Harmonics - A Power Quality Problem

For quality performance of various power system devices it is necessary to understand the problems due to harmonics deeply and take further remedial measures for improvement and better performance.

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Power Quality is defined by any problem manifested in voltage, current or frequency deviations that results in failure or mal functioning of customer sites or equipments.

The Manufacturer of equipment defines Power Quality as characteristic of Power supply that is required to make his equipment work properly but the customer is the one ultimately affected. Poor Power Quality can impact Industrial Process.

This concern has drawn much attention from utilities, manufactures of equipments and users. Hence vendors should ensure cleaner Power supplies. For quality performance of various power system devices it is necessary to understand the problems due to harmonics deeply and take further remedial measures for improvement and better performance.

Harmonics – A Power Quality Problem

- The power quality may defined as any problem manifested in Voltage, Current or Frequency deviations that results in failure or misoperation of customer sites or equipments.
- Harmonics, voltage flicker, voltage regulation, voltage sag, voltage swell and transients usually characterize the quality of electric power.
- Harmonics is one of the major factors due to which none of these conditions are fulfilled in practice.
- The presence of harmonics distorts the waveform shape of voltage and current. increases the current level and changes power factor of supply, which In turn creates so many disturbances.

Sources or Causes of Harmonics

- Rapid use of energy conservation devices in both domestic sectors and industrial sectors such as electronics chokes for tube lights, electronics energy

controllers for the motors and electronic fan regulators etc. also inject harmonics substantially.
• Large use of the shunt capacitors to improve power factor and stability has significant influence on harmonic level. Related to the supply system converters and traction are the major causes of generation of harmonics.
• More use of solid state power converters for industrial furnaces for mini steel and non-ferrous metal plants, use of thryistors for locomotives, extensive use of single phase electronic loads in domestic sectors are causes of harmonic generation. • A growing power quality concern is harmonics distortion that is caused by the non - linearity of customer loads.

Impacts of Harmonics on Various Equipment

• Transformers : The Primary effect of power system harmonics on transformers is the additional heat generated by the losses caused by the harmonics content of the load current. Magnetic loss increases due to higher frequency level of harmonic current. Copper loss increases in winding due to third harmonic current present with load current. Also copper loss increases in the delta connected transformer windings due to extra circulating zero sequence currents.
• Rotating Machines : An increase in motor, Generators, Turbine operating temperature will cause reduction of the rotating machine's operating life. Extra audible noise is produced during the operation due to the difference between the time harmonic frequencies. Also harmonics cause variation of mechanical resonance speed of adjustable speed drives, which may do damage due to amplification of the pulsating torques.
• Capacitor: The effect of the Harmonic component is to cause extra power loss due to decrease of impedance by increasing frequency; which in turn increases the temperature level and shortens the life by early equipment failure. Also it increases the dielectric stress inside the capacitors.
• Circuit Breakers: The Harmonic distortion of the current can affect the interruption capability of the circuit breakers and thermal magnetic breakers. . The extra heat due to losses for frequencies above the fundamental raises the temperature of the thermal device, which in turn may reduce the trip point of the circuit breaker.
• Measuring Meters: Wattmeter and watt-hour meter, Electronic Energy meter shows error from the frequency characteristic of the voltage and current waves affected by harmonics. Linearity of the meters can be degraded when the power factor is low or waveforms have large crest factor caused by the Harmonics. Absolute average responding meters calibrated in RMS and peak responding meters give erroneous result under the presence of harmonic distortion.
• AC / DC Drives: Voltage surges due to harmonics can damage the power diodes connected at the input of an AC variable frequency drive. Under sustained over voltage and under voltage condition the equipment may be shut down. Input voltage waveform containing of harmonics may have multiple zero crossing, which may change the firing angle of the thyristors.
• Conductors: There are two mechanism is which harmonic currents can cause heating in Conductors that is greater than for the RMS value of the current. The first mechanism is due to current redistribution within the conductor and includes the skin effect and the Proximity effect. The second mechanism causes abnormally high current that is due to excessive third harmonic current in the neutral conductor.
• Cables: Harmonics cause extra heating which in turn causes a degradation of dielectric, production of cable jacket both inits dielectric role & its mechanical protection role, reduction of life span due to oxidation and a possible overall reduction of maximum operating capacity of the cable.
• Computer Networks, Control Room, SCADA: Presence of Harmonics effects can cause nuisance tripping of sensitive loads. Some Computer controlled loads are sensitive to voltage distortion. Data acquisition through SCADA System may get effected due to Power disturbance like Voltage sag, swell, Transient events, and presence of harmonics
• Protective Relays: Waveform distortion does affect the performance of protective relays and may cause relays to operate improperly, or not to operate when required as in ground Relays due to zero sequence third harmonics and dual input relays by the phase relationship between the respective input harmonics. Changes of operating points operating torque and time of static relays may happen due to distortion of waveform, which in turn causes improper high speed operation of difference relays.

