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Electric Power Quality Improvement using Hybrid Compensator

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ABSTRACT : The proposal for Control Algorithm of 3- Phase HPF (Acronym For Hybrid Power Filter) . It has a Active filter and a passive filter . The Active filter is connected in series while the passive filter is connected in parallel across load . . The strategy for control is called as instantaneous reactive power control of vector theory . The compensation of the reactive power and harmonics due to load current by the injection of voltage waveform from from the active filter for the balancing of asymmetrical loads . The improvement of the passive filter behavior is seen from the algorithm for control . The MATLAB- Simulink platform is used for simulations . The Simulations are done with different loads and with different source impedances . The presentation of simulation results is here .

KEYWORDS : (PQ)Power Quality ,(HF)Hybrid Filters , (IRP)Instantaneous Reactive power , (APF) Active Power Filters

I. INTRODUCTION

The Deterioration of Power Qulaity in the power system due to increase in Non Linear loads and due to increase in electronic equipments connected to the power system . The Non Linear Loads always draw harmonic currents from the supply resulting in the distortion of the source voltage waveform at the coupling point know as PCC (Acronym for point of common coupling) because of impedance of source . The equipments malfunction and conductors overheat leading to decrease in efficiency and decrease in life of equipments connected to PCC .
Historically , the elimination of current harmonics is done through a passive LC filter which is parallel connected to the load .
This has some drawbacks such as hence the passive filter fails to provide complete solution , these are ,

- The characteristics of compensation totally depend on the impedance of the system due to smaller impedance of filter than the impedance of source so as to remove harmonics of the current source
- Overloading is possible in the passive filter because of the harmonics circulation arising from loads which are non linear and are closer to the point of connection of passive filter .
- variable loads are unsuitable for passive filters because paasive filters are specifically designed for a specific reactive power and secondly the detuning of filter happens due to the variation in impedance of load .
- The resonance problem can appear in the system . The resonance of both types such as series or parallel .

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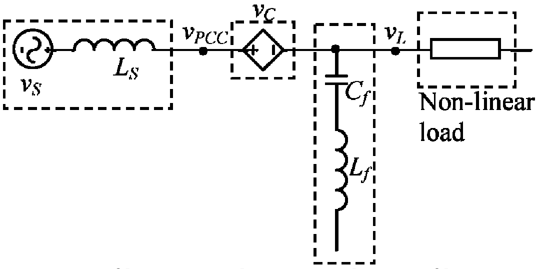

Fig.1. Active filter connected in series and passive filter connected in parallel.

The 3- phase pulse width modulated voltage source inverter is usually an active power filter . The (APF) when connected in series to the source impedance (AC) , then there is the possibility to improve the chararacteristics of compensation for the passive filters connected in parallel to the same load . fig.1 controlled source is shown as active filter ,the voltage across inverter v_c is the voltage which the inverter must generate so that the goal of the control algorithm discussed here is achieved .
Number of techniques are there for the active filter , to get the control signal such as to have the voltage generation in proportion to the harmonics of the source current , such a control algorithm makes it possible to eliminate the series or parallel resonance or both simultaneously . This passive filter is prevented by the active filter to become a harmonics drain in closed loads. Also it prevents the features of compensation from becoming depended on impedance of the system . Ideally,the value must high for k the proportionality constant between the source current harmonics and output voltage. . The value cannot be infinite because at this value the goal of control becomes impossible to achieve . The values of k is mostly small to mitigate the problems of instability and high power active filters . Since it is dependent on passive filter and the value of source impedance , hence it becomes tricky to find the appropriate value of k , further since the value of reactive power from passive filter is constant, hence it becomes unsuitable for variable load systems , the variable power factor is there for the load and set compensation equipment .
Control technique of another type , in this , the voltage waveform like the voltage harmonics at the load side in opposition is generated by the APF . This prevents the dependence of the source impedance on the passive filter . passive filter`s other limitations remain

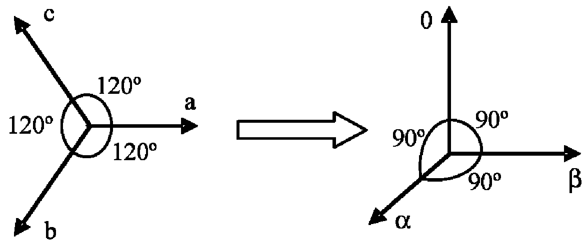

Fig .2 Conversion from the phase reference system (abc) to the 0αβ system .

