Detuned Reactors

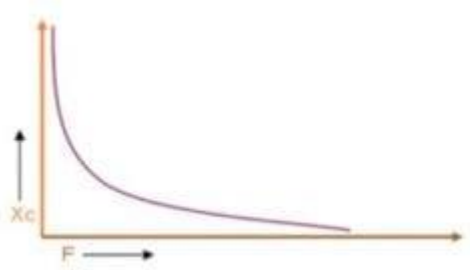
We will try to understand Detuned Reactors and analyse their usage and benefits. Detuned reactors, that are three-phase inductors dedicated to attenuating the amplification of harmonics in harmonic rich networks, protect the different components of the installation.

What are Detuned reactors?

Detuned Reactors prevent harmonic amplification caused due to RESONANCE and avoid the risk of overloading capacitors, thereby significantly reducing voltage and current harmonic distortion in the network. All connected equipment, and even remote substations are subject to voltage fluctuations which may result in equipment malfunction or failure. To avoid this problem, it is common to insert reactors in series with capacitor banks.

The reactor also by its nature will safeguard capacitor and associated switch gears against switching inrush, which other may damage capacitors, circuit breakers and contactors.

Why use Detuned reactor?

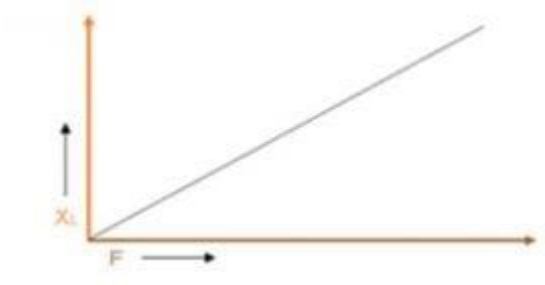


$$Xc = \frac{1}{2.\pi.f.C}$$

Presence of Harmonic distortion due to the non-linear loads within the network or due to import of harmonic from grid or power source will increases the current flowing through capacitors as the capacitive reactance is inversely proportional to the frequency, consequently capacitors will be subjected to overload. The overload on capacitors can cause premature failure in capacitor due to increased voltage and thermal stress on dielectric.

Calculation of Capacitor Impedance

If we look to the impedance equation of the capacitor, it is seen that the capacitor impedance decreases with the increase of the frequency. In this case, the current will flow at low impedance so that the total current on the capacitor will be equal to the sum of the nominal coupling current and the harmonic current. An unwanted state will occur on the capacitor due to the harmonic current.



$$Xl = 2.\pi.f.l$$

On the other hand, the inductive reactance XL of a Reactor is directly proportional to frequency: The magnitude of inductive reactance will increase with high frequency harmonics thus blocking the harmonic current. Hence, use of detuned reactor in series with capacitor will offer higher impedance for harmonics, thus eliminating risk of over load in capacitors.

The inductance value of detuned reactor is selected such that the resonance frequency is less than 90% of dominant harmonic in the spectrum. For example: if 5th harmonic is dominant in the spectrum, any series LC circuit having resonance frequency 90% of 250Hz (for 50Hz system), i.e., if the natural resonance frequency of LC is less than 225Hz, it is categorized as detuned filters or detuned capacitors.

Total Current = Nominal coupling current + Harmonic coupling current

$$Xt = Xc + Xl$$

To reduce the harmonic coupling current we need to increase the line impedance to which the capacitor is connected. As can be seen in Formula 2, the high impedance bobbin at high frequencies is possible by connecting the capacitor in series.
At this point the total impedance will be equal to the sum of the capacitor and coil impedance and the harmonic current flowing on this arm will be reduced to the lowest level.

Detuned Reactors can be manufactured as single-phase or three-phase, choosing the tuning frequency according to the dominant harmonic current order in the system according to the bus bar voltage and capacitor impedance / power.

Detuned reactors do not destroy harmonic components in the system. It only prevents the harmonic current from increasing in amplitude. It is a well-known misinformation to say that it destroys harmonics in the system.

What are the benefits of using a Detuned Reactor?

The typical benefits of a detuned reactor are as follows:

- It eliminates harmonic amplification
- It enhances the life of capacitors by reducing voltage and thermal stress due to harmonics.
- Prevents the constant nuisance of input fuse blowing or circuit breaker tripping
- Reduces over heating of the transformer, busbars, cables, switchgear etc caused due to harmonic amplification.
- Reduces the harmonic current in the electrical supply system
- Addresses the harmonic problems created by non-linear loads.
- Improves Power Factor in harmonic rich environment.

Technical data

They form a complete product range from 6 to 100 kvar and are available in the most common tunings like 135, 190 and 210 Hz for network voltage of 400/415V 50Hz. They must be chosen according to the capacitors they are associated with.

To prevent disturbances in a remote installation, select a tuning frequency that is at a lower value than the ripple control frequency (applicable for networks having Remote Utility metering system). In a detuned filter application, the voltage across the capacitors will be higher than the nominal system voltage due to Vector sum of voltage drop, hence the capacitors must be designed to withstand higher voltages. Typical capacitor voltages for 400/415V network are 480V, 525V etc.