A Review on Hybrid Series and Shunt with Power Quality Monitoring System

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Abstract - Power system harmonics are a menace to electric power systems with disastrous consequences. The line current harmonics cause increase in losses, instability, and also voltage distortion. With the proliferation of the power electronics converters and increased use of magnetic, power lines have become highly polluted. Both passive and active filters have been used near harmonic producing loads or at the point of common coupling to block current harmonics. Shunt filters still dominate the harmonic compensation at medium/high voltage level, whereas active filters have been proclaimed for low/medium voltage ratings. With diverse applications involving reactive power together with harmonic compensation, passive filters are found suitable. Passive filtering has been preferred for harmonic compensation in distribution systems due to low cost, simplicity, reliability, and control less operation. The uncontrolled ac-dc converter suffers from operating problems of poor power factor, injection of harmonics into the ac mains, variations in dc link voltage of input ac supply, equipment overheating due to harmonic current absorption, voltage distortion due to the voltage drop caused by harmonic currents flowing through system impedances, interference on telephone and communication line etc. The circuit topologies such as passive filters, ac-dc converter, based improved power quality acdc converters are designed, modeled and implemented. The main emphasis of this investigation has been on a compactness of configurations, simplicity in control, reduction in rating of components, thus finally leading to saving in overall cost. Based on thesis considerations, a wide range of configurations of power quality mitigators are developed, which is expected to providedetailed exposure to design engineers to choose a particular configuration for a specific application under the given constraints of economy and desired performance. For bidirectional power flow applications, the current source converter is designed and simulated with R-L load.

Keywords- Passive Filters, Active Filters, Hybrid Filters, Power quality, nonlinear loads

Literature Survey-

SHILPA.R and P.S.PUTTASWAMY (2014) latest innovative ideas to make the life easier using the technology depends upon the application of power electronics in turn about power quality. According to development of electric power consumption, and increasing nonlinear loads in power systems, production of electric power with a high quality is the main problem of power engineering. Therefore, it is necessary to evaluate the problems of power quality in the power systems in order to improve. Comprehensive knowledge of power quality issues is important in today's electrical power system operating environment, but the ultimate purpose of learning about power quality is to be able to solve power quality problems. The paper describes a review of so far the work carried out on power quality issues which would be helpful for the researchers to do the future work related to power quality.

Shaik Mahammad Rasool et al. (2016) Renewable energy has made a stunning entrance to the market. The integration of these systems (wind energy, hydro energy, solar power etc.) created different kinds of problems in the grid. Whether system stability problems or Power Quality issues, these issues need solving. Classically passive filters were used but nowadays active filters such as Static Var Compensator (SVC), Dynamic Static Compensator (DSTATCOM), Dynamic Voltage Regulator (DVR), Unified Series-Shunt Compensator (USSC) and Unified Power Quality Conditioner (UPQC). The UPQC is a relatively new member of the custom power device family. This paper presents a 3-phase unified power quality conditioner (UPQC) to compensate voltage fluctuation and current distortion in the power utility side. The UPQC compensates for any unbalanced or distorted three-phase supply voltages and load currents in a power distribution network. In this paper, UPQC and its control strategies are described. Hysteresis current controller is used for obtaining the gate pulses from the reference current and voltage signal. The simulation has been done by MATLAB/SIMULINK and shows the work of the UPQC.

Shitsukane Aggrey Shisiali et al. (2016) This paper presents mitigation of power quality problems introduced by nonlinear loads. Through the expansion of modern industrial technology enormous number of non-linear loads are used in power system, which causes harmonic distortion. At the same time the power quality and safe operation becomes substandard. Therefore alleviation of harmonics is very essential under this situation. A Hybrid power filter constituting a series active filter and a passive filter coupled in parallel with the load is proposed to improve the power quality. To validate the developed theoretical analysis, the control strategy is verified by means of an experimental prototype using Multisim software. Shunt, hybrid and series active power filters are described showing their compensation characteristics and principles of operation. The results to verify the effectiveness of the proposed control algorithm is presented.

Rudranarayan Senapati et al. (2017) This paper describes about mitigation of power quality issues using shunt active filter in a grid connected hybrid energy system consisting of PV-Battery-Fuel Cell. The shunt active filter control is based on Sinusoidal Current Control Strategy. The shunt active power filter is implemented in the hybrid system to mitigate the harmonic current component as well as to recompense the imaginary or reactive power owing to their exact and reckless operation. The sinusoidal current control strategy is utilized to extricate sinusoidal current commencing from the source. Action of the shunt active power filter under passive load conditions using non-linear load, the performance of the sinusoidal current control technique is evaluated using MATLAB R2016a. MATLAB simulation results validate the efficacy of the power filter system to mitigate harmonic, it also offered to validate the control strategy. The total harmonic distortion (THD) of voltage as well as of current determines the practical feasibility of controller designed for ShAPF to deliver a harmonic separation of passive loads.