Numerous other control strategies have been there , these combine the above theories to improve the compensation characteristics of the parallel passive filter , however other theories suffer from the difficult calculation for obtaining the value of the gain k for the APF .
The latest approach suggests that the voltage generated from the active filter compensates the load reactive power and passive filter , hence current harmonics are removed . The instantaneous reactive power theory forms the basis for calculation through control algorithm The objective is to have a source side constant power
The electric power vector theory dual formulation forms the basis of new control strategy in this paper . The reference load considered here is the balanced and resistive load . The plan achieves the objective of ideal behavior from set hybrid load-filter by using or generating the voltage from active filter , when the power factor is unity and the source voltages are sine wave and balanced , or elimination of source harmonics and compensation of load reactive power ., so without depending on the system characteristics of system impedance , improvement of passive filter characteristics of compensation becomes possible because the load-filter set will exibit resistive behavior . The dangers of becoming a harmonics drain for close loads by the passive filter is mitigated , and the risk of resonance (series or parallel) with the

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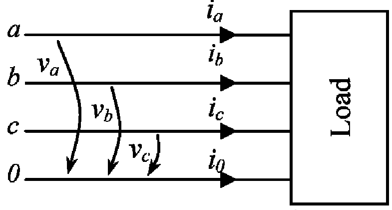
remaining system is avoided too . , Further the variable load compensation becomes certain and this will inhibit the detuning of passive filter .
The instantaneous reactive power theory based APF series control is not very new , the purpose of this paper is a new formulation which will affect the control loof designing . this paper defines instantaneous reactive power as as a dot product , and in older papers its defined as a cross product , as a consequence , the reference generation method gets easy and any compensation strategy can be obtained in the final development which includes unity power factor .
The MATLAB – Simulink is used for simulation of compensated electric system and the balanced , unbalanced 3-phase system exposed to the strategy The theoretical beahviour has been verified with the simulation results .

II. THE THEORY OF DUAL INSTANTANEOUS POWER

The controlling strategy for the APF is the Theory of Dual instantaneous reactive power .The compensation equipment is the main application of this theory , the Clarke coordinate transformation from the phase coordinates forms the basis of this theory . (figure – 2)

Fig- 3 . 3 - phase system



In the 3 – phase system of fig 3 , current and voltage vectors are defined by

$i = [\, i_a \quad i_b \quad i_c \,]^T \qquad v = [\, v_a \quad v_b \quad v_c \,]^T$ **(1)**

from The phase reference system a-d-c to α-β-0 coordinates , vector transformations can be obtained , thus

$$\begin{bmatrix} v_0 \\ v_\alpha \\ v_\beta \end{bmatrix} = \sqrt{\tfrac{2}{3}} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} v_a \\ v_b \\ v_c \end{bmatrix} \quad (2)$$

$$\begin{bmatrix} i_0 \\ i_\alpha \\ i_\beta \end{bmatrix} = \sqrt{\tfrac{2}{3}} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} \quad (3)$$

The calculation of instantaneous real power in the α-β-0 frame is as follows .

$p_{3\phi}(t) = v_\alpha i_\alpha + v_\beta i_\beta + v_0 i_0$. (4)

The power can be expressed as follows

$p_{3\phi}(t) = p + p_0$ (5)

here , instantaneous real power is given by p which is not with zero sequence component , it is given by

$p = v_\alpha i_\alpha + v_\beta i_\beta$ (6)

alternatively by means of dot product , in vectorial form it could be expressed as

$p = i_{\alpha\beta}^T v_{\alpha\beta}$ (7)

here $i_{\alpha\beta}^T$ in α-β coordinates , it is the transposed current .

$i_{\alpha\beta} = [\, i_\alpha \quad i_\beta \,]^T$ (8)

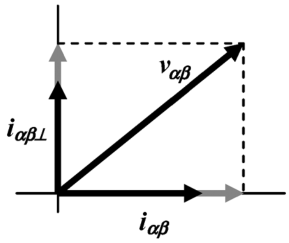
Similarly , $v_{\alpha\beta}$ in the same coordinates , it is the voltage vector

$v_{\alpha\beta} = [\, v_\alpha \quad v_\beta \,]$ (9)

in the equation (5), zero sequence instantaneous power is p_0 , calculated as :

$p_0 = v_0 i_0$ (10)

no Zero – sequence current components in a three wire system , which means $i_0 = 0$. on the α-β axes only the



instantaneous Power is defined, $v_0 i_0$, the product is always zero .

Fig 4 Voltage vector decomposition .

The equation for imaginary instantaneous power .

$q \approx v_\alpha i_\beta - v_\beta i_\alpha$ *(11)*

it could be represented by the dot product , with respect to equation (7)..

$q = i^T_{\alpha\beta\perp} v_{\alpha\beta}$ (12)

perpendicular to $i_{\alpha\beta}$ is the transposed current vector $i^T_{\alpha\beta\perp}$ expressed as .

$i^T_{\alpha\beta\perp} = [\, i_\beta - i_\alpha]^T$. (13)

Expression for the power variables defined earlier are ,

$$\begin{bmatrix} p \\ q \end{bmatrix} = \begin{bmatrix} i^T_{\alpha\beta} \\ i^T_{\alpha\beta\perp} \end{bmatrix} v_{\alpha\beta}. \quad (14)$$

The two coordinates axes in the αβ plane are established by vectors , $i_{\alpha\beta}$ and $i_{\alpha\beta\perp}$ .The decomposition of voltage vector $v_{\alpha\beta}$ into its orthogonal projection on the axis on the basis of real instantaneous power , vectors of voltage can be expressed as

$\boldsymbol{v}_{\alpha\beta}$ our wire system $= \frac{p}{i^2_{\alpha\beta}} i_{\beta\alpha} + \frac{q}{i^2_{\beta\alpha}} i_{\beta\alpha\perp}$ (15)

p_0 which is zero sequence instantaneous power is not null in the four wire system . In this case (15) an additional term with the form ($p_0 / i_0^2) i_0$ is included here vector i_0 is the zero sequence current vector .

