Review Paper on Harmonic Mitigation using Shunt Active Filter

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Abstract— Harmonic is a most severe problem in power system. With wide use of power electronics devices at industries, commercial, residential electrical load there is a serious problem relating to power quality. One of such problem is generation of current and voltage harmonics. Traditionally it was suppress by LC filters known as passive filters. On another way newly developed active filters are universally suppressing the harmonics. Active filters are comparatively superior to conventional passive filters. In this paper the active shunt filter control strategies for harmonic mitigation is reviewed.

Keywords: Harmonic, Non Linear Loads, Shunt Active Filter, Synchronous Reference Frame

I. INTRODUCTION

Power electronic switching device in conjunction with nonlinear loads causes serious harmonic problem in power system due to their inherent property of drawing harmonic current and reactive power from AC supply mains. They cause voltage unbalance and neutral currents problem in power system. With the distortion of current and voltage waveform due to presence of harmonic effect the power system equipment that are connected to maintain steady and reliable power flow in the power system. Major effects include overheating, capacitor failure, vibration, resonance problem, low power factor, overloading, communication interference and power fluctuation. Thus to improve the performance it is required to eliminate harmonics from power utility system. One of the method used for elimination is the use of shunt active power filter (SAPF) in which a reference current is generated to remove distortion from the harmonic currents. Shunt active power filter continuously monitor the harmonics current and reactive power flow in the network and generate reference current from distorted current waveform. Thus dynamic closed loop action of SAPF helps the reduction of harmonics and compensation of reactive power in real time basis with little time delay. SAPF can be used with different current control strategy such as d-q method, fuzzy logic controller, p-q method, neural networks etc. which is helpful in removing effective harmonic from power system.

II. LITERATURE REVIEW

C Sankaran, H Akagi [1-2] described power quality issues. Power quality is a term that means different things to different people. Institute of Electrical and Electronic Engineers (IEEE) Standard IEEE1100 defines power quality as "the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment." As appropriate as this description might seem, the limitation of power quality to "sensitive electronic equipment" might be subject to disagreement. Electrical equipment susceptible to power quality or more appropriately to lack of power quality would fall within a seemingly boundless domain. All electrical devices are prone to failure or malfunction when exposed to one or more power quality problems. The electrical device might be an electric motor, a transformer, a generator, a computer, a printer, communication equipment, or a household appliance. All of these devices and others react adversely to power quality issues, depending on the severity of problems. Shunt Active filter can compensate only for the harmonic current of a selected non linear load and can track change in its content. This literature presents several approaches to shunt active filters for grounded and ungrounded system.

D. C. Bhonsle and R. B. Kelkar [3] Harmonic pollution at domestic level Power quality is a major concern for power system engineer. This paper represents harmonic field measurement for different domestic load such as fan regulator, personal computer, laptop and LCD projector. Analysis shows that total harmonic distortion on current spectrum varies from 12.9% to 156.2% which violates the limit of IEEE-519.

B. Singh, K. Al-Haddad and A. Chandra [4] presents a comprehensive review of active filter configuration, central strategies, selection of components and other related economic and technical considerations. The paper is representated in seven parts. A brief analysis of harmonic of harmonic pollution, effects and causes are represented. Active Filter is a effective solution in new trend of harmonic mitigation AF can be classified based o topology, supply scheme and connections. Control strategy. Gating signal in different varieties is given. Selection of switches like IGBT/GTO for VSI, input filter value for VSI, passive ripple filter at terminal supply voltage is an important phenomenon. Technically IEEE-519 standard will result in increased use of AF in coming years. As a result modern active filter are capable for compensating 25th harmonic. Also, now a days AF,s cost reduces significantly. Specific AF for specific application is an important task. For harmonic current compensation, voltage compensation, current and voltage compensation different AF & their combination should be implemented

K. Bhattacharjee [5] presents the application of simulation tool to analyze the effectiveness of Shunt Active filter in harmonic current suppression. He proposed synchronous reference frame based three phase 3 wire shunt active power filter model. This model has been simulated on MATLAB/SIMULINK. Proposed model indicates shunt active filter can restrain source active current very effectively.

S. Sahadev and Manju B [6] objective is to find suitable control strategy of VSI Current harmonic is a cruisal issue due to wide spread of harmonic loads. Due to technological improve several Active Power Filter with several control mechanism are available. This paper evaluates APF performance for synchronously rotating reference frame control mechanism. The performance is based on PI controller & FUZZY controllers are compared. FUZZY

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controller gives better result w.r.t THD and settling time of DC capacitor voltage

K. Bhattacharjee [7] implemented SRF theory for generation of reference current signal Increased number of passive power electronic components greatly impacted on quality of power supply. Shunt Active Power filter having VSI is an useful technology for suppression of harmonic filter. In this paper SRF theory is implemented for generation of reference current signal and adaptive hysteresis control technique for controlling VSI. Simulation result indicates that the proposed active power filter can restrain harmonics of electrical source current effectively. One important result is that low switching frequency increases THD