Margo Pujiantara et al. (2016) Harmonic analysis currently plays an important role for the power quality analysis because the non-linear loads, as source of the harmonic distortion, have significantly increased. The harmonic distortion influences power quality in power systems such as overheating of electrical equipment and aging of electrical equipment. Therefore, non-linear loads should be monitored in real time. This research proposes the design and implementation of the prototype current harmonic analysis that can be applied in real time based on S-transform Method. The equipment of this prototype can be explained as follows: CT-235, TZ2L9 and CT for KWH meters as current sensor, microcontroller AT mega 8535 as data acquisition, and Visual Basic software as displaying current waveform, current spectrum, rms current value, and total harmonic distortion (THD) for current. S-transform method is used to obtain the THD for current. The experimental result is validated by FLUKE 43B and the THD for current is accurately measured.

Dr.D.Sivakumar et al. (2016) Power electronic device use in consumer increases and power quality monitoring suit essential. This survey paper reviews the various recently used devices such as Remote terminal unit, digital signal processor, microcontroller, etc that monitor the power quality issues. These devices monitor the different parameters of the power system and various events of the power quality using techniques such as Wavelet transform, S-transform, Radial Neural network, etc. The survey also discusses the communication techniques such as wireless, wire-based communication used for the transmission of data from the power system network to the system operator and control techniques such as Dynamic Voltage Restorer, Shunt Active Power Filter, etc. In addition to that, this paper discusses the monitoring of various power quality parameters in the transmission line using a motor load experimental setup. The SIGVIEW software captures the real time signal under different conditions and analyzes the various distributions of the signal such as frequency distribution, probability distribution, etc using MATLAB program.

Anju Antony (2016) et al. According to growth of electricity demand and the increased number of non-linear loads in power grids, providing a high quality electrical power should be considered. The use of renewable energy resources to meet the load and to reduce the use of finite resources is also increased. In this paper, voltage sag and swell of the power quality issues due to the load and a wind turbine system are studied. A power system is said to be more reliable when it is stable and is able to supply the load without any harmonics and power fluctuations. The use of flexible ac transmission (FACT) devices can be used to mitigate the power quality issues. The distributed power flow controller (DPFC) is used to mitigate the voltage deviation and improve power quality. The DPFC is a new FACTS device, which its structure is similar to unified power flow controller (UPFC) which is a combined series-shunt compensator. Thus a comparative study on the use of a series and shunt fact controller with a combined series shunt fact controller is done. A system with Static Synchronous Compensator (STATCOM), which is a shunt compensator and Dynamic Voltage Restorer (DVR), a series compensator is studied. These FACT devices are replaced by DPFC. The system is studied in MATLAB/Simulink environment. The presented simulation results validate the DPFC ability to improve the power quality.

Manjulata Badi Power system harmonics are a menace to electric power systems with disastrous consequences. The line current harmonics cause increase in losses, instability, and also voltage distortion. With the proliferation of the power electronics converters and increased use of magnetic, power lines have become highly polluted. Both passive and active filters have been used near harmonic producing loads or at the point of common coupling to block current harmonics. Shunt filters still dominate the harmonic compensation at medium/high voltage level, whereas active filters have been proclaimed for low/medium voltage ratings. With diverse applications involving reactive power together with harmonic compensation, passive filters are found suitable. Passive filtering has been preferred for harmonic compensation in distribution systems due to low cost, simplicity, reliability, and control less operation. The uncontrolled ac-dc converter suffers from operating problems of poor power factor, injection of harmonics into the ac mains, variations in dc link voltage of input ac supply, equipment overheating due to harmonic current absorption, voltage distortion due to the voltage drop caused by harmonic currents flowing through system impedances, interference on telephone and communication line etc.

P.S.PUTTASWAMY (2015) et al. In modern information society requirements and expectations associated with power quality have become increasingly important. Reasons for that are increased requirements for power quality by network utilities, customers and regulators. Many industrial and commercial customers have equipment that is sensitive to power

disturbances. Therefore, it is more important to understand the quality of power being supplied in a power system, faults, dynamic operations, or nonlinear loads often cause various kinds of power quality disturbances such as voltage sags, voltage swells, switching transients, impulses, notches, flickers, harmonics, etc. One critical aspect of power quality studies is the ability to perform automatic power quality monitoring and data analysis. Usually, utilities install power quality meters or digital fault recorders at certain locations so that various power quality events can be recorded and stored in the form of sampled data for further analysis Power quality is defined in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms as the concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment Utilities may want to define power quality as reliability. Power Quality may also be defined as "a set of electrical boundaries that allows equipment to function in its intended manner without significant loss of performance or life expectancy."

Dr. D. Mary et al. (2016) The integration of renewable energy such as wind, photovoltaic, fuel cell, and tidal to the grid solved many problems and replenished the exceeding and ascending need for electrical energy but created plenty more. This leads to a more complex electrical network or "Grid". This enlargement and enrichment in equipment has caused problems such as stability, reliability and power quality. The issue of power quality is of great importance to the wind turbine. There's a need to find solutions to these problems, using different technologies such as smart meters, monitoring system, controllers, remote ability. The integration of wind energy into a weak system is a challenge; voltage fluctuation, voltage dips, swells and swags are created due to the uncontrollable resource and the nature of the DWIG (Distributed Wind Induction Generators) on the already weak system. This causes stability issues, reliability and power quality issues which need to be solved.