III. COMPENSATION STRATEGY

Electric companies try to generate electrical power with reference to sinusoidal and balanced voltages . Due to this , the ideal reference load based compensation target must be linear balanced and resistive , it means that the system will have unity power factor and source currents are collinear to the supply voltages . If, in fig 3 voltages are assumed as sinusoidal and balanced , ideal currents will be proportional to the supply voltages .

$v = R_e I$ *(16)*

equivalent resistance is R_e , *the* load voltage vector is v and the load current vector is i.

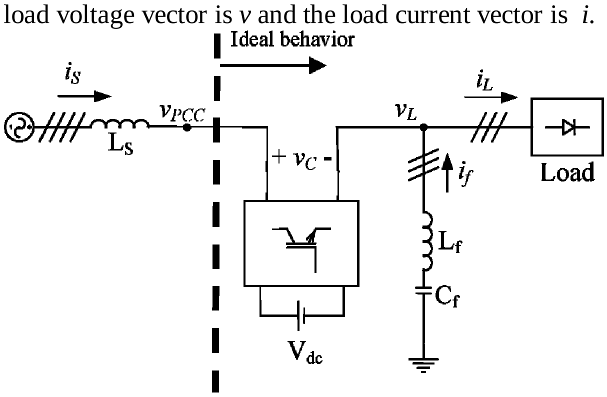


Fig 5. compensation equipment along with the system .

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The source supplied average power will be

$P_S = I_1^2 R_e$ (17)

In the above equation , square rms value of the fundamental harmonics of the source current vector is I_1^2 .,the current fundamental components transports the power consumed by the load when the voltage is sinusoidal and balanced.

The difference between the instantaneous power supplied by the source and the total real instantaneous power required by the load is the Compensator instantaneous power

$P_C(t) = p_L(t) - p_S(t)$. (18)

In the following equation , null average power is exchanged by the compensator , which means

$P_C = \frac{1}{T}\int p_C(t)dt = 0$ (19)

For calculation of average values in (18) , the equations of (17) and (19) are taken into consideration .

$0 = \frac{1}{T}\int p_L(t)dt - I_1^2 R_e.$ (20)

Hence the equivalent resistance is calculated as ,

$R_e = \frac{P_L}{I_1^2}$ (21)

here , load average power is P_L , which is defined as

$P_L = \frac{1}{T}\int p_L(t)dt.$ (22)

Fig.5 shows the system with, unbalanced and nonsinusoidal load , series active filter ,and parallel passive filter. The objective is that the load and set compensation equipment has an ideal behavior from the point of common coupling , the active filter connection point In 0αβ coordinates at this point the voltage at can be determined as follows :

$v_{PCC\alpha\beta} = \frac{P_L}{I_1^2} i\alpha\beta.$ (23)

source current in 0αβ coordinates is $i_{\alpha\beta}$. In this eq. , by the active filter there is the restriction on the exchange of null average power

The load voltage is determined as per eq. (15) by

$\boldsymbol{v_{L\alpha\beta}} = \frac{p_L}{i_{\alpha\beta}^2}\boldsymbol{i_{\alpha\beta}} + \frac{q_L}{i_{\alpha\beta}^2}\boldsymbol{i_{\alpha\beta\perp}}$ (24)

Where real instantaneous power is p_L and load imaginary instantaneous power is q_L

The active filter reference signal for the output voltage is

$\boldsymbol{v_{C\alpha\beta}^*} = \boldsymbol{v_{PCC\alpha\beta}} - v_{L\alpha\beta}.$ (25)

From , (23) and (24) , the voltage for compensation is

$\boldsymbol{v_{C\alpha\beta}^*} = (\frac{P_L}{I_1^2} - \frac{p_L}{i_{\alpha\beta}^2}) i_{\alpha\beta} - \frac{q_L}{i_{\alpha\beta}^2} i_{\alpha\beta\perp}$ (26)

When the compensation voltage is supplied by the active filter , the compensation equipment sand set load imitates the behavior as a resistor R_e .

Finally , if currents are nonsinusoidal and unbalanced , ideal reference load is a balanced resistive load . hence , the equation defining the equivalent resistance becomes as .

