COMPARISON OF PASSIVE & ACTIVE FILTER USING MATLAB/SIMULINK TOOLS ENVIRONMENT

[1]SHIVAM SINGH RAJPUT, [2]SUMITA CHAKRABORTTY, [3]NAIMESH ZAVERI

[1]UG student-EE Dept., MSCET,Surat
[2]Professor-EE Dept., MSCET,Surat
[3]Professor-EE Dept., CKPCET,Surat
E-mail: [1]shivamrajput74297@gmail.com, [2]sumitamam.electronics@gmail.com,
[3]zaverinaimesh@yahoo.com

Abstract—The proliferation and rejuvenation comes as a imperative aspect when the quality of desired output declines in many ways. Moreover, if the dilemma affects the load as well as source too, it renders a vital issue. In this paper, mainly the comparison between two distinct types filters has been enumerated. By using which the quality of power can be ascended and the harmonics would be compensated. At the end, the simulation model of both passive and active filter has been elicited by using which the analysis has been depicted lucidly.

Index terms— Active filter, Passive filter, Power quality, Reactive Power, THD.

I.INTRODUCTION

As the power consumption and its demand is increasing as a balloon the satisfaction to overcome the problems cannot be achieved as it ascends. Therefore, sudden surges and many distortions have been revealed as the hazardous output that needs to be compensated as early as possible. This plight also affect the quality of power and hence the change in voltage, current occurs that entails the problem in power quality. Power quality has always been shown as the betterment prospects in which if the amelioration has been occurred then it may admit the fruitful results in pessimistic way while, this does not happen always and as a deduction the harmonics comes in a role.

Harmonics have never been sought as a single part thus it has always been described in numerous kinds. It is defined as the integer multiple of fundamental frequency and mathematically it can be expressed as follows;

$f_{har}=n * f_{funda.}$

Where, f_{funda}=fundamental frequency (50/60 Hz)
f_{har}= frequency of harmonic content
n = integer number

Mainly, harmonics are of only two types current harmonics and voltage harmonics. But, here when we use the non-linear load it draws the current that is not necessarily sinusoidal and hence distortion takes place. On similar way , the voltage harmonics are produces due to current. Because, the current affects the voltage source and it affects the load too. Afterwards, the THD analysis needed to be done for any consideration. In which according to IEEE 519 in 1992 harmonics have been introduced and then the limitation of THD that is total harmonic distortion has been allowed that was less than 5%. Due to all of this the harmonics study and improvement in power quality plays an essential role in our power system. As a consequences the filters has been introduced which have been firstly classified as voltage harmonic remove filter and another one is current harmonic remove filter. The analysis of current is imperative here because the load current at the end passes through filter and at the end to the source so if the current is corrected properly the voltage correction becomes more easy. In harmonic analysis THD should be calculated and it always depicts the range of unnecessary contents in percentage. So, by using different kinds of filters the illustration of THD needs to be studied for benign results.

To overcome from all of former problems initially the passive filters has been introduced by using which the removal of distortive contents were not such sufficient as it have some limitations. Hence, the active filter has been admitted and by using both methods the improvement in power quality and compensation of reactive power has been assisted mainly by using non-linear loads such rectifiers, IGBT, GTO etc. The compensation in reactive power that means the effect of inductor and capacitor on our system is also important by doing which the amelioration in power factor also comes and like this the declivity in harmonics can be achieved. These all three terms are interrelated and if it is improved the system will be prepared for further aspects.

II. MODELING OF PASSIVE FILTER

Passive filter has been introduced to improve the power quality. For better enhancement in the quality of supply many aspects needs to be utilized .So, the passive filter has been considered as one pith part. The passive filter has three main functions which are

reactive power compensation, absorption of harmonics currents produced by the load and coupling of inverter to grid. Here, the load is variable at different levels and the main focus applied towards non-linear loads in which all power electronic devices are being considered. Now, for non-linear load in its waveforms the change in impedance per half cycle is the dilemma and it occurs mainly due to characteristics of passive filter. In passive filter it does have low input impedance and high output impedance Thus, the variation in impedance comes and that renders the results for non-linear load. Passive filter does not require any external power supply.

