REVIEW ON POWER QUALITY IMPROVEMENT BY POWER FILTER'S

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ABSTRACT

In recent year power system is turn towards smart grid and micro grid i.e renewable energy sources are integrated with utility grid system and hence various power electronics and non-linear lodes are used which leads to power quality problems in power system. the critical issue of power quality problem is harmonics present in power systems so for power quality improvement various power filters are used. this paper I m going to review recently published paper in ieee on power quality improvement by using various power filter and control strategies. As we know there are mainly three type of power filter are available to reduced THD, which are active power filter ,passive power filter and hybrid power filter and recently used inductively active power filter. all researcher trying to reduced THD below 2% and by using various type controller such as P,PI,PID controller, Hysteresis current control, fuzzy logic controller, adaptive controller, PSO for MPPT,ANN Techniques,UPQC, SMC, least squares harmonic extraction technique. Also various custom power devices such as DSTATCOM, DVR, etc

Keyword : - *power quality1 ,power filter2,THD3, and P,PI,PID4, fuzzy ,adaptive ,UPQC, least squares5 etc*

1. INTRODUCTION

Due to the advancement of technology, industrial structure reforming, and the development of smart grid technology recently, people have a higher demand for improved power quality [1]. However, with the proliferation and increased use of power electronics devices and motor loading, it is becoming more difficult to achieve this goal [2]. In mid 1940s, passive power filters (PPF) were developed to suppress current harmonics and compensate reactive power [20]. In 1976, active power filters (APF) were developed to compensation harmonics. HAPFs are more attractive in harmonic filtering than pure APFs from both viability and economical view [21][22]. To achieve the best performance, the united power quality converter (UPQC), has been developed with an extremely high cost [23]During 1967-2005, HAPFs are mainly applied to traditional industry, such as steel furnace, ASD, etc. Most research works focus on basic and single function, just harmonic compensating. After 2005, many researchers focus on the development of application, optimal design, and dynamic reactive power compensating. Some literatures [24] have discussed the feasibility of HAPF in railway, wind farm, and photovoltaic generator. As the price and operating loss of power electronic switcher limit the performance of HAPF, many researchers have proposed optimal design method in parameter selection, control method, and structures.

1.1 Power Quality Issues

Approximately 70 to 80% of all power quality related problem can be contributed to faulty connection and/or wiring. Power frequency disturbances, electromagnetic interferences, transient, harmonics and low poor factor are the other categories of PQ problems that are related to source of supply and load types. Survey reported of 8european country cost due to PQ issues found that 150bn Euros. Its huge cost so necessary to mitigates PQ issues.[25]

1.2 Mitigation of PQ Problem

There are two ways to mitigate the power quality problem first is from customer side & other from utility side. The first way can be given as load conditioning, which ensures that equipment is less sensitive to power disturbances. The alternative solution to add a line conditioning systems that suppress power system disturbances. Several devices

including flywheels, super capacitor, other energy storage devices, constant voltage transformer, transient voltage surge suppressor, harmonic filters are used for mitigation of specific PQ problems. Custom power devices (CPD) like DSTATCOM, DVR are capable of mitigates multiple PQ problems associated with utility distribution and end user appliances. But the presence of harmonics is highly dangerous for both the connected loads & also for the power system connected to the grid due to harmonic current flow.[25]

2. GENERAL CONTROL ALGORITHMS

Its seen that the mathematical algorithm is required to analysis harmonic component is same in all references hence we called here as "GENERAL CONTROL ALGORITHMS" which is "p-q Instantaneous Real and Reactive Power Theory & another is d-q generalized theory"

2.1 p-q Instantaneous Real and Reactive Power Theory

This theory takes into account the instantaneous reactive power arises from the oscillation of Power between source and load and it is applicable for sinusoidal balanced/unbalanced voltage but fails for non-sinusoidal voltage waveform. It basically 3 phase system as a single unit and Performs Clarke's transformation (a-b-c coordinates to the α-β-0 coordinates) over load current and voltage to obtain a compensating current in the system by evaluating instantaneous active and reactive power of the network system. The p-q method control strategy in block diagram form is shown in fig-1.This theory works on dynamic principal as its instantaneously calculated power from the instantaneous voltage and current in 3 phase circuits. Since the power detection taking place instantaneously so the harmonic elimination from the network take place without any time delay as compared to other detection method. Although the method analysis the power instantaneously yet the harmonic suppression greatly depends on the gating sequence of three phase IGBT inverter which is controlled by different current controller such as hysteresis controller, PWM controller, triangular carrier current controller. But among this hysteresis current controlled method is widely used due to its robustness, better accuracy and performance which give stability to power system.[19]

