to as full spectrum cancellation in which the full current waveform is used by the controller of the filter, which removes the fundamental frequency component and directs the filter to inject the inverse of the remaining waveform[5].

Active harmonic filter reduces harmonics which are existing due to non linear load in the power system as shown in fig.1 as the non linear load is connected to the generators and motors which are nothing but the sources of harmonics to distort the current and voltage waveform, so it is active power filter who has contractual obligation to confiscate the distortion from the waveform and improve the power quality. The basic thought is to replace the portion of the sine wave that is missing in the current in non-linear load. An electronic control monitors the line voltage and current, by precisely switching the power electronic devices to approach the load voltage or current and force it to be sinusoidal. Active filters can be programmed in a such way that, they correct power factor as well as harmonic distortion. So therefore it is essential to evaluate the parameters of the filter which is to be designed.

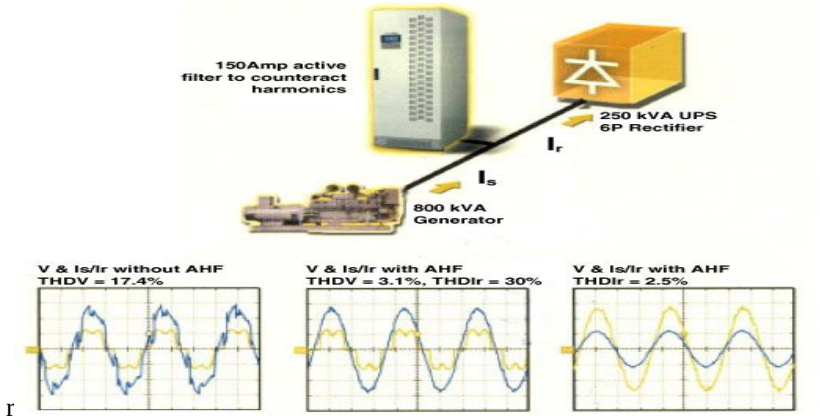

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Fig. 1

II. SYSTEM WITHOUT ACTIVE POWER FILTER:

In modern electrical system there are various types of load as the system supplies power to the different types of load such as

a. Commercial loads: single phase power supplies, fluorescent lightning, adjustable speed drives.
b. Industrial loads: three phase power converters, DC drives, AC drives, arcing devices, saturable devices.

Due to such sources of harmonics, they produces harmonic distortion which effects the imperative equipment like capacitors, transformer, motors, telecommunication, impact on energy and demand metering[2]. The system without filter in Fig. 2 has many distortions which are blamed for many power quality disturbances with high frequency component, it increases closer to the load. mostly harmonics are occurred in a steady state condition and are integer multiple of the frequency.

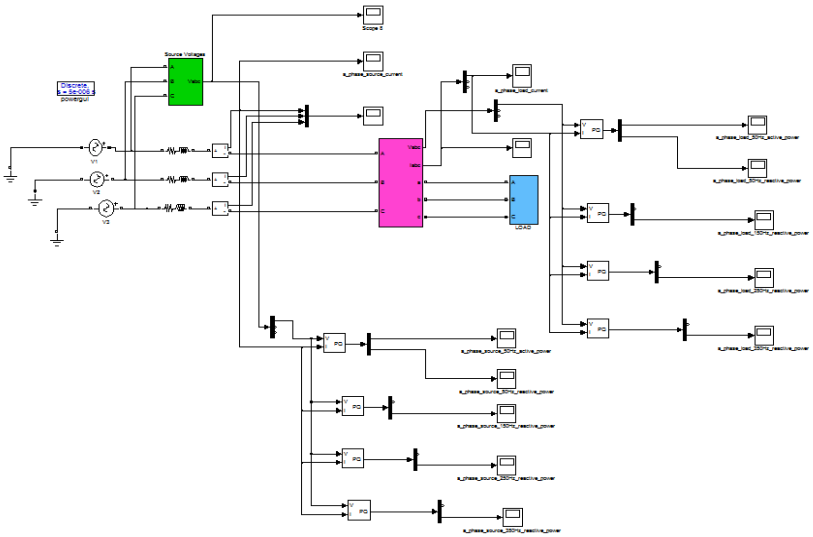

Fig. 2

III. SYSTEM WITH ACTIVE POWER FILTER:

In an active power filter, a harmonics to be eliminated is determined by a controller. The output of this controller is the reference of a three-phase current controlled inverter. In modernelectrical system nonlinear load is connected to the power system and is supplied by the non sinusoidal current .The active power filter is connected in parallel to the mains, on the point of common coupling PCC, and supplies the current harmonics needed to maintain the source current sinusoidal. Traditionally active power filter shunt active filters were proposed as a means of removing[12]