As a filter here inductor and capacitor are used and then it has been classified in different types on the basis of connection likewise low pass filter, high pass filter and band pass filter. The block diagram has been depicted as in fig.1 which consists the basic operation of passive filter.

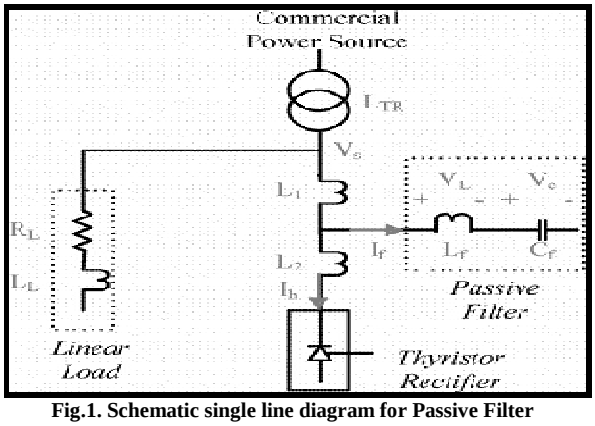

Fig.1. Schematic single line diagram for Passive Filter

As shown in fig.1 the generalized block diagram or simulation diagram has been shown in which as a non-linear load the uncontrolled rectifier is used and RL load has been considered. The configuration is for 3 phase system whereas L and C have been used as filter. Like this by applying different load values by trial and error method the passive filter can be used. But, there is one drawback in passive filter in which it cannot endure every load and cannot operate on higher frequencies. Hence, the dealing with higher number of odd harmonics is not such ease as it was for one load.

III. MODELING OF ACTIVE FILTER

To overcome from the barriers of passive filter the active filter has been introduced. Here, it differs in following manners, firstly it does not need any external supply. It does have high input impedance and low output impedance. Here, only capacitor is used as filter and inductor is used as a smoothing reactor or ripple content removal reactor. In active filter the load current is being compared with the filtered current. At the end, the corrected source current has been resulted as an output. Here, as a load the controlled rectifier is used which is managed by proper firing angle .Hysteresis band technique is used for current controlling for shunt active filter.

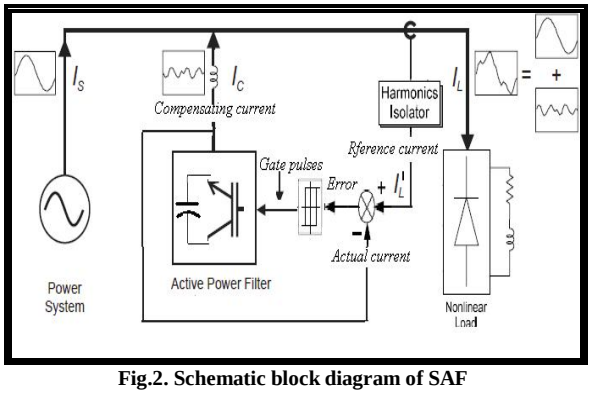

Fig.2. Schematic block diagram of SAF

By using hysteresis current control technique it can manage the higher frequencies and different loads. The basic operation of this technique is that it always attunes with the feedback signal and manages the required output. The reactive power can be calculated by the following equation:

$$Q=V^2/X_c$$

where, Q= reactive power
V= supply voltage
X_c=capacitive reactance

Here, the X_c can be expressed as follows:

$$X_c=1/2\pi RC$$

Now, by using above equation different values of capacitors will be considered and trial & error method will be implemented. As shown in fig.2 the harmonic isolator is provided for discretion of two different waveforms of load current and filter current to get the corrected source current as a desired output. The active filter indulges the load current which do have distortion and then it apply it towards the smoothing reactor. Thence, the I_s will be the actual output.

IV. MATHEMATICAL EQUATIONS

For harmonic analysis the fast fourier transform technique will be used in MATLAB. While, for power factor with help of power triangle the analysis will be introduced.

$$\cos\varphi=P/S=P/\text{ sqrt}(P^2+Q^2)$$

where, P=real power
Q=reactive Power
S=Apparent power

For, THD analysis the equation will be as follows:

THD= sqrt($V_2^2+V_3^3+\ldots+V_n^2$)/V_1

Hence, from above equation the overall harmonic contents will be calculated. Thus, if it will be in the range of 5% ,it will be based on proper IEEE standards.