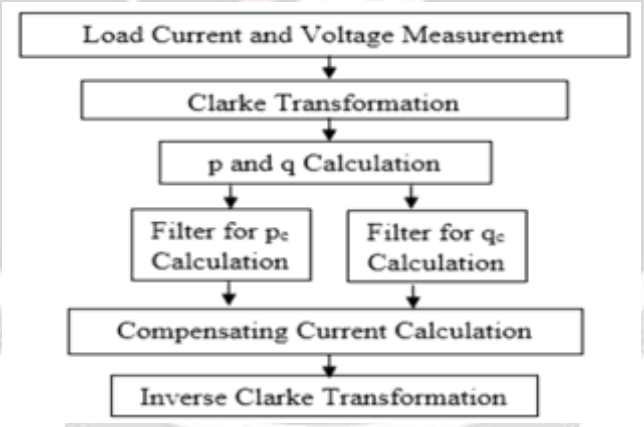


Fig -1 P-Q method control strategy

2.2 Hysteresis Current Controller

Hysteresis current control method is used to provide the accurate gating pulse and sequence to the IGBT inverter by comparing the current error signal with the given hysteresis band. As seen in figure 3 the error signal is fed to the hysteresis band comparator where it is compared with hysteresis band, the output signal of the comparator is then passed through the active power filter to generate the desired compensating current that follow the reference current waveform. [19]. Asynchronous control of inverter switches causes the current of inductor to vary between the given hysteresis band, where it is continuously compare with the error signal, hence ramping action of the current takes place. This method is used because of its robustness, excellent dynamic action which is not possible while using other type of comparators, There are two limits on the hysteresis band i.e. upper and lower band and current waveform is trapped between those two bands as seen from figure 4. When the current tends to exceed the upper band the upper switch of the inverter is turned off and lower switch is turned so that the current again tracks back to

the hysteresis band. Similar mechanism is taking place when current tends to cross the lower band. Thus current lie within the hysteresis band and compensating current follow the reference current.

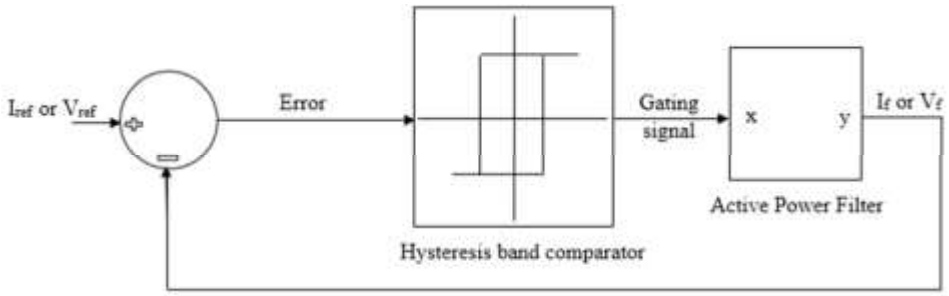
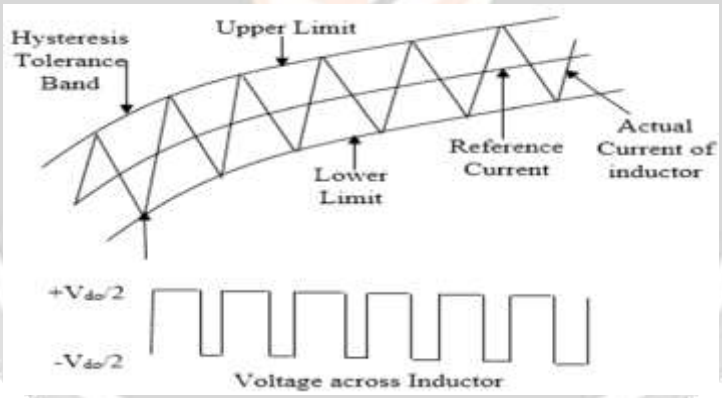


Fig.2 Hysteresis Controller control logic

Hence, Upper limit hysteresis band= Iref + max (Ie) and where, Iref = Reference Current
Lower limit hysteresis band= Iref - min (Ie) Ie = Error Current
As a result, the hysteresis bandwidth= 2*Ie.
Thus smaller the bandwidth better the accuracy,Switching frequency can be easily determined by looking at the voltage waveform of the inductor. The voltage across inductor depends on gating sequence/gating pulse of IGBT inverter which is again dependent on the current error signal of the hysteresis controller. Variable frequency can be obtained by adjusting the width of the hysteresis tolerance band.[19]