R. Belaidi, M. Fathi, M. M. Larafi, G. M. Kaci, R. Belaidi and A. Haddouche [8] represent simulation of a PV interactive Shunt Active filter for harmonic current damping and reactive power compensation. During day shunt active filter brings all its function into operation while night only inverter provides reactive power compensation and harmonic. Synchronous d-q-0 algorithm is used for reference current calculation because it allows harmonic compensation and reactive power compensation simultaneously. Hysteresis current control is used for switching signal. Simulation result is found satisfactory according to IEEE 519 standard and also it indicates perfect compensation of reactive power

S. H. Qazi, M. W. B. Mustafa, S. Soomro and R. M. Larik [9] highlighted two references current extraction methods (1) Synchronous Reference frame (2) Instantaneous Reactive Power theory for shunt active filter. Modern days wind turbine generator is connected to grid. In this paper, Analysis is done with SAF based on these two t9echniques for grid connected permenant magnate synchronous generator of wind turbine. Simulation result of THD at PMSG and PCC sides indicates that shunt active filter reduces THD to satisfactory level vis-à-vis to IEEE 519 when applied with wind energy conversion system.

N. B. Atan and B. B. Yunus [10] concentrated to interface simulink model of shunt active filter with real time Digital Signal Processor (DSP). The reference current is to be detected from load current and processed by active filter controller is obtained from two different control algorithm namely, instantaneous reactive power theory (p-q theory) and synchronization ref. frame theory (SRF Theory).Observation made based on simulation result from the active filter shows that in sinusoidal and balanced source voltage condition the compensating current reference do not differ greatly.

Murat Kale,Engin Ozdemir [11] presents an adaptive hysteresis band controller is adopted for elimination harmonic and to compensate reactive power for 3 phase rectifier.Adpative hysteresis band current controller changes the hysteresis bandwidth according to modulation frequency, supply voltage,DC capacitor voltage and slop of i*c reference current compensation. The algorithm used is Synchronous Reference Frame (SRF).Simulation result shows that the fix band hysteresis current control and the adaptive hysteresis band current controller are equally good in filtering the harmonic generated by load. The instantaneous switching frequency remains constant in adaptive band controller rather than fixed band hysteresis current controller

N. Mendalek, K. Al- Haddad, L. A. Dessaint and F. Fnaiech [12] represents modeling and a non linear control of three phase voltage source active filter using space modulation switching strategy . The three phase thyristor bridge rectifier with R-L is taken as non linear load. The reference harmonic components are extracted from sensed non linear load currents by applying synchronous reference frame method. The voltage level of DC side is regulated using a linearizing feedback control. The reference current needed to maintain a regulated dc voltage is added to current loop reference. The MATLAB/SIMULINK result indicates that PI based compensator of SAF considerably reduces lower order current harmonic. The current controller is designed to obtain low overshoot that is verified in simulation.

P. Karuppanan and K. Mahapatra [13] illustrate five level cascaded multilevel inverter based shunt active filter for power line conditioner. An extraction method is SRF.VSI switching signals are generated through triangular periodical current controller which gives better dynamic performance under steady state and transient condition. The simulation result indicates that cascaded multilevel inverter provides higher performance for power line conditioner

A. Esfandiari and M. Parniani [14] present an investigation of power quality arising from electric arc furnace operation. Arc furnace is highly varying load. In addition to harmonic pollution EAF generates many troublesome emissions such as voltage flicker and voltage notching. Reference signals are obtained from instantaneous current vector component on a rotating reference frame. A series inductor is introduced for limiting variations in load currents. Simulation result indicates that voltage flicker and non integer harmonic at PCC voltage considerably reduces

G. A. Dongre, V. V. Choudhari and S. P. Diwan [15] present two different reference current generation technique viz. modified synchronous reference current generation (MSRF) and cross correlation function approach. Due to day by day use of non linear load an important issue is to remove harmonic contents from power system. One of the effective way is Shunt Active Power Filter (SAPF).Heart of SAPF is reference current generation technique. Result shows that THD percentage in both of this technique are acceptable under IEEE-519 standrad, however cross corelation function technique is slightly better against percentage THD point of view Sangsun Kim [16] proposed a new approach scheme based on synchronous reference frame. Non linear load could be unbalance due to either supply voltage or load imbalance. In this paper unbalance non linear load mathematically analyzed to apply for real time Active Power filter. Conventionally in SRF method Park transformation is applicable to balanced load condition only. The new propose scheme is based on three phase as well single phase system in which SRF currents are divided into three a, b, c components which include (DC, 2nd and higher order harmonic)

III. CONCLUSION

Literature indicates harmonic mitigation is a challenging task for modern power system. Also due to de-regulation in electricity generation a lot of power generating company based on wind, solar are entering in this field. As a result it is necessary to suppress harmonics in real time. Active filter is an effective solution among all available tool. The above review indicates that Synchronous reference frame based control strategies to generate reference current are more preferable than other for shunt active filter.

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