Effects of Power Quality Terms on Passive Power Filters

Dr.M. Rathinakumar and S. Murugan

***Abstract*---** Power quality has become a major issue in modern power systems. Harmonic, which is a very significant power quality perspective, can have a significant impact on electrical devices. Non-linear loads such as electric arc furnaces and power electronics cause electrical system compliance problems due to their voltage-current characteristics. Passive filters (PPFs) are useful for compressing power systems. Passive harmonic filters are designed to measure non-linear loads in the context of their method. Under conditions of distorted power quality, such as voltage changes, frequency fluctuations, transient loads, and phase angle changes, the behaviour of the designed passive filter is analysed, simulated, and the results obtained.

***Keywords*---** Power Filters, Quality Terms, Passive filters (PPFs).

I. INTRODUCTION

The linear load increase of the Power Grid and Power System is seriously distorted. This is also known as power quality issues. Major distortions are classified as harmonics, flickers, voltage dips and voltage swells. The most common power quality problem is defined as the harmonic component of a time waveform with amplitudes of the fundamental frequency

This is when steel mills start to line up with companies that affect power quality and have a wide range of harmonic components. Active power filter (APF) is the main compliance source of steel facilities. Because of the unstable discharge during this melting process, the electric arc furnace has non-linear voltage-current characteristics. The most deserving issue in the steel industry is the harmonics generated by the electric furnace.

As for power systems, various harmonic methods are used to improve power quality. Passive Filters (PF) and Active Power Filters (APF) are widely used to reduce the amount of harmonic components. Due to the performance-to-cost ratio, APF offers a suitable solution for compatible condensation in electrical systems

Passive Filter Design

- Harmonic Filter Design Procedure
- Master Library Models
- Series (Single-Tuned) Filter
- High-Pass Filter
- Band-Pass Filter
- C-Type Filter

Passive filter elements are enclosed at a single frequency, or the frequency band transmits the capacitor and induction mixture. In power systems, passive filters are used to suppress harmonic currents and to reduce the voltage distortions that occur in important parts of the system.

The passive filter operates by displaying two different impedance values at the resonance frequency. Filters connected to the series must exhibit high impedance harmonic frequencies to be blocked. Continuous configuration is possible, but the most common is a co-filter. This shunt configuration panel converts the harmonic current to the ground and at the same time provides the reactive power that can be used to adjust the power factor. Therefore, the passive shunt filter is designed as a capacitor at the base frequency.

Harmonic Filter Design Procedure

To design a harmonic filter, information about the local electrical system, including environmental data, is necessary.

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Power system information has characteristics such as nominal line-to-line voltage, and conventional equipment is the system voltage level, base frequency, and system configuration and impedance system components. Clear understanding of device location internal or external, operating controls, current duty cycle of the device, operating rate switches, environmental data (such as ambient temperature and air load), compatible measurement or manufacturer compliance characteristics, it is important to consider the design process for starting the filter should

Determine Harmonic Filter Bank kVA Size

As mentioned earlier, the filtering device provides a system with capacitive and reactive power to improve the power factor, which helps maintain the voltage during heavy loads, rather than harmonics filtering. The "effective reactive power" of the filter depends on the magnitude of the power factor, as well as the voltage control, where the required value is usually the capacitive, reactive power required by the electric flow projection

Select Initial Harmonic Filter Tuning

Filter tuning is necessary to reduce the harmonic voltage and current distortion to meet the required harmonic performance. The harmonic filter is usually adjusted to the most important harmonic low limit frequency. However, it is recommended to adjust the harmonic filter by below the required frequency to provide adequate harmonic filtering, and allow for spatial potential filter inhibition. The performance of the harmonic filters across the entire spectrum should be considered on the filter level side (normal and emergency conditions).