$R_e = \frac{P_L}{I_1{}^{+2}}$ (27)

Here square rms value of the positive sequence fundamental component is I_1^{+2} . In this case eq (26) is changed , where I_1^+ takes the place of I_1 that is

$v_{C\alpha\beta}^* = (\frac{P_L}{I_1^{+2}} - \frac{p_l}{i_{\alpha\beta}^2})\, i_{\alpha\beta} - \frac{q_L}{i_{\alpha\beta}^2}\boldsymbol{i_{\alpha\beta\perp}}$ (28)

By means of the reference calculator as shown in fig9 and Fig.10 reference signals are obtained. In unbalanced loads , the scheme shown in fig.17.takes the place of block "Fundamental component calculation " in fig9 its responsibility is to calculate the current positive sequence fundamental component .

The one presented in eq. (16) is the Compensation target imposed on a four-wire system . control scheme of fig.9is modified . in the modification , there is a third input signal from the zero sequence power p_0. $v_{0\alpha\beta}^*$ is generated in the control block .

The stiff feeder , the proposed control strategy is suitable , where undistorted voltage could be considered .

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IV. SIMULATION RESULTS

In fig 6 the system is shown . it has been simulated on the platform of Matlab simulink for the verification of the proposed control . SimPowerSystem toolbox library is used to model every power device . The 3 –phase power system circuit is supplied along with the source inductance of 5.8mH, a source resistance of 3.6 Ω and a sinusoidal balanced 3= phase 100 – V source . insulated Gate Bipolar Transistor (IGBT) bridge is there in the inverter , two 100 V dc sources are connected on the DC side ,. to eliminate the high frequency components at the output of the inverter a LC filter has been included. By means of three single – phase transformers with a turn ratio of 1:1 ,this set is connected to the power system

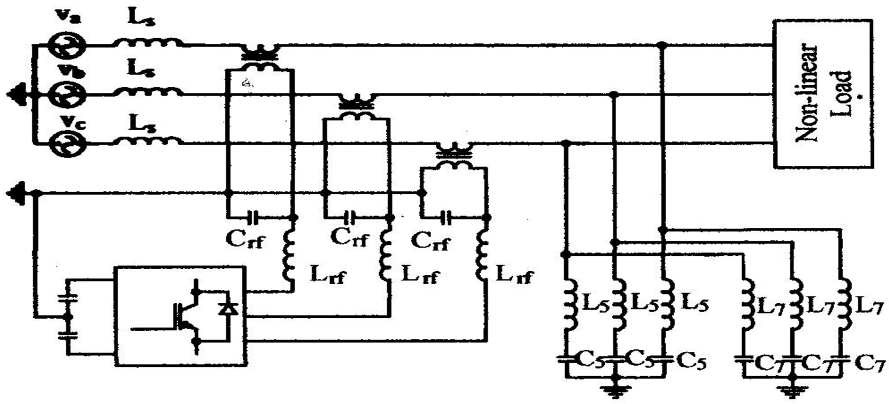

Fig 6 . passive filter topology and series active power

TABLE I
Values of passive element

Source	L_s= 5.8milliHenry ; $R_{s = 3.6}$ ohm	
Passive Filter	L_5 = 13.5 millihenry	C_5 = 30 microfarad
	L_7 = 6.75millihenry	C_7 = 30 microfarad
Ripple Filter	L_r = 13.5 millihenry	C_r= 50 microfarad

L_s is source inductance , L_r and C_r are inductance and capacitance values for ripple filter , L_5 and C_5 are the inductance and capacitance values to tune to the 5^{th} harmonics and similarly L_7 and C_7 are the inductance and capacitance values to tune to 7^{th} harmonics .

The criteria for selection to fix the ripple filter are

1- for low frequency components , that the voltage across C_{rf} is almost equal to inverter output voltage .
2- for high – frequency components , The voltage across capacitor C_{rf} . must be higher than the reduced voltage in L_{rf}

Further , the C_{rf} and L_{rf} values must be choosen so as not to increase the transformer burden . hence , the design criterias must be taken into account are as follows .

- $X_{Lrf} \gg X_{Crf}$, to make sure that across L_{rf} at the switching frequency the inverter output. voltage drops.
- $Z_S + Z_F >> X_{Crf}$ to make sure that voltage divider is between C_{rf} and L_{RF}, here source impedance is Z_S , the shunt passive filter is Z_F , secondary winding reflection .

At switching frequency of 20 – Khz, X_{Lrf} = 1696 Ohms . X_{crf} = 0.16 Ohms , Z_F = 565 ohms , Z_S = 728 ohms ,
Two types of load were Simulated :

- balanced Non Linear Load ;
- unbalanced non linear load.

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A. CASE 1: BALANCED NON LINEAR LOADS

In this , on the DC side , the non linear load consists of connection in series of a uncontrolled 3 – phase rectifier having an inductance of 55mH and a 25 ohm resistor.

Fig. 7 depicts the phase load current of phase "a". The total harmonics distortion (THD) is 18.6% and the power factor is 0.947 in the load current in an uncompensated system .

The most important harmonics are the 7^{th} and 5^{th} harmonics in the current waveform which are 8.4% and 16.3% of the fundamental one.