2.3 d-q Synchronous Reference Frame theory

Another method to separate the harmonic components from the fundamental components is by Generating reference frame current by using synchronous reference theory. In synchronous reference theory park transformation is carried out to transformed three loads current into synchronous reference current to eliminate the harmonics in source current. The main advantage of this method is that it takes only load current under consideration for generating reference current and hence independent on source current and voltage distortion. A separate PLL block it used for maintaining synchronism between reference and voltage for better performance of the system. Since instantaneous action is not taking place in this method so the method is little bit slow than p-q method for detection and elimination of harmonics. Figure 5 illustrate the d-q method with simple block diagram.[19]

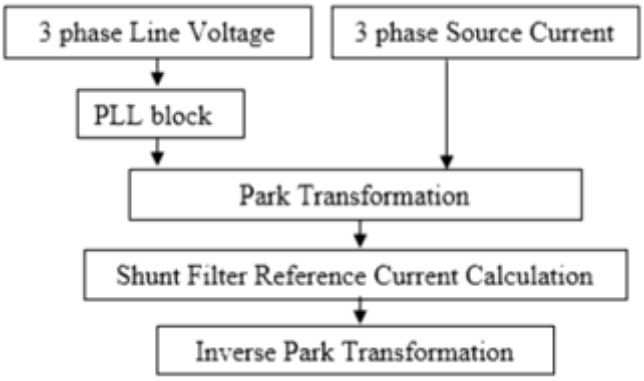


Fig.3 D-Q method control strategy

3. POWER QUALITY IMPROVEMENT BY POWER FILTER'S

In this paper, (voltage dip) and momentary rise in voltage (voltage swell) are discussed and they are nullified using Dynamic Voltage Restorer (DVR), in order to mitigate voltage sags and swells in low voltage distribution systems. Dynamic Voltage Restorer can provide the most cost effective solution to mitigate voltage sags and swells that is required by customer also this research paper give comparison of DVR over DSTATCOM & UPQC.[3]

In this paper, Comprehensive analysis of the operation and control of DSTATCOM using both PI and Fuzzy logic controller as seen from result fuzzy logic controller gives more correct response but very closed with PI controller [4]

In this paper, APF are act as current source which injects an anti-phase but equal magnitude to the harmonic and reactive load current to eliminate the harmonic and reactive components of the supply current in distribution system. These active filters have limitations in medium and high voltage application due to semiconductor's reverse voltage rating constraint, and use of high rated transformers consequently system becomes inefficient, costly and bulky. Cascade seven level inverter based SAPF is a viable solution in medium and THDs are lowered down to less than 5%,after compensation THD is 1.98%.[5]

In this paper, we will investigate the effect of using an APF to improve the output power quality of a simplified synchronous generator (SSG) with distorted back-EMF. A Matlab Simulink model for the SSG is built to simulate all the system, the APF and the proposed generator. Using an APF, simulation and experimental results show significant improvements in generator output current and reduced the THD in the system. High voltage applications as these provide high output voltages with less voltage rating of individual device. It also able to achieve the required voltage levels using low voltage rating devices which eliminates the need of transformer to feed the power to high voltage distribution network [6]

	Before enabling the APF		After enabling the APF			
	load/generator		Load		Generator	
	THD%	Amp	THD%	Amp	THD%	Amp
Phase-A	14.6	57.5	20.3	60.0	3.7	54.6
Phase-B	15.4	56.5	19.7	58.9	3.3	52.9
Phase-C	20.1	45.4	25.5	47.1	3.8	53.7

Chart -1 with & Without APF load & generator side.

In this paper, Active filter for power quality improvement by artificial neural networks technique has a total harmonic distortion (THD) of an overall THD of around 2.9 % when the proposed adaptive shunt active filter is used.[7]

In this paper, Enhancement of Power Quality Disturbances using Hybrid Power Filters. It is observed that the THD value is improved significantly to 4.20% and 4.76 % respectively by shunt and series hybrid filters. Harmonic Compensation using hybrid filters based d-q Theory. [8]

In this paper, Realization of Current Control Strategies of Shunt Active Power Filter Operating with Unbalanced Loads. Used hysteresis current controlling to track harmonics current components and finally compensation provided with THD improvement upto 2.64%.[9]