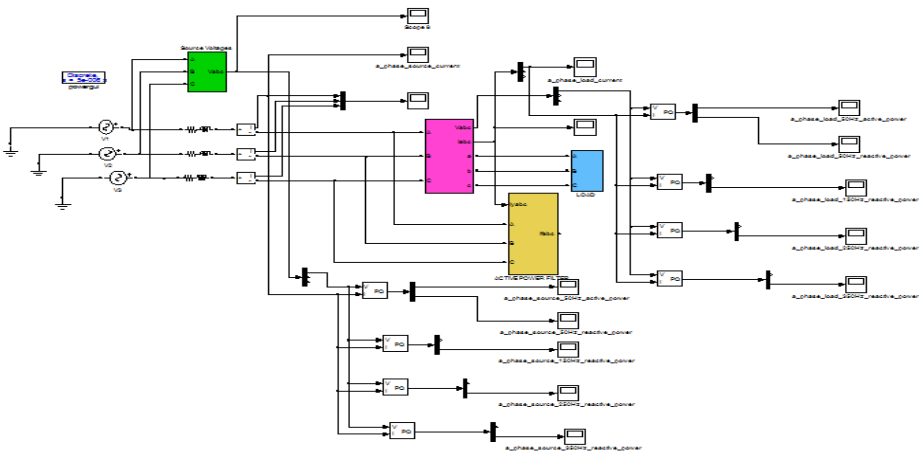

Fig. 3

Active power filter reduces the total harmonic distortion in the system so that the quality of power get enhanced, and this is utterly depends on the filter which is to be designed for the system. Fig. 3 shows the configuration of the system with active power filter, number of scopes connected to the system to see the variations due to harmonic in the current, voltage, active and reactive power waveform at number of harmonic frequency(for 3rd harmonic, frequency equals to 150Hz, for 5th harmonic frequency equals to 250Hz).

3.1.Result:

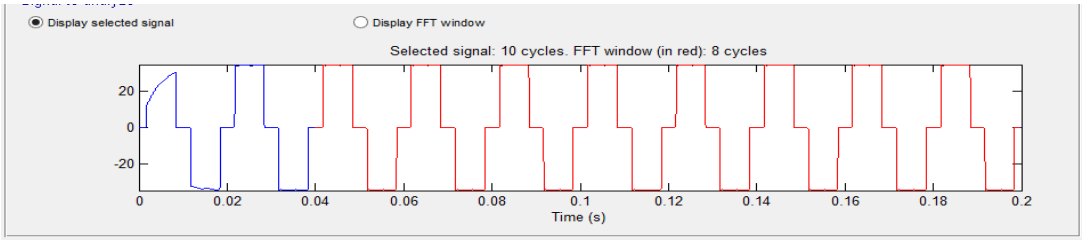

Fig. 4 System signal which is to be analyzed (without filter)

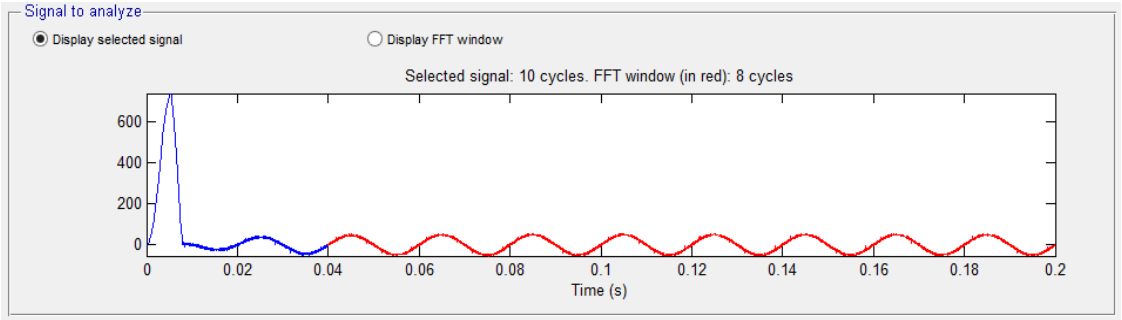

Fig. 5 System signal which is to be analyzed (with filter)

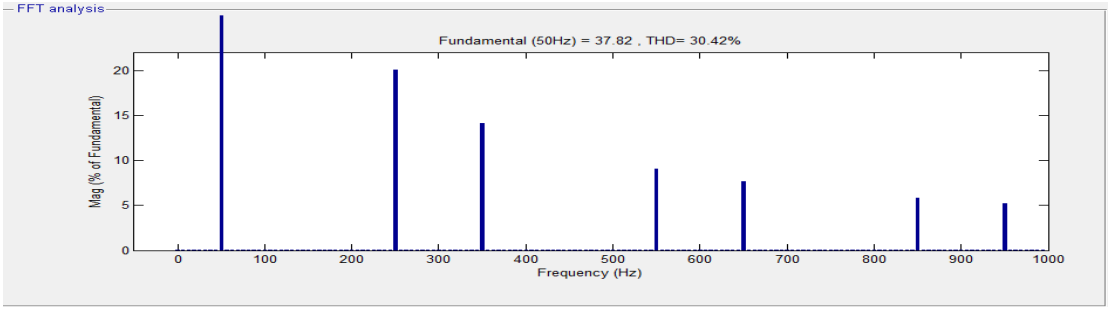

Fig. 6 Bar representation of the signal (without filter)