The main reason for adjusting the harmonic filters below the required level is the nature of the filter interaction with the system. That is, the harmonic shift of the filter may be very close to the co-resonant frequency. This may be due to changes in filter and system configuration such as: loss of transformers, natural system changes such as equipment replacement or routine maintenance; Filter capacitors are made within the tolerances of both, the capacitors due to temperature varying; Harmonic filter capacitor unit / component failure due to fuse operation (reduced total capacity and increased filter vibration frequency).

If the magnitude of the harmonic distortion is not important, the customer may want to avoid overloading the harmonic filter capacitor with the harmonic current, but not with the vibrations generated by the system. Then, the third harmonic and vibration of the system must be controlled by the filter to avoid vibration with the harmonic below the characteristic harmonic tuning**.**

Optimize the Harmonic Filter Configuration to Meet Harmonic Guidelines

The IEEE provides some recommendations for meeting the limits of standard compliance deviation. The filter must meet the current and voltage distortion requirements of normal computer configurations and unusual conditions.

If the degree of distortion is high, the new parallel vibration in the system may be a possible cause. Filter reuse or multiple tuned harmonic filter devices can help solve this problem.

Harmonic Filter, Filter Adjustment and Standards, Capacity Value, Trigger and Reaction, Capacity, Induction and Number of Allowable Tolerances, Harmonic Filter Furner (X / R Ratio) at tuning frequency, and standard requirements for harmonic filter anti-phase energy dissipation, compatible research And the results of the analysis can be used. Harmonic voltage and current, basic and normal and emergency recovery system conditions, and are important results of spectrum analysis of all significant harmonic frequencies

There is a common practice in the simulation scheme of the harmonic load spectrum for high harmonics for possible operating conditions, while for a simple system, this can be estimated manually

Determine the Component Ratings

Harmonic filter capacitor ratings are usually the first step to be determined, followed by furnace, resistor and switch ratings. This process requires adjustment and is usually reactivated. Transient simulation studies may also require some harmonic filter configurations.

Harmonic Filter Capacitors

Harmonic filter capacitors are rated according to voltage and reactive power and are usually supplied by the manufacturer; Harmonic spectrum, instantaneous high voltage, depending on requirements and system data. The estimated reactive power of the condenser bank is not equal to the effective reaction force due to the impact of the filter reactor.

The rated voltage of the capacitor varies from the maximum voltage value to the static position (including harmonics) with a filter, and sometimes the intermediate judgment (less than half a cycle) and mechanical (up to a few seconds) associated with the circuit breaker operation. In most single-tuned applications, the harmonic filter capacitor voltage is based on the steady-state duty. The highest peak voltage used in a harmonic filter capacitor should not exceed of the peak capacitor voltage rating for normal computer operation and emergency situations.

For a given estimated reactive power and voltage, the total RMS current through the harmonic filter capacitor must be less than of the capacitor unit's normal current, and the current must be placed within the capacitor fuse. Additional checks include evaluations of dielectric heating of harmonic filter capacitors. In addition, it is desirable to have a harmonic filter with greater capacities than the required harmonic loads and a generous margin is usually included in the filter design phase.

Harmonic Filter Reactors

The physical location of the harmonic filter furnace associated with the harmonic filter condenser has been identified because it affects the thermal problems, magnetic flux heating and reactor short circuit estimation.

Excessive warming causes decomposition of components due to underlying and compatible currents, which can be a serious problem in installing iron core harmonic filter furnaces for internal metal enclosed filters. Loss of eddy current, induced by metal structure, effect of air core filter reactor magnetic flux must be analysed at design stage.

The relative insulation level is considered the same because it is connected to the transformer at the same voltage level. Abnormal can be caused by the safety of the lightning arrester and the filter coil used to directly land the harmonic filter with the furnace terminal attached to the ground

In a process like harmonic filter capacitors, high voltage transient and dynamic conditions must be checked. The short circuit should be subjected to the current analysis under maximum operating voltage to check the harmonic filter furnace with short current capability.