To mitigate the 5^{th} and 7^{th} harmonics two LC branches were connected. The passive filter with the source current waveform is shown In Fig.8. THD climbs down to 4.7% . The 7^{th} and 5^{th} harmonics decrease to 0.9% and 3.6% . to compensate the source current harmonics only the passive filter was designed ; the reactive power was not taken into account . The 0.97 is the power factor of the set passive filter and load.

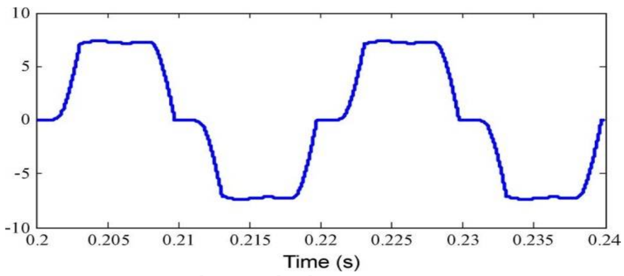

Fig.7 phase "a" load current .

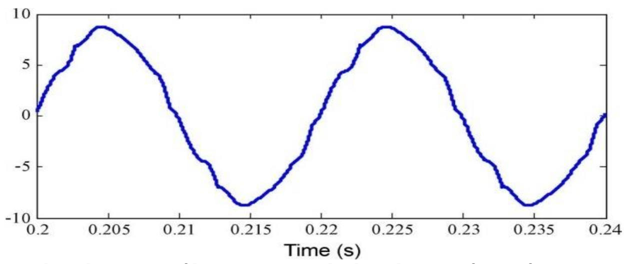

Fig.8 : When the passive filter is connected , then the waveform of source current

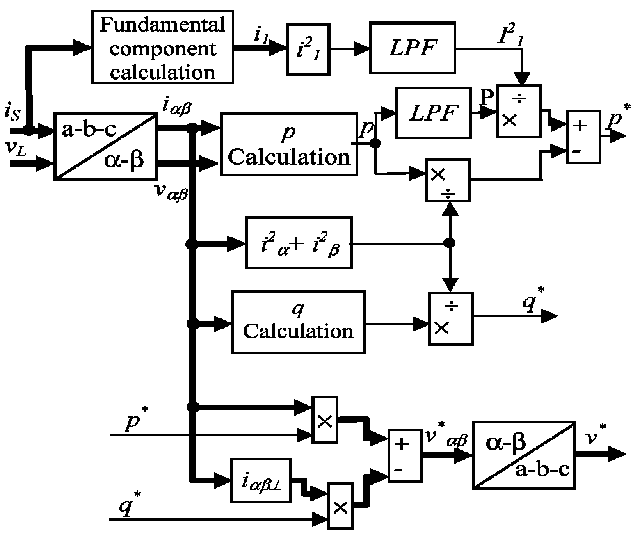

Fig.9 Scheme for control

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To simulate a passive filter with the active filter in series connection, Fig 6 APF reference signal becomes necessary to be determined . To calculate the active filter compensation voltage a control scheme as shown in Fig. 9 is used . the source current vectors and the voltage vector on the load side are input signals . By the use of a calculation block **,** in the αβ coordinates the $\boldsymbol{v}_{\alpha\beta}$ **e** $\boldsymbol{i}_{\alpha\beta}$ vectors can be determined . The the instantaneous real power is calculated by the product of these vectors , with a low-pass filter(LPF) average value is obtained . hence the power requirement of the set passive filter and load is obtained . The average value of the sum of the square of the instantaneous values of the current fundamental component is divided by the average power .

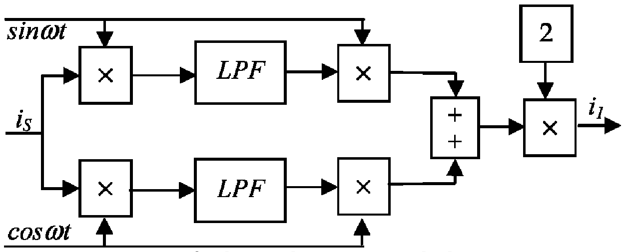

Fig.10. fundamental component calculation

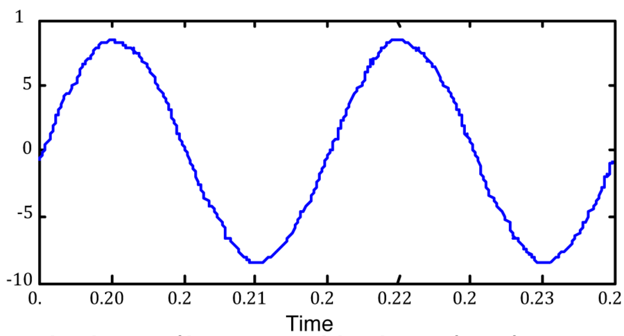

Fig.11. when the active filter is connected then the waveform of source current .

