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AN OVERVIEW ON POWER QUALITY ISSUES IN POWER SYSTEMS

Ms. Ankita A. Yeotikar[1], Swapnil B. Mohod[2]

[1]PG Student, Electrical and Electronics Engg., PRMCEAM Badnera, Maharashtra, India
[2]Asst. Professor, Electrical and Electronics Engg. Deptt., PRMCEAM Badnera, Maharashtra, India

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Abstract - *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. The power quality issue will take new dimension due to power system restructuring and shifting trend towards distributed generation. Huge loss in terms of time and money have made power quality problems a major anxiety for modern industries with non-linear loads in electrical power system. Power quality consists of a large number of disturbances such as voltage sags, swells, harmonics, notch, flicker, etc. 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. Power quality problems can be mitigated by many methods. 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. A review of high-performance, state-of-the-art, active power-factor-correction (PFC) techniques for high-power, harmonic current compensation applications is presented. The merits and limitations of several PFC, HCC, RPC techniques that are used in today's network-server and telecom power supplies to maximize their conversion efficiencies are discussed.*

***Key Words*: Active power filter (APF), harmonic current compensation (HCC), power factor correction (PFC), power quality (PQ), reactive power compensation (RPC).**

1. INTRODUCTION

Electricity is not anymore a luxury article like few decades ago, but it has become a necessity and a part of our everyday life. Even short interruptions and voltage sags can be harmful when the amount of computers, programmable logics etc. in industry and as well in households have increased rapidly. 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."

1.1 Problems In Power Quality & Its Issues

A recent survey of Power Quality (PQ) experts indicates that 50% of all Power Quality problems are related to grounding, ground bonds, and neutral to ground voltages, ground loops, ground current or other ground associated issues [9]. Electrically operated or connected equipment is affected by Power Quality. The commonly used terms those describe the parameters of electrical power that describe or measure power quality are Voltage sags, Voltage variations, Interruptions Swells, Brownouts, Blackouts, Voltage imbalance, Distortion, Harmonics, Harmonic resonance, Inter harmonics, Notching, Noise, Impulse, Spikes (Voltage), Ground noise, Common mode noise, Critical load, Crest factor, Electromagnetic compatibility, Dropout, Fault, Flicker, Ground, Raw power, Clean ground, Ground loops, Voltage fluctuations, Transient, Dirty power, Momentary interruption, Over voltage, Under voltage, Nonlinear load, THD, Triplens, Voltage dip, Voltage regulation, Blink, Oscillatory transient etc. The issue of electric power quality is gaining importance because of several reasons:

1. The society is becoming increasingly dependent on the electrical supply. A small power outage has a great

economical impact on the industrial consumers. A longer interruption harms practically all operations of a modern society.

2. New equipments are more sensitive to power quality variations.

3. The arrival of new power electronic equipment, such as variable speed drives and switched mode power supplies, has brought new disturbances into the supply system.

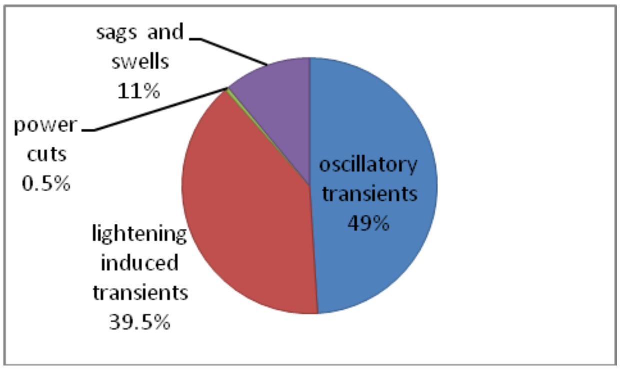

Fig 1: Monitoring of Computer Installations for Power Line Disturbances

The Allen- Segall study concluded that 88.5% of AC power problems were transient related shown in Figure1. Allen and Segall found that the most disruptive (49%) of power problems stemmed from oscillatory, decaying transients. These are examples of long duration, non-lightning related, transients. Lightning induced voltage spikes or impulse transients were the next most frequent, representing 39.5% of the total number of AC power problems.

1.2 Effect Of Power Quality Problems & Methods For Its Correction

A Power quality problem is an occurrence demonstrated as a nonstandard voltage, current or frequency that results in a failure or a miss-operation of end use equipments. The sign of a power-quality problem is a distortion in the voltage waveform of the power source from a sine wave, or in the amplitude from an established reference level, or a complete interruption. Harmonics causes the disturbances in current or by events in the main voltage supply system. The disturbance can go for a fraction of a cycle (milliseconds) to great durations (seconds to hours) in the voltage supplied by the source. Power quality problems can basically start at four levels of the system that delivers electric power, first one, includes Power plants and the entire area transmission system. The second one are Transmission lines, major substations where as third one includes distribution substations, primary, and secondary power lines, and distribution transformers and last and fourth one includes service equipment and building wiring.

2. WORK DONE ON POWER QUALITY ISSUES

Power Quality is characterized by parameters that express harmonic pollution, reactive power and load unbalance. The economic impacts associated with PQ were characterized and some solutions to mitigate the PQ problems were presented.