Controls & Remedies for Harmonics

• Limit harmonic current injection from nonlinear loads Transformer connections can be employed to reduce harmonics in three phase system using

parallel delta-delta and wye delta transformers to yield net 12-pulse operation or delta connected transformers to block triple harmonics.

• The Harmonic distortion in adjustable speed drives can be controlled will within IEEE 519-1992 limits by drive design modification, switching from 6 pulses to higher pulses converters, connection of series reactor.

• Modify system frequency response to avoided adverse interaction with harmonic currents. This can be done by feeder sectionalizing adding or removing capacitor banks adding shunt filters or adding reactors to detune the system away from harmful resonances.

• Applying Harmonic like Filter harmonic current at the loads or on the system with shunt filters or try to block the harmonic currents produced by the loads. There are number of devices to this. Their selection is largely dependant on the nature of the problems encountered. Solution can be as simple as an in-line reactor (i.e. a choke) as in the PWM based adjustable speed drive applications or complex as designed active filter.

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• Monitoring problem manifested in V, I, Hz. Data acquisition is the primary step for both the situations. The requirement is the data on the current and voltage distortion both as it exists.

• For Quality performance of various Power system devices it is necessary to understand the problems deeply and requires further remedial measures for improvement and better performance. • So for Quality performance of various Power System devices it is necessary to understand the problems deeply and requires further remedial measures for improvement and better performance. Data acquisition is the primary step for both the situations.

Planning & Designing for Harmonic Suppression

• Analyzing the spectra and knowing the size of systems planned, different solutions can be deduced and incorporated in the design that will lessen the disturbances or possibly eliminate them entirely.

• Providing solution to Power Quality problems, cost plays a major role. Hence it is always necessary to find cost effective solution to resolve Power Quality issues to minimize equipment downtime and loss of production by using Handy and Easy to use Instruments for Monitoring, Measuring and Recording all necessary values in three phase like TRU-RMS value, Voltage, Current, Frequency, Apparent & Reactive Power, Energy, Power Factor, Phase Angle and above all Harmonic Analysis with Transients events.

MECO Power & Harmonic Analyzer

Meco Power & Harmonic Analyzer, A Analyzer which is a state of the art versatile instrument using micro controller technology that would be ideal for an Engineer / Inspector for carrying out Periodic Visits, Vigilance checks, Surveys, Raids, Audits and Recording at Industrial and Consumers end.

• Graphic 3P4W System Parameters & Phasor Diagram

• Display of Overlapped Voltage & Current Waveform

• Display of 35 Parameters in One Screen

• Detection of Maximum 28 Transients with

• Programmable Threshold

• Display of 50 Harmonics IN One Screen with Waveform

• Display of Waveform with Peak Values

• Graphic Phas or Diagram with 3 Phase System Parameters

• Display of Overlapped Voltage and Current Waveform

• Programmable CT (1 to 600) and PT (1 to 3000) Ratios

• Active Power(W, KW, MW, GW), Apparent & Reactive Power (KVA, KVAR)

• Power Factor (PF), Phase Angle (Φ) & Energy (WH, KWH, KVARH, PFH)

• Average Demand (AD in W, KW, MW) & Maximum Demand (MD in W, KW, MW) with Programmable Period

• 512K Memory with Programmable Interval (1 to 6000 seconds, 17000 records for 3P4W System)

• Output of Waveform, Power Parameters and Harmonics at Command

• Large Dot Matrix LCD Display with Backlight

Objective

Objective of is to provide steady state Harmonic Limits that are reasonable to both Electric Utilities & the Users.

• The power provider should limit Harmonic voltage since they have control over the system impedance

• The users should limit Harmonic Currents, since they have control over loads.

• Both parties share the Responsibilities for holding Harmonic levels in check.