In In this paper, we had analyzed a various controlling techniques which can be used with hybrid power filter in order to get a more current waveform of inverter. By the simulation and analysis, it is clear that the response of P-type the hybrid active filter contains more peak output in inverter can be improve with PI & PD controller but these controller cannot completely remove non linearity in the output. Lastly when the same filter used with PID controller it is observed that its removes the peak as well as non linearity of inverter output and load current waveform is almost sinusoidal.[10]

In this paper, a simplified control technique without dc voltage regulation loop of SAF has been suggested for harmonic Mitigation and reactive power compensation in the distribution system. The suggested control algorithm without dc voltage Sensing element not required; so cost reduced and 3) the source current are balanced. This kind of control algorithm used in Low cost applications. It has been shown that the SAF is able to keep the 4.71% THD of the supply current within the limits. The simulation results are validated with the proposed control algorithm to improve power quality by SAF in distribution System. [11]

Hysteresis current control (hcc) technique is basically an instantaneous feedback current control method for pwm and instantaneous reactive power theory utilized for power quality improvement in distribution systems using shunt active power filter. The simulation results are validated with the proposed control algorithm to improve THD upto 2.46%. [12]

An Inductively Active Filtering Method for Power-Quality Improvement of Distribution Networks with Nonlinear Loads. IAF method can effectively prevent harmonic components from flowing into the primary (grid) winding of The transformer. Since the harmonic components are suppressed near the harmonic source, it is good for the power-supply system and especially good for the converter transformer. Besides, since the harmonic flow is limited to near the harmonic source, the PQ of the public network can be guaranteed completely. The simulation results are validated with the proposed control algorithm to improve THD upto 4.18%. [13]

Reduction of Harmonics and Voltage Sag Compensation by Series Active Power Filter.Here proposes the hysteresis control algorithm for the improvement of power quality by series active power filter (APF).Here, the Simulink model of series active power filter and its control technique by hysteresis PWM controller has been carried out in MATLAB SIMULINK. The voltage sag analysis and total harmonic distortion (THD) analysis are also carried out by using FFT analysis. Simulation result shows that the proposed configuration for series APF has the expected Performance. Load Voltage THD (With Series APF) is upto 1.82%. [14]

Shunt Active Power Filter For MV 12-Pulse Rectifier Using PI With SMC Controller, The simulation results are validated with the proposed control algorithm & it is seen that THD measured with PI and with PI-SMC controller are0.46% and 0.37% respectively. [15]

Shunt active power filter compensates current harmonics by injecting equal-but-opposite harmonic compensating current indirect current control method for the single phase APF is used. Simulation result shows that the proposed configuration Improvement of Energy Efficiency through Power Quality by the Compensation of Harmonics with %THD of 3.52%using simple Shunt Active Power Filter[16]

presents D-Q Synchronous Reference Frame (SRF) current control method in order to generate the required reference current for 3-phase 4-wire shunt hybrid active power filter (SHAPF) to solve harmonics problem in power system network. Here, the passive elements of SHAPF have been used for compensation of reactive power and to eliminate the lower order harmonics and the active part have been used for the higher order harmonics. A modified phase lock loop (PLL) has been used to handle the double frequency element of non-ideal voltages. Simulation

result shows that the proposed configuration for series APF has the expected Performance. Load current THD (With Shunt HAPF) is upto 3.52%. [17]

Improvement of power quality using PQ-theory shunt-active power filter. A simulation model of the three-phase shunt active filter had been implemented based on the mathematical modeling of the system where we can observe the considerable improvement in the source current in the norms of Total Harmonic distortion (THD) of source current upto 3.75%. We can also observe the correction in the power factor (PFC).Properties are restored in the terms of source voltage and source current are in phase by this implementation.[18]

4. CONCLUSIONS

We firstly Concluded that Custom power devices (CPD) like DSTATCOM, DVR is effectively reduced THD but only for Load side and hence PQ problem of supply side is remains as it is [3], Then we used power filters also reduced harmonics upto standard THD 2% but only for load side. the only proposed power filtering technique namely as "inductively active power filter" technique reduced harmonics from both side power supply & load side but %THD is only upto 4.71% that is only disadvantage[13]. Then secondly we conclude that out of controller, PI controller and fuzzy controller is good but with PI-SMC controller improves THD upto 0.37%[15].Finally we concluded that for mathematical analysis AC to DC domain and vice versa is must for detection of harmonic component hence p-q & d-q algorithms generalized & important for power quality improvement using power filter.[3]-[25]

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