V. MATLAB RESULTS

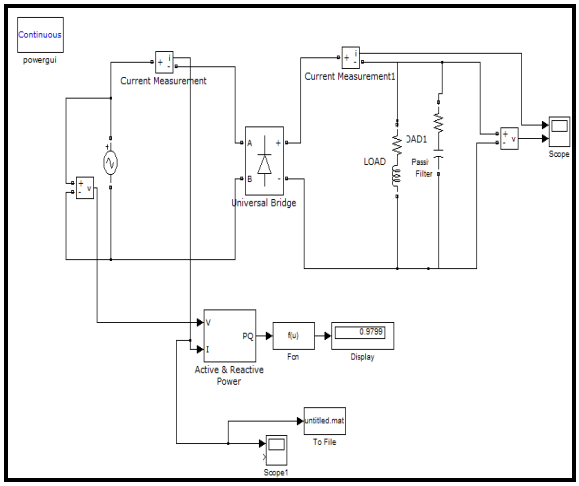

Fig.3. Simulation of Passive filter with Non-linear load

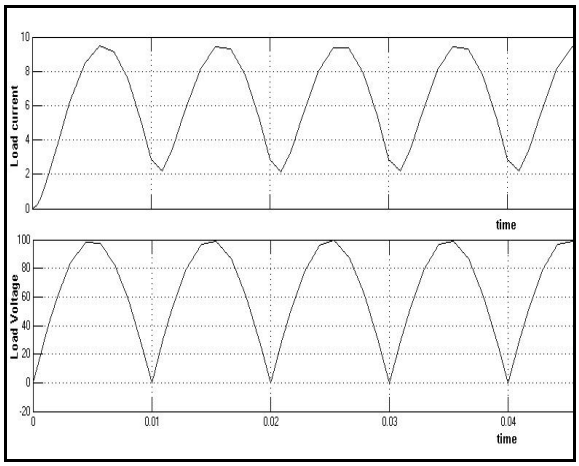

Fig.4.(a) load Current & Voltage Waveform-without PPF

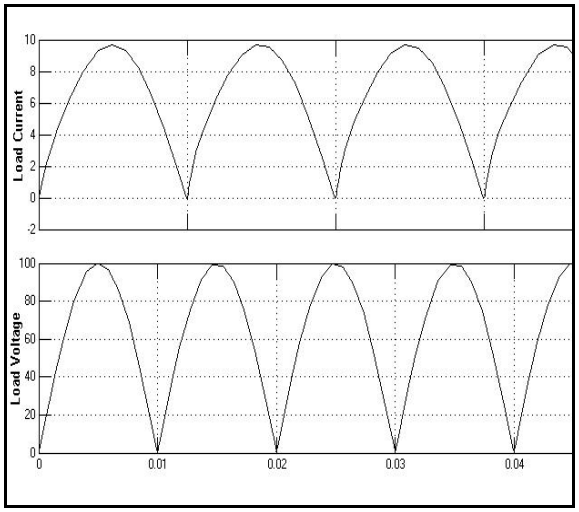

Fig.4 (b)load Current & Voltage waveform- using PPF

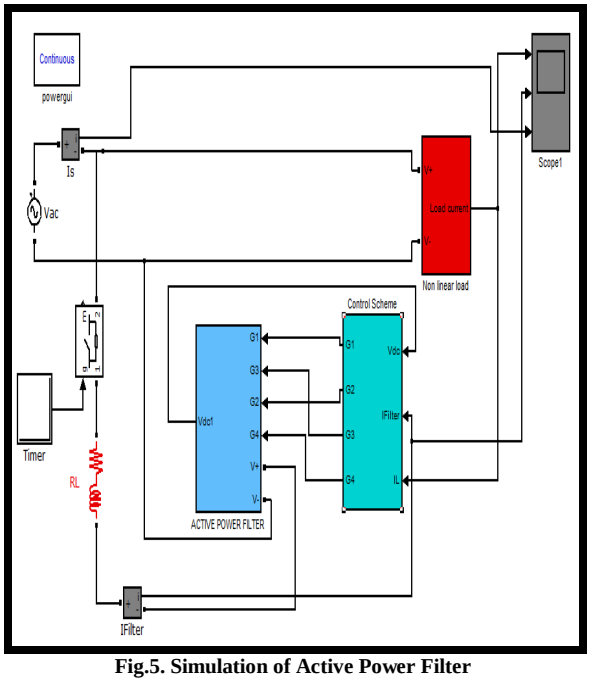

Fig.5. Simulation of Active Power Filter

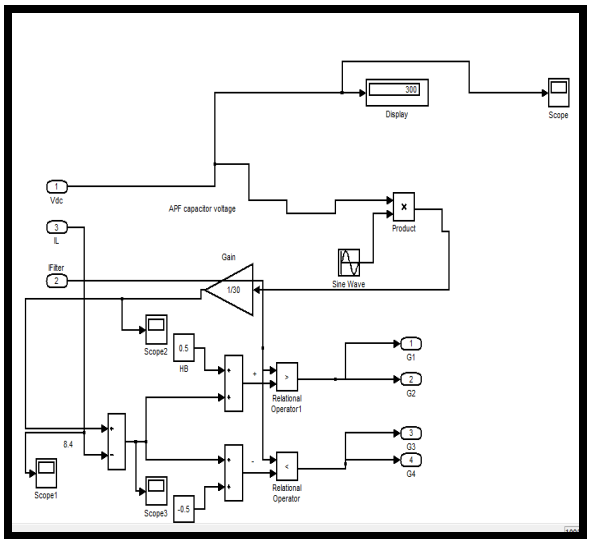

Fig.6. Simulation of Control Scheme circuit for SAF

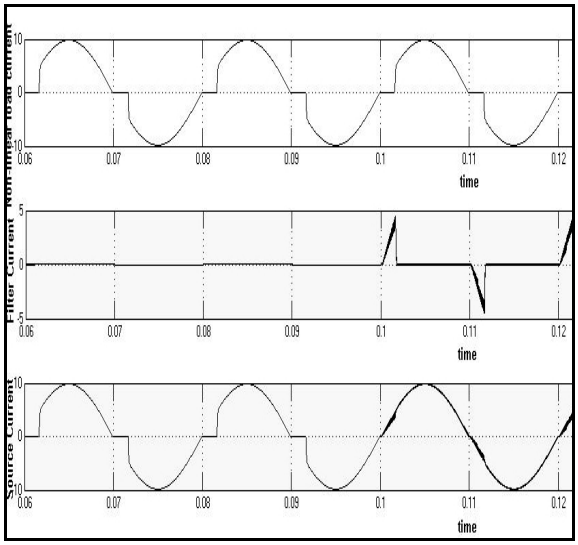

Fig.6. load current, filter current & Corrected Source Current

VI. COMPARISON OF OUTCOMES

Table.1. Comparison of % of harmonics

Harmonic order	Before Compensation	SAPF
3rd	4.79	0.70
5th	18.80	3.28
7th	14.24	2.56
11th	1.66	0.89

Table.2. Comparison of % THD

SYSTEM	%of THD
Before connection of filter	16.18
Passive Filter	3.47
Shunt Active Filter	3.32

Table.3. System Parameters

System Parameters	Values
PPF load para.	R=10Ω, L=10 mH
APF load para.	R=10Ω, L=0.5 mH
PPF	R=6 Ω, C=0.1 μF
SAPF	C= 5F

CONCLUSION

As the basic outcome has been illustrated, it can be reckoned that the 3rd order harmonics are the one aspect of consideration by solving which the THD would be compensated properly. Here, it is lucid apparent that before connection of passive filter or active filter the % of THD was approximately 16 % but, when passive filter is connected it abated till 3.47% and if the active filter is connected then this % of approximation will be 3.32% . Thus, it can be decree that Active filter method is much benign than the passive filter. Because, it can endure any load under different circumstances and can deduct the harmonic contents from the system.

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