Filter Resistors

The physical location of the harmonic filter resistor associated with the harmonic filter capacitor must be identified because it affects the thermal problems and the resistance short circuit evaluation

Excessive heat leads to component degradation. Due to the fundamental wave and high harmonic currents, this can be a serious problem for metal-covered filters. Protection measures are an important consideration for outdoor installations.

As with induction, the level requirements depend on the position of the resistor inside the filter. The resistance of the short-circuit filter must be designed to withstand the maximum short-circuit current. The magnitude and duration of transient and dynamic high voltages must be identified and evaluated with resistance. Arrested security should be included in case of parameter violation

Circuit Breaker or Switch

Requirements for capacitive switches must be based on the worst case scenario with maximum system voltage, capacity tolerance and harmonics. Analysis of short circuits requires close-range and latch and instantaneous current checks and short-circuit current conditions for the capacitor switches to handle, although the capacitor switches, when compared to circuit breakers, should not be interrupted. In addition, it is important to keep in mind that in parallel with the filter bank, the parallel capacitor bank produces high voltage recovery through the transmission. Therefore, it is important to focus on the choice of switching device.

Switching Transients

It wants to provide transient research analysis data (wave form maps) to designers, but it is not easy to do because of the randomness of events. However, some of the worst harmonic load scenarios model harmonics are possible to determine the magnitude and duration of the current in the worst-case region. Some common cases are discussed in the following paragraphs.

Due to the harmonic filter tuning furnace, the back-end switch is back to the current range compared to the shunt reactor bank and does not need to be installed in an additional current limiting furnace. Under normal circumstances, replacing single-tuned harmonic filters does not require the use of capacitors or furnaces, which is expected to avoid the extraordinary charge of the capacitor bank. However, it may be necessary to start operating the transient performance analysis filter with some legs to ensure that no high current or voltage is expected.

If the filter is connected to the system and a computer is interrupted and is then considered to be receiving energy, the short-term harmonic filter will be loaded higher due to the transformer concentration harmonics. Similar effects on the filter can cause transformer concentration and filtering errors near high load results. Transient studies are highly desirable to determine the effectiveness of harmonic filters

Master Library Models

The Master Library Contains four Flter Blocks

- Series filter,
- High-Pass filter,
- band-pass filter and
- C-type filter.

Series filters are also known as single-tuned or peak filters and are the most commonly used type of industry. High-pass filters are used to suppress a wider range of frequencies than single-tuned filters, reduce the size of the component, and avoid the capacitive power factor when the system is unloaded. Band pass filters are an unusual profession, but components can be used to model high-order filters or double-tuned filters. The C-type filter is a second-order filter, designed to have an impedance similar to a single-tuned filter, and has the advantage of low power loss.

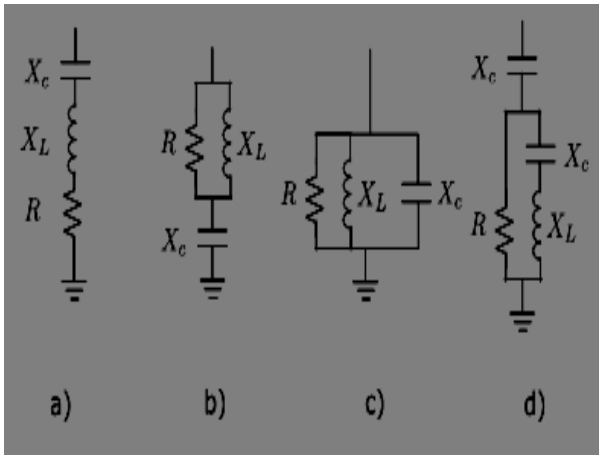

Figure 1: Series (Single-Tuned) Filter

Shows the circuit schematic and a typical impedance characteristic for the series or single-tuned filter.