The diagram shown in Fig.10 in that the fundamental component is obtained . with the help of the block function . multiplication by $\sin \omega t$ and $\cos \omega t$ of each component of the source current vector here ω is the fundamental frequency in rad/s . using two low pass filters the average values of the results are obtained. Again they are multipled by $\sin \omega t$ and $\cos \omega t$ then by the number 2 . hence the current vector fundamental component are obtained ; conversely , is division of the real instantaneous power by $i_{\alpha\beta}^2$. The product is multiplied by the $\boldsymbol{i}_{\alpha\beta\perp}$ which is the current vector. This further allows the first term in the compensation voltage at equation (26) to be obtained .
Alternatively , we find the imaginary instantaneous power , the imaginary instantaneous power is divided by $i_{\alpha\beta}^2$, further it is multiplied by the $\boldsymbol{i}_{\alpha\beta\perp}$ which is a current vector . hence the second term in the compensation vector in equation (26) is obtained .
After the connection of the active filter , it is seen that there is a fall of 1.30% of the THD in the source current .fig.11 shows the waveform . power factor gets raised to 0.99 . hence the verification of the proposed control is completed .the improvement in the passive filter compensation characteristics and power factor of unity is achieved .
In order to be effective the passive filter impedance has to be lower than impedance of the system . if a impedance source quality factor is or branch LC is low , then the functioning of harmonics filtering also deteriorates or decreases . To verify the compensation equipment behavior under the above mentioned situation we now modify the source impedance . It is modified from 4.6 ohms and 6.7 mH to 2.3 ohms and 1.43 mH . when the active filter is not connected then the source current has a THD of 10.1 % and the passive filter as the compensation equipment is only connected .

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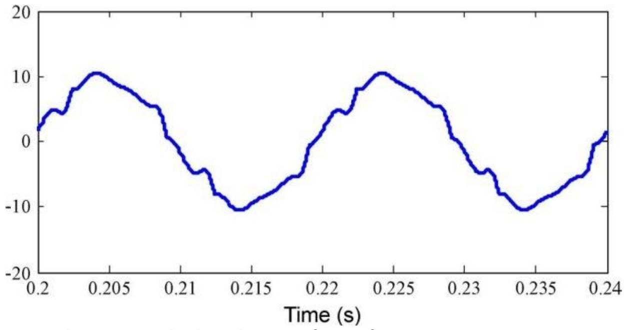

Fig.12 . when the passive filter is only connected , then the waveform of source current . Source Impedance 2.34 mH and 1.3 ohm

Fig.12 shows the source current waveform . The 7th and 5th harmonics are 2.5% and 8.2% of the fundamental harmonic and the 0.97 is the power factor .

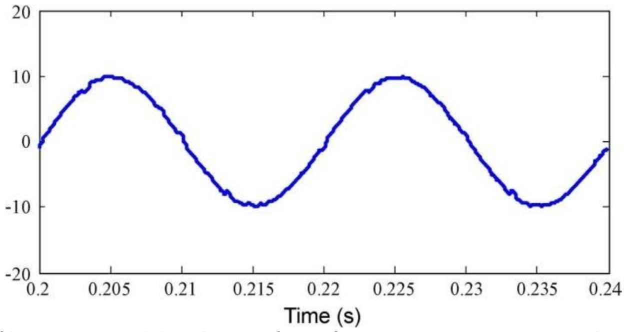

Fig.13. when the active filter is connected then the waveform of source current . source impedance 2.34 mH and 1.3 ohm

Fig.13 shows the current waveform . When the proposed control algorithm is working with the active filter, the power factor is 0.99 and the THD of the source current improves to 1.6% .

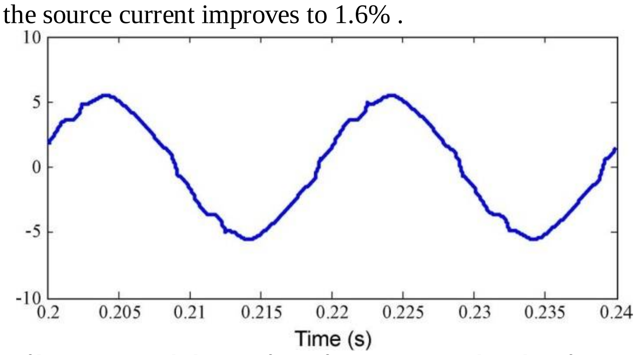

Fig.14. When only passive filter is connected, the waveform of source current . the value of resistor on the dc side is 50ohm

In a practical distribution system , load power may witness variations. For the verification of the behavior of the proposed control algorithm , at the dc side of the uncontrolled three-phase rectifier the resistor value was changed from 25 Ohms to 50 ohms . The source impedance is 5.8 mH and 3.6 ohm. after the passive filter is connected , fig .14 shows the source current waveform which has the THD of 4.9% and the power factor is 0.91 .
After the active filter is connected Fig. 15 shows the source current waveform and THD shows the improvement from 4.9 to 1.8 % , the power factor improves to 0.99 .
hence , with the control algorithm being proposed , the set of passive filter and active filter fulfills the objective of compensation for variable loads .

