

## Harmonic

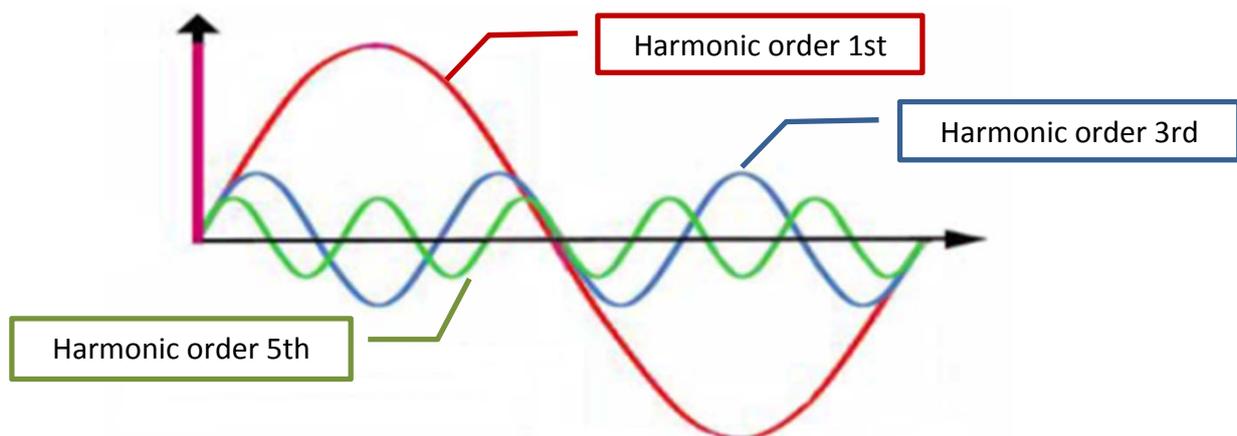
When we talked about electrical system in buildings and factories, capacitor bank is one of electrical equipments which is concerned because it increase power factor in electrical system.

But at the present, you have heard about detuned filter instead of cap bank for increasing P.F. Why ???

The reason is technology of electronic equipments help you working or manufacturing.

There are many kinds of electronic devices involved in everywhere. The electronic device will generate harmonic which effects to some electrical equipments connected to the same electrical system.

Harmonic is a component frequency of the signal that is an integer multiple of the fundamental frequency such as 50Hz in Thailand. If the fundamental frequency is  $f$ , the harmonics have frequencies  $f$ ,  $2f$ ,  $3f$ ,  $4f$ , etc. The harmonic voltage subsequently disrupt operation of other sensitive equipment connected to the same line. Harmonic voltage distortion can also cause motors operating on the line to overheat. Capacitor bank can be damaged by harmonic current and Neutral line can be overheated by harmonic current which is divided by 3 without fraction. Thus,



- Frequency of harmonic order 1st is 50 Hz (1 x 50 Hz)
  - Frequency of harmonic order 3rd is 150 Hz (3 x 50 Hz)
  - Frequency of harmonic order 5th is 250 Hz (5 x 50 Hz)
  - Frequency of harmonic order 7th is 350 Hz (7 x 50 Hz)
- and go on ...

In fact all electrical system around the world there are many order of harmonics.

Somebody said "What kind of electrical equipment can it generate harmonic?" We answer simply that all electrical equipments, which have ac to dc inverter, ac to dc converter or something like this, can generate harmonics in your electrical system. Some special equipments working with fault current such as welding machine, arc furnace, hardener, etc. can generate many order of harmonics.

You can see at electrical equipments you use. You will find almost equipments consisting of the said component generating harmonic. We will describe how the generated harmonic effect to capacitor bank in the next step.

### Impact of Harmonic current affecting to Capacitor bank

Except for harmonic order 1st or fundamental 50Hz (Thailand) electrical equipment use, other harmonic orders are not used but they can disrupt operation of sensitive equipments and overheat some equipments. Capacitor bank will be damaged or declined by harmonic current.

More frequency (f) of electrical current passing through, more impedance of capacitor unit ( $X_c$ ) reduces. Referring to electrical formula impedance of capacitor ( $X_c = 1 / 2\pi fC$ ); it shows if frequency (f) is higher as divider in equation, value of  $X_c$  is less. As of electrical circuit theory, most electrical current will go to where impedance is lower. Thus other harmonic orders such as harmonic order 5th, 7th, 11th are high frequency as 250Hz, 350Hz, 550Hz respectively, impedance of capacitor ( $X_c$ ) will highly decrease. Most of the said harmonic currents will go to capacitor bank and causing capacitor unit damaged by overcurrent or overvoltage or overheat. Service life of capacitor is shorter.

As the mentioned above, detuned filter will be used instead of capacitor bank. The detuned filter consists of capacitor unit and series reactor. The reactor will block some harmonic current passing through capacitor unit because impedance of reactor ( $X_L$ ) will increase when frequency (f) of electrical current is higher as formula  $X_L = 2\pi fL$ . Thus, impedance of detuned filter, which is impedance of capacitor adding with impedance of reactor, will be higher.

Detuned filter will be indicated to be 6%, 7% or 13%. The percentage is ratio between impedance of reactor and impedance of capacitor. If the percentage is higher, harmonic current pass through capacitor unit less.

Somebody may ask if harmonic current is not passing through capacitor unit, where does it go? The answer is the harmonic current will go to electrical line of electrical utility. Harmonic current passing through electrical utility will be compatible with Electrical utility 's regulation.