Mathews Ondiek Amuti et al. (2015) The existence of harmonics in the power electrical systems is the key source of the electrical wave pollution that course so many problems. The indiscriminate escalation of non-linear loads has given rise to research into new compensation equipment centered on power electronics. The core design target for this system is the eradication of the harmonic present in the system and lessening of reactive power. Depending on the application type, series or parallel configurations or combinations of active and passive filters [1, 2]. Most of the power electronic equipment are used in industrial and domestic purposes, the equipment (ac drives, electronic ballast) have significant impact on the quality of supplied voltage and have increased the harmonic current pollution of the distribution systems. They have many negative effects on the power system equipment's and customers, such as additional losses in overhead and underground cables, transformers and rotating machines, problems in the operation of the protection systems, over voltages ,error of measuring instruments. This has necessitated improvement on the compensation characteristics required satisfying more stringent harmonic standards.

Manoj Kumar Maharana et al. (2016) With the advent of renewable, new buzzwords like Distributed Generators (DGs), Micro Grid, Smart Grid (SG) has changed the power market scenario. Due to a stiff relationship of population between the increasing energy demands as well as the increasing complexity in integrating the DGs with the main grid need to be ensured about the unaffectedness of the existing infrastructure, quality of supply has to be maintained and must be free from any faults or interruption. Although substantial quantity of energy is generated, but it has become very difficult as well as challenging for power engineers to reconcile the rising expectation of getting high quality of power which is possible by the mitigation of harmonics in power system specifically caused by nonlinear loads.

Conclusion- The effect of multiple harmonic sources can be investigated by applying the superposition principle. The SVC harmonic generation modeled by positive-, negative-, and zero-sequence harmonic sources. The system represented by linear models at each harmonic frequency. The precise evaluation of harmonic distortion must have accurate load modeling. Hence the TCR-TSC combination is better in SVC.

Reference

1. SHILPA.R, and P.S.PUTTASWAMY, "A REVIEW ON POWER QUALITY ISSUES IN POWER SYSTEMS" International Journal of Industrial Electronics and Electrical Engineering, ISSN: 2347-6982 Volume-2, Issue-10, Oct.-2014.

2. Shaik Mahammad Rasool 1, Dr. D. Mary, "Active Control for Power Quality Improvement Using Unified Power Quality Conditioner (UPQC) in Hybrid Power Systems" International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 5, Issue 5, May 2016.

3. Shitsukane Aggrey Shisiali , Mathews Ondiek Amuti "Power Quality Improvement using Hybrid Filters" , International Journal for Research in Electronics & Communication Engineering .

4. Rudranarayan Senapati, Rajendra Narayan Senapati, Manoj Kumar Maharana, "Study and Analysis of Performance of 3-Phase Shunt Active Filter in Grid-tied PV-Fuel Cell System Employing Sinusoidal Current Control Strategy", INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH R. Senapati et al., Vol.8, No.1, March, 2018.

5. Margo Pujiantara, Dimas Okky Anggriawan, Anang Tjahjono, Defin Permadi, Ardyono Priyadi, Mauridhi Hery Purnomo, "A Real-Time Current Harmonic Monitoring System Based on Stockwell Transform Method",International Review of Electrical Engineering (I.R.E.E.), Vol. 11, N. 2 ISSN 1827- 6660 March April 2016.

6. Dr.D.Sivakumar1, J.P.Srividhya2, and T.Shanmathi, "A Review on Power Quality Monitoring and Its Controlling Techniques" 8th International Conference on Latest Trends in Engineering and Technology (ICLTET'2016) May 5-6 2016 Dubai (UAE).

7. Anju Antony1, Geevarghese Kurian Mathew, "A Comparative Study on Power Quality Improvement in a Hybrid System Using DVR and STATCOM vs. Distributed Power Flow Controller (DPFC)" International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 09 Sep-2016.

8. Bhim Singh, Kamal Al-Haddad, Ambrish Chandra," A review of active filters for power quality improvement" ,IEEE Trans. on industrial electronics, Vol.46, No. 5, pp. 960-971, October 1999.

9. [3] Mohan, Underland and Robbins, Power Electronics, John Wiley and Sons, 1995.

10. [4] American National Standards Institute, "American National Standard Voltage Ratings (60Hz) for ElectricPower Systems and Equipment," ANSI Std. C84.1-1989.

11. [5] R. C. Dugan, M. F. McGranaghan, S. Santosa, and H. W. Beaty, Electrical Power Systems Quality, 2nd edition, McGraw-Hill, 2002.

12. S.Khalid, B.Dwivedi, "Comparative Critical Analysis of Advanced Controllers used for Active Power Filter,"National Conference on Power Electronics and Renewable Energy Systems, PEARES, Kalavakkam, 2009.