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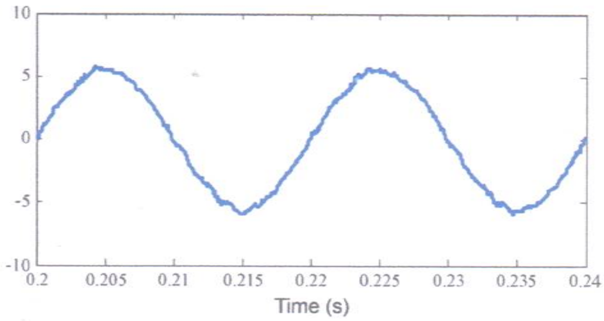

Fig 15 The active filter connected , resistor value is 50 ohms on dc side , the resulting source current waveform .

Table II
Values for the Passive Elements connected to load

	Capacitor value	Resistance value
Phase a	2200 microfarad	16.67 ohm
Phase b	2200 microfarad	25 ohm
Phase c	2200 microfarad	50 ohm

The capacitor and resistance values for the three phase circuit having phases as “a” , “b” and “c” for the passive filter

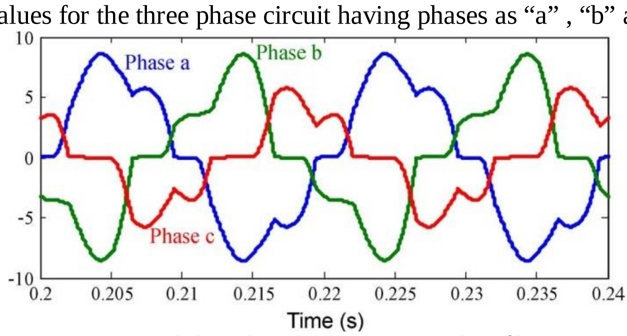

Fig.16. , Unbalanced Load source current without filters

The control algorithm can improve the behavior of the passive filter . and can compensate reactive power

B. CASE 2 : UNBALANCED NON LINEAR LOADS

In this , the 3 – phase load is constructed with at the dc side , 3 single phase uncontrolled rectifiers with resistors and capacitors connected in parallel with the values as is shown in Table II .
Fig. 16 shows about in the uncompensated system , the source currents . Current THDs of “c” “b”, and“a”, phase are 37.6%, , 35.0%, and 18.8% respectively .
Fig. 9 shows the control scheme for the active filter , for unbalanced loads it is modified . in Fig. 9 the block “ Fundamental component calculation “is replaced by the scheme shown in Fig. 17 . The average (Avg) power denoted by P is divided by the square root mean square value of positive sequence fundamental component . now , by means of the block “ Positive sequence component ” we get positive sequence component , to implement the Fortescue transformation which is obtained with an all pass filter for this the operator a= $e^{2\pi/3}$becomes necessary. Subsequently, from the application of Fortescue inverse transformation applied . its fundamental value is calculated .
The three source currents as shown in Fig. 18 when this control is applied to the active filter . behavior similar to a resistive and balanced load is shown by the system . the source currents Total Harmonics Distortions are 1.3% 0.85% and 1.4%, in phases “c”. “b” and “a”,

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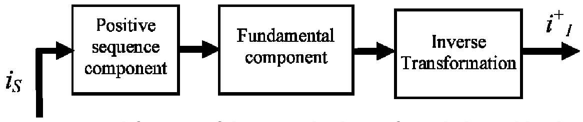

Fig.17. Modification of the control scheme for unbalanced load

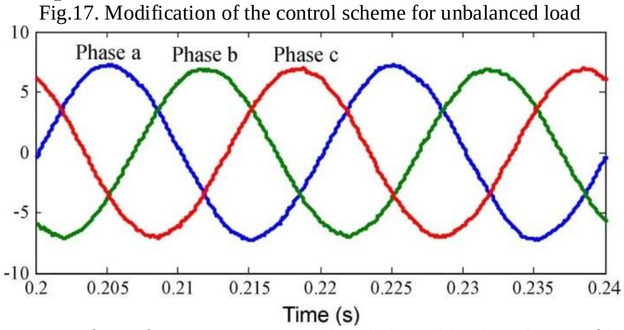

Fig.18. waveforms for Source current with unbalanced loads and active filters

The compensation objective is to obtain unity power factor as shown in fig 16 . A sinusoidal and balanced source surrent is obtained whenever the voltage is sinusoidal and balanced . Although the source current is distorted unity power factor is achieved whenever the voltage is distorted , ,.

V. CONCLUSIONS

For a hybrid power filter , the control algorithm is constituted by a passive filter and series active filter connected in parallel with the load . The dual vectorial theory of electric power forms the basis of control strategy . The new control methodology achieves the following objectives .

- The system impedance is independent of the compensation characteristics of the hybrid compensator .
- The resistive behavior is exhibited by the set hybrid filter and load . The risk of overload due to the current harmonics of non linear loads close or near to the compensated system is eliminated .
- As the compensator is not affected by changes in the tuning frequency of the passive filter , hence it can be applied to loads with random power variation further the active filter compensates for the reactive power variation
- Since the compensation equipment and load presents resistive behavior hence the Series and/or parallel resonances with the rest of the system is avoided .

