Harmonic Distortion

4.1Voltage versus Current Distortion

The word *harmonics* is often used by itself without further qualification. What does that mean? Generally, it could mean one of the following three things.

- ❷ The harmonic voltages are too great (the voltage too distorted) for the control to properly determine firing angles.
- ❷ The harmonic currents are too great for the capacity of some device in the power supply system such as a transformer, and the machine must be operated at a lower than rated power.
- ❷ The harmonic voltages are too great because the harmonic currents produced by the device are too great for the given system condition.

Nonlinear loads appear to be sources of harmonic current in shunt with and injecting harmonic currents *into* the power system. For nearly all analyses, it is sufficient to treat these harmonic-producing loads simply as current sources.

As Fig. 4.3 shows, voltage distortion is the result of distorted currents passing through the linear, series impedance of the power delivery system, although, assuming that the source bus is ultimately a pure sinusoid, there is a nonlinear load that draws a distorted current. The harmonic currents passing through the impedance of the system cause a voltage drop for each harmonic.

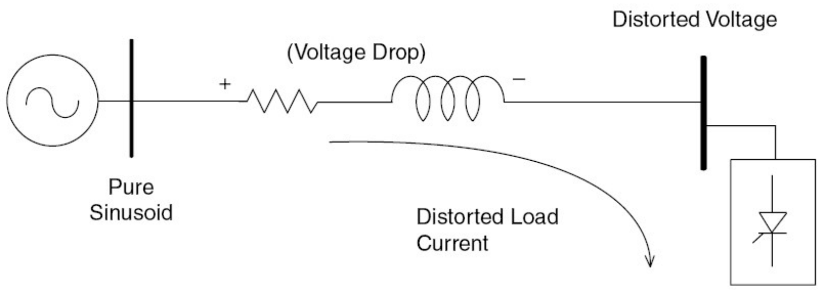

Figure 4.3 Harmonic currents flowing through the system impedance result in harmonic voltages at the load

This results in voltage harmonics appearing at the load bus. The amount of voltage distortion depends on the impedance and the current. Assuming the load bus distortion stays within reasonable limits (e.g., less than 5 percent), the amount of harmonic current produced by the load is generally constant.

While the load current harmonics ultimately cause the voltage distortion, it should be noted that load has no control over the voltage distortion. The same load put in two different locations on the power system will result in two different voltage distortion values.

Recognition of this fact is the basis for the division of responsibilities for harmonic control that are found in standards such as **IEEE Standard 519-1992, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*:**

- ❷ The control over the amount of harmonic current injected into the system takes place at the end-use application.

- ❷ Assuming the harmonic current injection is within reasonable limits, the control over the voltage distortion is exercised by the entity having control over the system impedance, which is often the utility.

4.2.2 Harmonics versus Transients

Harmonic distortion is blamed for many power quality disturbances that are actually transients. A measurement of the event may show a distorted waveform with obvious high-frequency components. Although transient disturbances contain high-frequency components, transients and harmonics are distinctly different phenomena and are analyzed differently.

Transient waveforms exhibit the high frequencies only briefly after there has been an abrupt change in the power system. The frequencies are not necessarily harmonics; they are the natural frequencies of the system at the time of the switching operation. These frequencies have no relation to the system fundamental frequency.

Harmonics, by definition, occur in the steady state and are integer multiples of the fundamental frequency. The waveform distortion that produces the harmonics is present continually or at least for several seconds. Transients are usually dissipated within a few cycles. Transients are associated with changes in the system such as switching of a capacitor bank. Harmonics are associated with the continuing operation of a load.

4.3.2 Total Demand Distortion

Current distortion levels can be characterized by a THD value, as has been described, but this can often be misleading. A small current may have a high THD but not be a significant threat to the system. For example, many adjustable-speed drives will exhibit high THD values for the input current when they are operating at very light loads. This is not necessarily a significant concern because the magnitude of harmonic current is low, even though its relative current distortion is high.

Some analysts have attempted to avoid this difficulty by referring THD to the fundamental of the peak demand load current rather than the fundamental of the present sample. This is called total demand distortion and serves as the basis for the guidelines in IEEE Standard 519-1992, *Recommended Practices and Requirements for Harmonic Control in Electrical Power*

Systems. It is defined as follows:

$$TDD = \frac{\sqrt{\sum_{h=2}^{h_{max}} I_h^2}}{I_L} \quad \text{-------------------------} \quad (4.3)$$

I_L is the peak, or maximum, demand load current at the fundamental frequency component measured at the point of common coupling (PCC).

Source : http://nprcet.org/e%20content/Misc/e-Learning/EEE/IV%20YEAR/EE1005%20-%20POWER%20QUALITY.pdf