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HARMONICS & POWER QUALITY

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Abstract

This paper refers the definition of Harmonics in terms of Power Quality. Measure of Harmonics is by calculation of THD. Papers explain the causes of Harmonics in the system. It also provides the solution of harmonics by use of Active Filters.

Introduction

Ideal AC power signal is sine wave. If due to any reasons this sine wave is interfered by multiples of frequency then it is described as harmonically distorted. We need to measure how much the Harmonic distortion has taken place. This measure is termed as THD (Total Harmonic Distortion)

THD is defined as the ratio of power in the supply due to all

Harmonics and the power of fundamental supply.

$$THD = \sqrt{\frac{\sum_{n=3,5,7.....} V_n^2}{V_1^2}}$$

Causes of Harmonic Distortion

The electrical circuits nowadays are controlled by power electronics. We require DC supply for most of the gadgets commonly used such as computers etc. With the utility of electronics in the gadgets appliances become non-linear.

UPS systems are often used. It receives the AC power supply and gives out DC supply. The DC component is very high frequency signal and it interferes with the nearby AC signals. Harmonics are defined as waveforms at multiples of frequency of the fundamental input signal.

For the 50 Hz AC waveform (the fundamental or the 1st harmonic frequency) above the harmonics will look like-

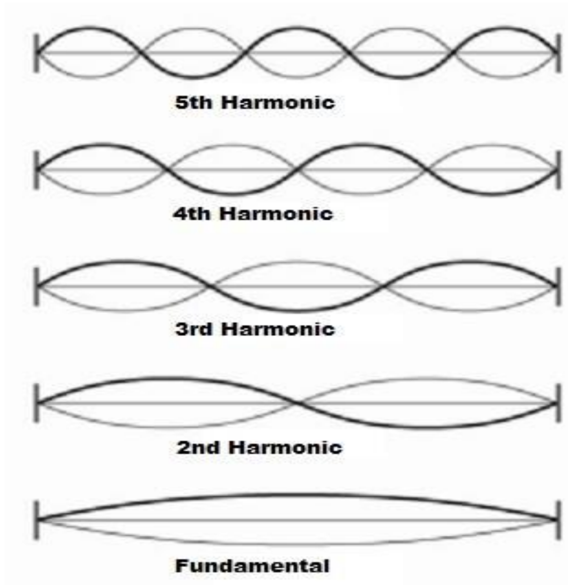

Fig 2

Fundamental	**A** 0°	**B** 120°	**C** 240°	**A-B-C**
3rd harmonic	**A'** 3 x 0° (0°)	**B'** 3 x 120° (360° = 0°)	**C'** 3 x 240° (720° = 0°)	*no rotation*
5th harmonic	**A''** 5 x 0° (0°)	**B''** 5 x 120° (600° - 720° - 120°) (-120°)	**C''** 5 x 240° (1200° - 1440° - 240°) (-240°)	**C-B-A**
7th harmonic	**A'''** 7 x 0° (0°)	**B'''** 7 x 120° (840° - 720° + 120°) (120°)	**C'''** 7 x 240° (1680° - 1440° + 240°) (240°)	**A-B-C**
9th harmonic	**A''''** 9 x 0° (0°)	**B''''** 9 x 120° (1080° = 0°)	**C''''** 9 x 240° (2160° = 0°)	*no rotation*

Fig 3

Above table shows that-

a) 2, 5, 8, harmonics create negative torques and negative sequence Harmonics.
b) 4, 7, 10, harmonics create positive torques and positive sequence Harmonics.

The negative torque is overcome and thus overloading motors to create counter torques.

The Triplen harmonics i.e. multiples of 3 (9, 15, 21 etc) are called as zero sequence Harmonics.

Interaction between positive sequence and negative sequence harmonics produces torsion oscillations on shafts of motor. Presence of 3rd Harmonics can cause the temperature of motor by 6 degrees.

Solutions of Harmonics

Harmonic distortions are created by non – linear loads are cancelled by Active harmonic filters. This filter utilization leads to power factor improvement, voltage variation control, flicker mitigation and load balancing. These filters are built on 3-level topology and are designed for light industrial and commercial buildings load. Applications available from 480 to1000 volt are used.

Domestic and industrial loads contain various electronic circuits which supply non-sinusoidal currents. Mostly we go for frequency regulation. In this frequency regulation we convert Alternating Current (AC) to Direct Current (DC) and then DC to AC. For these conversions we require electronic power converters such as Rectifiers & Inverters etc. Common loads like computers, LED, lifts, discharge lighting, etc

The non- sinusoidal current wave is due to superposition of sinusoidal waves with frequencies that are multiples of network frequency (Harmonics).These percentages may be measured using a harmonic analyzer which measures THD.

The harmonic problem spreads to other users connected to the same network depends on the impedance of the network. This impedance is calculated from the short circuit power available.

Users have section of the distribution lines before they reach final load. Harmonics that may arise at the main connections of their installations may be attributed to a lack of short circuit power. In many cases the harmonics that may arise at points farther down the line from the mains connection are often due to impedance in the installation itself.

The line impedance has a very significant inductive component. Therefore many a times this inductance is limited by braiding & twisting the distribution cables. Corrective measures (Filters) must be close to the loads that generate harmonics.

Active filters are units which are based on transducers that modulate the PWM pulse width. There are two types of Active filters-

a) Serial filters
b) Parallel filters.

Parallel filters are based on using an inverter. It injects the harmonics consumed by the loads into the network in anti-phase. The sum of Load current and passive filter current gives us a sinusoidal current.

Active filters are having a capacity for 30 Amp per phase and 90 Amp of Neutral. If more filtering capabilities are required the system may be extended by connecting filters in parallel. These filters reduce harmonic currents up to 50th harmonics (2500 Hz)

Conclusions

Deteriorating voltage wave quality signals the presence of increasing in harmonics in distribution lines. Due to this installations cause additional losses. Filters optimize & in installations reduce losses.

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