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A Review on Power Quality Issues and Corrective Measures

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Abstract: **From last decade power quality issues has become more complex at all level of power system. It is a major topic of concern due to the sensitivity of the modern equipment which are nonlinear loads and hence results in imbalance of the power system. Power quality parameters consist of harmonic distortions, dips and swells, interruptions, flickers, transients, frequency deviations etc. The aim of this paper is to review the most common power quality issues, the effect of the same on the power quality and various techniques utilizing in the present system for its improvement.**

Keywords: Power quality Parameters, monitoring and mitigation techniques

I. INTRODUCTION

In recent years, advancement in power electronics devices and Semi-conductor technology have increased the utility of non-linear loads. An excessive use of non-linear loads deteriorates the quality of power in entire system. The ideal power quality is defined as electrical power energy with pure sinusoidal supply voltage waveform at a constant frequency and a specified constant magnitude. These days the power quality is not only defined by the continuity of electricity but also measured by its main parameters such as frequency and magnitude of the supply voltage, current and voltage harmonics, voltage sags and swells, flicker , imbalances etc.[1]

In today's environment, electronic loads are very sensitive to these parameters. In order to show the undesirable effects and adversity of these non-sinusoidal signals, harmonic definition was introduced by Institute of Electrical and Electronics Engineers (IEEE) in 1981 which is defined as the sum of the sinusoidal signals in integral multiples of frequencies by Fourier series. As per IEEE Standard 519 [2] reported in 1981, "A sinusoidal component of a periodic wave which have a frequency that is an integer multiple of the fundamental frequency is called as harmonic".

The increase in the usage of non-linear loads which contain power electronic devices, results in distorted current and voltage waveforms at the point of common coupling of industrial loads.

II. POWER QUALITY PARAMETERS

1. Reactive power: The phase angle between the current and voltage waveforms in an AC system. Used to develop magnetic field in motors, causes low power factor. Low reactive power loads up the supply system unnecessary.

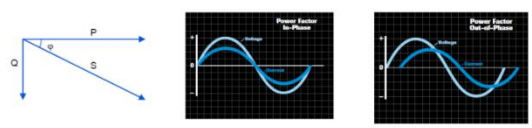

Fig 1.1 Reactive Power

2. Harmonics

Multiples of the supply frequency, i.e. the fifth harmonic would be 250 Hz if the supply frequency is 50 Hz. Caused by e.g. power electronic loads such as variable speed drives and UPS systems Harmonic pollution causes extra stress on the networks and makes installations run less efficiently.

The harmonic pollution is often characterized by the Total Harmonic Distortion or THD which is by definition equal to the ratio of the RMS harmonic content to the fundamental. Typical 5%, for voltage only3%.

$$\text{Harmonic Factor (Voltage)} = \frac{\sqrt{\sum_{h=2}^{\infty}(V_h^2)}}{V_1} \quad (1)$$

$$\text{Harmonic Factor (Current)} = \frac{\sqrt{\sum_{h=2}^{\infty}(I_h^2)}}{I_1} \quad (2)$$

$$\text{Total Harmonic Distortion (THD)} = \frac{\sqrt{\sum_{h=2}^{50}(V_h^2)}}{V_1} X100\% \quad (3)$$

V_h: *Magnitude of the voltage harmonic component of order "h"*

I_h : *Magnitude of the current harmonic component of order "h".*

3. Network (Load) Unbalance: Different line voltages caused by single-phase loads, phase to phase loads and unbalanced three-phase loads like welding equipment. Load imbalance, especially in office building applications, as the unbalanced loads may result in excessive voltage imbalance causing stress on other loads connected to the same network, and leading to an increase of neutral current and neutral to earth voltage buildup. This can also cause damage to direct online motors by creating a reverse torque.[3]

4.**Transients (fast disturbances):**Rapid change in the sine wave that occurs in both voltage and current waveforms. Caused by switching devices, start- and stop of high power equipment. They can vary widely from twice the normal voltage to several thousand volts and last from less than a microsecond up to a few hundredths of a second.

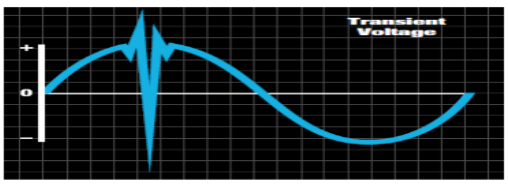

Fig 1.2 Transient Voltage.

Voltage variations (dips, sags, swells, brown-outs): The line voltage is higher or lower than the nominal voltage for a shorter period caused by e.g. network faults, switching of capacitive loads and excessive loading.

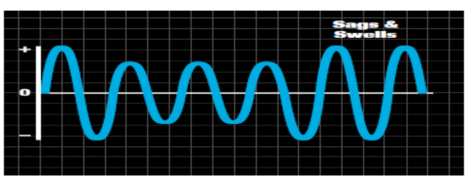

Fig 1.3 Sag and Swells

5.Flicker: Random or repetitive variations in the voltage. caused by e.g. mills, EAF operation (arc furnaces), welding equipment and shredders. Flicker is defined as 'Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time'. Or in other words, voltage fluctuations on the supply network cause change of the luminance of lamps, which in turn can create the visual phenomenon called flicker. Above a certain threshold it becomes annoying to people present in a room where the flicker exists. The degree of annoyance grows very rapidly with the amplitude of the fluctuation.

6.Oscillations (resonances): The flow of electrical energy, e.g. between the magnetic field of an inductor and the electric field of a capacitor, changes direction periodically.[4]

III Consequences of Poor Power Quality

Some direct effects of poor power quality are:

- Reduced production rate
- Penalties imposed by the utilities
- Device damage or reduced life span
- Premature aging
- Information loss.

IV Corrective Methods

Power quality issues cannot be resolved completely but can be reduced using the following methods.

1. Power factor corrector circuit: -When the detected reactive power absorbed by the load is greater than the compensator rating, the power factor correction obtained by using capacitor banks to generate locally the reactive energy necessary for the transfer of electrical useful power, allows a better and more rational technical-economical management of the plants [5,6]:

2. Filters- Power Quality Improvement is done with the help of filters generally. They reduce problems of poor power factor, voltage distortion, current distortion, etc Three types of filters are passive filter, active filters and hybrid filters are used. Concept of R, L and C loads are used in case of Passive filters whereas Active filters make power electronics technologies their base which cancel the harmonic current components by producing specific current components .Mostly Active Filters are sued for Power Quality as they are very reliable. Active and Passive System combines to form Hybrid Filter which works very effectively for harmonic and other waveform distortion in the system.[7]

3. FACTS devices: - Due to high requirement of liability and quality issue in electricity, recently a new technology have been developed named Flexible Alternating-Current Transmission Systems (FACTS). An extra-ordinary performance has been witnessed using FACTS on steady state variables (voltage levels, transmission losses, and generating costs). [9,10]

CONCLUSION

Issues like overheating in system equipment, over loading, harmonics generations, waveform distortion etc can be caused because of poor power quality. These can go away through various techniques through filters facts devices and power factor corrected circuits. This paper presents a review on power quality terms, problems and their corrective methods.

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