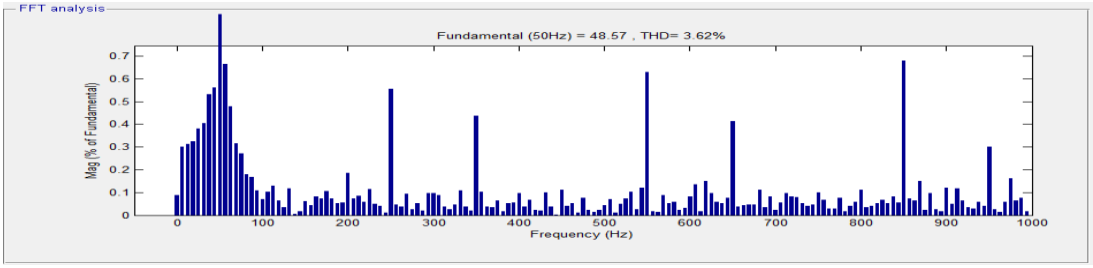

Fig. 7 Bar representation of the signal (with filter)

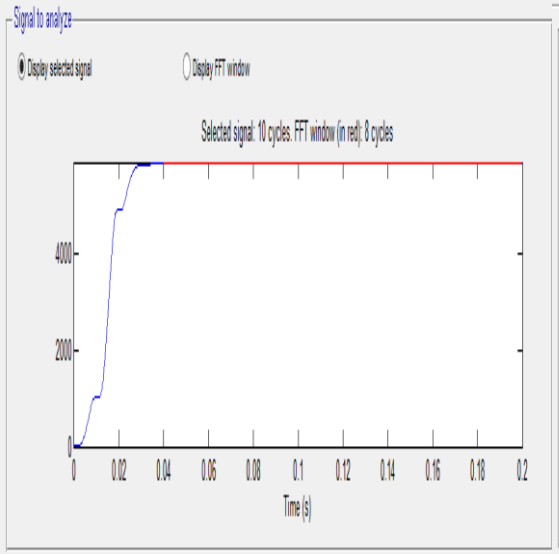

Fig.8 Signal to analyze without filter

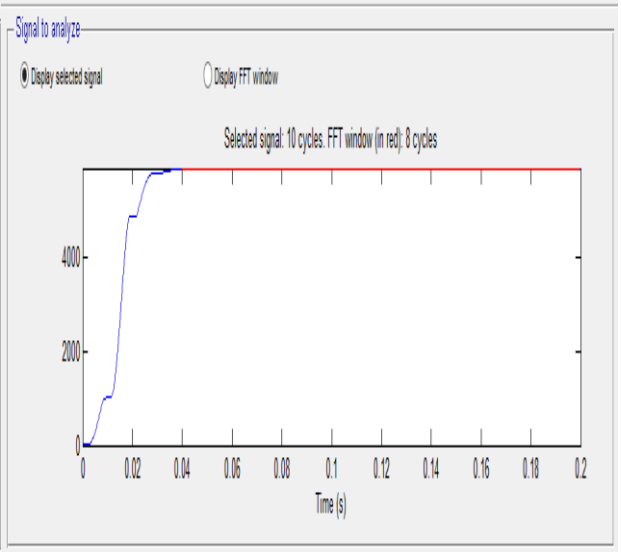

Fig.9 Signal to analyze with filter

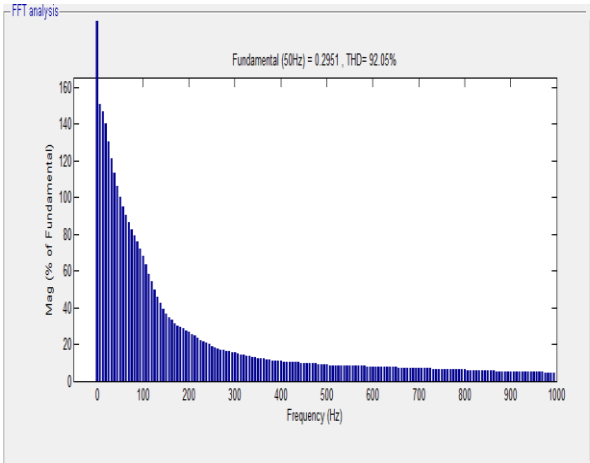

Fig.10 Bar representation of the signal (without filter)