Hence , with the above designed control algorithm , the harmonic compensation features of the passive filter and the power factor of the load are improved by the active filter

Now with different loads and with variation in the source impedance the simulations with the MATLAB – simulink platform were performed , Simulation results are exibited.

REFERENCES

[1]. Adams , D. J., and Peng, F.Z., “Harmonics sources and filtering approaches” ,Industry Applications Conference , Vol.1 , pp. 448-455 , 2013
[2]. Dass J . C., ”passive filters- potentialities and limitations” , IEEE Transactions and Industrial Applications , Vol. 40 , Issue no. 1 pp.232-241, 2004.
[3]. Czarnecki, L.S.,and Ginn, H.L., “An optimization based method for selection of resonant harmonic filter branch parameters ”, IEEE Transactions Power delivery, Vol. 21 , issue no. 3 , pp . 1445-1451 , 2012
[4]. Pomilio, J.A., and Deckmann, S.M., “ Characterization and compensation of harmonics and reactive power of residential and commercial loads ” .IEEE Transactions Power Delivery, vol 22 , issue no. 2 , pp. 1049- 1055 , 2007 .
[5]. Akagi, H., “active harmonic filters” ,Proceedings of the IEEE Vol. 93 , issue no. 12 , pp 2128-2141 , 2005
[6]. Chandra, A., Al- Haddad, K., and Singh, B., “ A review of active filters for power quality improvements “ IEEE Transactions Industrial Electronics ,Vol.46, no 5 , pp. 960 -971 , 1999 .
[7]. Morna,L. A., Venegas, G., and Dixon,J.W., “ A series active power Filter based on a sinusoidal current controlled voltage- source inverter .” IEEE Transactions Industrial Electronics , vol 44 no. 5 ,pp 612- 620, 1997
[8]. Aggarwal, V., and George, S., “ Optimum control of selective and total harmonics distortion in current and voltage under non sinusoidal conditions ”IEEE Transactions power Delivery , Vol. 23, no. 2, pp 937- 944 , 2008 .

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ISSN (Print) : 2320-9798

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(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 5, May 2016

[9]. Ren, S., and Yeng, H., " a practical series shunt hybrid active power filters based on fundamental magnetic potential self balance "IEEE Transactions of power Delivery , vol 23 , no. 4 , pp 2089 – 2096 , 2008 .
[10]. Tu, C., Zhu, W., Shuai, Z., Fan, R., and Luo, A., "Development of hybrid active power Filter based on the adaptive fuzzy dividing frequency – control methods ", IEEE Transactions Power Delivery, Vol. 24 , no 1, PP 424 – 432, 2009.
[11]. Nabac, A., Akagi, H., and Peng,F. Z. ,"A novel harmonic power filter ", Proceedings of IEEE/ PESC, , pp 1151 – 1159 . 1988
[12]. Nabae, A., Akagi, H., and Peng, F. Z., "New approach to harmonic compensation in power systems- a combined system of shunt passive and series active filters ," IEEE Transcripts Industrial Applications, Vol. 26, no 6 , pp 983-990 ,1990.
[13]. Zhong, H., Ma, H., Lu, Z., and Chen, P., "Three phase four wire series hybrid active power filters with fundamental current bypass channel, " , Industrial Electronics society (IECON), Vol. 1 , pp 536-539, 2004.
[14]. Liu, J., Yao, W., Wang, Q., and Wang, Z., " A series active power filter adopting hybrid control approach " IEEE Transactions of Power Electronics , Vol. 16, no. 3 , pp. 301 – 310 , 2001 .
[15]. Seok, J. K., Lee, D. C., and Lee, G.-M., " Control of series active power filters compensating for source voltages imbalance and current harmonics ,"IEEE Transactions Industrial Electronics ,Vol. 51, no. 1, pp132- 139, 2004.
[16]. Ko, S. H., Kim, J. S., and Kim,Y. S., " Three phase three – wire series active power filters , which compensates for harmonics and reactive power" IEEE Electric Power Applications " Vol. 151 , no. 3 , pp 276-282, 2004 .
[17]. Peng, F. Z., and Lai, J. S., "Generalized instantaneous reactive power theory for three phase power systems ". IEEE Transactions of Instrumentation and Measurement , Vol. 45 , no. 1 , pp 293-297 ,1996.
[18]. Herrera, R. S., and Salmeron, P., "Instantaneous Reactive Power theory : A comparative evaluation of different formulations", IEEE Transactions Power Delivery , Vol. 22, No. 1 , pp 595 – 604 , 2007 .
[19]. Salmeron, P. Herrera, R. S., and Vazquez, J. R., "Mapping matrices against vectorial frame in the instantaneous reactive power compensation ", IET Electrical Power Applications, Vol. 1 , No. 5 , pp 727-736 , 2007.

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