The need for controlling reactive power in transmission and distribution lines has been recognized in ac power system [2]. Permanently connected and switchable shunt capacitors and reactors have been used from the beginning to ensure desirable voltage profile along the transmission and distribution lines, and to minimize voltage variation in face of daily power demand changes. Dynamic var compensation is provided in modern power electronics technology [3]. High power thyristor valves are capable of switching large capacitor banks and controlling current in reactor banks accurately and rapidly. The thyristor-controlled reactors (TCRs) are used in combination with fixed or thyristor switched capacitors (7SCs) to form a static var generator whose output is continuously variable over a specified capacitive and inductive range. Power electronic circuits, using gate turn-off (GTO) thyristors, can provide controllable var output without capacitors or reactors. A static var generator can be converted into a static var compensator by external control loops, which vary the var output so as to maintain or control specific parameters of the ac power system. Static var compensation increases the transmission capacity of the power system. This can be achieved by providing voltage support and increased stability margins. For receiving end terminal voltage support, as well as for transient stability improvement, the static var compensator is operated essentially as a voltage regulator. For dynamic stability improvement, the var output is varied in concert with frequency variations so as to damp power oscillations.

The substantial increase in the use of solid-state power control results in harmonic pollution above the tolerable limits. The injected harmonics, reactive power burden, unbalance, and excessive neutral currents cause low system efficiency and poor power factor. Utilities are finding it difficult to maintain the power quality at the consumer end, and consumers are paying the penalties indirectly in the form of increased plant downtimes, etc. They also cause disturbance to other consumers and interference in nearby communication networks. Active filtering of electric power becomes a mature technology for harmonic and reactive power compensation in two-wire, three-wire , and four-wire ac power networks with nonlinear loads [1]. Active Filter (AF) is a well developed technology available to compensate harmonic current, reactive power, neutral current, unbalance current, and harmonics. The utilities in the long run will induce the consumers with nonlinear loads to use the AF's for maintaining the power quality at acceptable levels [5].

Controller design of a STATCOM based voltage compensator requires a valid analytical model of the system. If phasor algebra is used for modeling, it is difficult to accurately describe the STATCOM behavior during compensation of subcycle transients in the PCC voltage. STATCOM model, therefore, can be used for controller design where sub cycle voltage transients are to be compensated [7]. Voltage controller, so designed, can accomplish voltage sag mitigation. This method is helpful to investigate problem of voltage compensation at a PCC, at the end of a distribution line.

To attain high efficiencies in high-power PFC converters, it is important to eliminate the switching losses introduced by the reverse recovery characteristic of the boost rectifier. For fast recovery rectifiers, the turn-off rate of the rectifier current is controlled and the reduction of the reverse recovery related losses can be achieved. To reduce the reverse recovery losses a larger number of boost topologies that employ various active snubbers are employed [4]. Various Zero - Voltage - Switching (ZVS) or Zero - Current - Switching (ZCS) also employed to reduce reverse recovery related switching losses as well as techniques for the minimization of the conduction losses. Since in the topologies with ZCS the IGBT is used as a boost switch, ZCS boost PFC topologies offer much better silicon utilization than the ZVS topologies where the boost switch is the MOSFET. The Silicon Carbide (SiC) boost rectifier is used instead of a fast recovery rectifier to simplify the design of high performance boost PFC converter. Since SiC rectifiers virtually do not exhibit reverse recovery characteristic, no active snubber circuit is necessary as long as the switching frequency of the converter is not too high so that the switching losses of the boost switch start limiting the efficiency. Therefore the size of the boost inductor can also be reduced. Bridgeless boost PFC topology also minimizes the conduction losses by eliminating the line-voltage bridge rectifier. The bridgeless boost PFC converter implemented with SiC rectifiers and DSP control may become the mainstream PFC technology.

The imbalance in three phase power is compensated two ways either through a DSTATCOM or through a DG - compensator [8]. The operation and control of single phase DG sources are considered in a three phase utility connected grid. A DSTATCOM can compensate for unbalances and nonlinearities, while providing reactive power support. The size of the dc capacitor determines how much reactive power support the DSTATCOM can provide without any drop in voltage. The choice of this capacitor is thus a trade-off between the reactive support and system response. Alternatively a three phase DG -compensator can be connected at the PCC to share the real and reactive power with utility and to compensate for the unbalance and nonlinearities in the system. The efficacy of the compensation is validated through extensive simulations and calculation of THD. With the proposed structure of distribution system, it is possible to operate single phase DG sources in a utility connected grid and this might become a useful tool as their penetration in distribution systems increases.

To improve the current quality of the distribution system improved dynamic current harmonics and a reactive power compensation scheme for power distribution systems with generation from renewable sources has been proposed [6]. Advantages of this scheme are related to its simplicity, modeling, and implementation. The use of a predictive control algorithm for the converter current loop proved to be an effective solution for active power filter applications, improving current tracking capability and transient response. Simulated and experimental results have proved that the proposed predictive control algorithm is a good alternative to classical linear control methods. The predictive current control algorithm is a stable and robust solution.

3. CONCLUSION:

The present paper gives an assessment of power quality. Various issues concerning PQ have been highlighted and discussed. The paper also discusses about various issues related to power quality classification and characterization of disturbances, propagation of disturbances, and measurement strategies being used to monitor the power quality. Semiconductors are the heart of computer industry; unfortunately these electronic components are non-linear and thus may affect the safe or reliable operation of computers and computer-based equipment. Often more important than the physical effect on the equipment is the loss of productivity, resulting from computer equipment failure, miscalculations and downtime. And thus changes in the equipment on site will change the harmonic profile, so rendering the filters ineffective. Thus, a versatile control scheme for unidirectional ac–dc boost converters is one of the most efficient technologies to mitigate grid power quality. It is an almost no-cost solution for compensating harmonic current and reactive power in residential applications since most power factor correction circuits available in the commercial market utilize unidirectional ac–dc boost converter topologies. Unidirectional ac–dc boost converter can be used to quantify the input current distortions for supplying not only active power to the load but also reactive power.

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