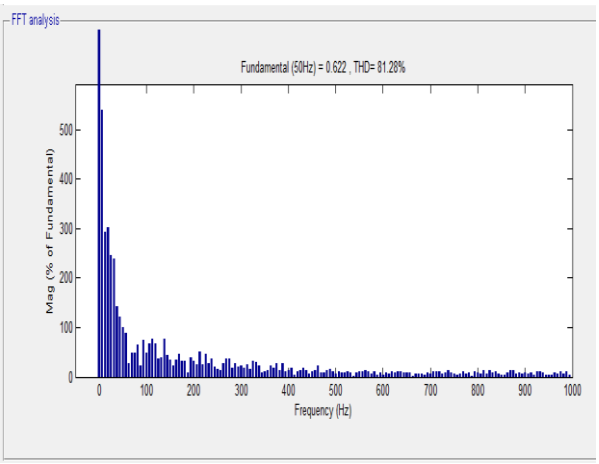

Fig.11 Bar representation of the signal (with filter)

The bar representations(fig. 6 and fig. 7) of signals(fig. 4 and fig. 5) shows the difference in total harmonic distortion between the system with and without active power filter, total harmonic distortion was 30.42% before implementing active filter and total harmonic distortion get reduces to 3.62% after the implementation of active harmonic filter. Similarly in fig. 10 and 11 having a same signal but first one is without active power filter, and the other one is with active power filter, 11% of reduction in harmonic distortion.

REFERENCES:

[1] Roger C. Dugan, Mark F. Mcgranaghan, Surya Santos and H. Wayne Beaty, Electrical power system Quality, Tata McGraw Hills publications, (2002).

[2] Nur Izzati Nadiah Binti Ishak, simulation of active power filter using matlab/simulink, universiti teknikal malaysia melaka, 22 april 2010.

[3] Ying-Tung Hsia , "Design of Filters for Reducing Harmonic Distortion and Correcting Power Factor in Industrial Distribution Systems", Tamkang Journal of Science and Engineering, Vol. 4, No. 3, pp. 193-199 (2001).

[4] Jain Sandesh, Thakur Shivendra Singh and Phulambrikar S.P. "Reduce the Harmonics Distortion of Sensitive Load against the Induction Motor Drive Non-Linear Load", Research Journal of Engineering Sciences ISSN 2278 – 9472 Vol. 1(6), 1-8, December (2012).

[5] Jain Sandesh, Thakur Shivendra Singh and Phulambrikar S.P, "Improve Power Factor and Reduce the Harmonics Distortion of the System", Research Journal of Engineering Sciences ISSN 2278 – 9472 Vol. 1(5), 31-36, November (2012)

[6] Hussein A. Kazem, "Harmonic Mitigation Techniques Applied to Power Distribution Networks", Hindawi Publishing Corporation Advances in Power Electronics Volume 2013, Article ID 591680, 10 pages http://dx.doi.org/10.1155/2013/591680.

[7] George Adam, Alina G. Stan (Baciu) and Gheorghe Livinţ, "A MATLAB-SIMULINK APPROACH TO SHUNT ACTIVE POWER FILTERS" Technical University of Iaşi 700050, Iaşi, Romania.
[8] Michael C. Pacis, Jesus M. Martinez Jr., and Jaypee V. Tecson, "Modelling and Simulation of Active Power Filters for Harmonic Compensation, Voltage Sags and Swells Mitigation and Power Factor Correction", Proceedings of the World Congress on Engineering and Computer Science 2010 Vol II WCECS 2010, October 20-22, 2010, San Francisco, USA.
[9] I. Zamora, A. J. Mazon. P. Eguia, I. Albizu, K. J. Sagastabeitia, E. Fernández, "Simulation by MATLAB/Simulink of active filters for reducing THD created by industrial systems", Paper accepted for presentation at 2003 IEEE Bologna Power tech conference, june 23rd -26th Bologna Italy.
[10] Ogundana, "Design and Simulation of Harmonic Filter Using Matlab® Software"
Ahmadu Bello University, Zaria, international Journal of Engineering and Mathematical Intelligence, Vol. 2, No. 1-3, 2011.
[11] IEEE Standard 519 (1992). IEEE Recommended Practice and Requirements for Harmonic Control in Electrical Power System.
[12] M. CHANDRA SEKHAR1, B. KIRAN BABU2 KL University, India "enhancement of power quality using active power filter, In a medium voltage distribution network switching loads" International Journal of Modern Engineering Research (IJMER) www.ijmer.com Vol.2, Issue.2, Mar-Apr 2012 pp-431-435 ISSN: 2249-6645.

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