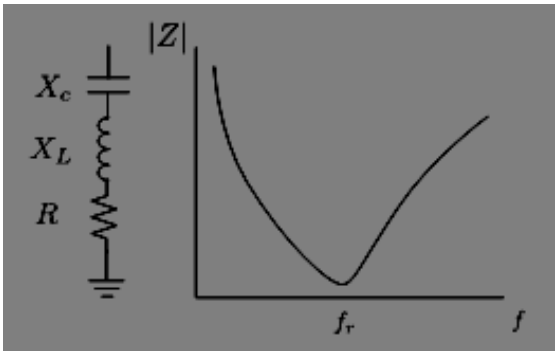

Figure 2: Characteristics Frequency of filter Design

This filter is designed to suppress single frequency and is based on three dimensions it must be blocked, which is the harmonic current command and its quality factor to provide capacitive reactive power. The voltage level and base frequency provided by the system must be considered during the design process.

h	Tuning point of the filter (harmonic order)
Q_c	Reactive power of the filter [MVAR]
Q	Quality factor
f	System frequency [Hz]
V	System voltage [kV]

High-Pass Filter

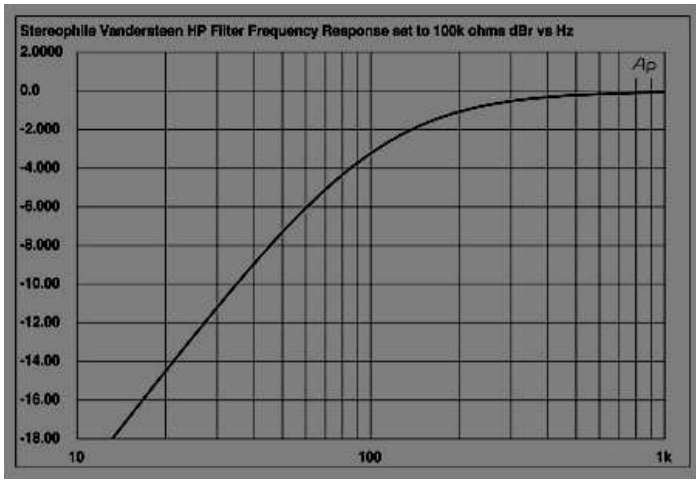

Figure 3: An Impedance Characteristic that is Flat for High Frequencies

This filter is designed to have an impedance characteristic that is flat for high frequencies. Looking at the equation that represents the variation of the impedance with the frequency,

Band-Pass Filter

This filter is designed to suppress single frequency and is based on three dimensions: it must be blocked, which is the harmonic current command and its quality factor to provide capacitive reactive power. The voltage level and base frequency provided by the system must be considered during the design process.

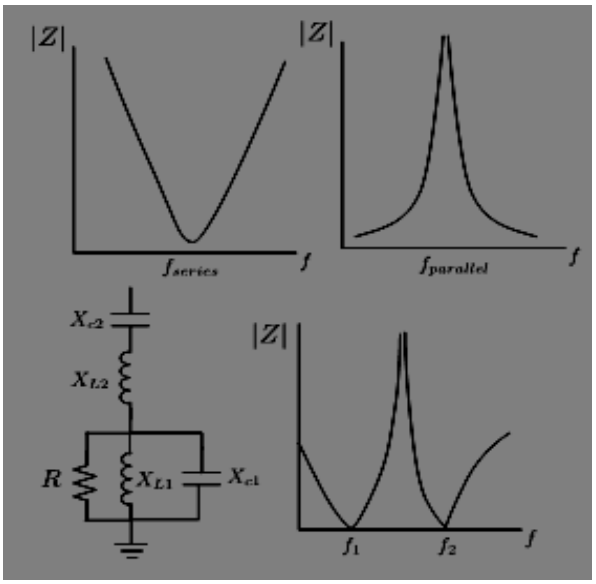

Figure 4: Band Pass Filter

C-Type Filter

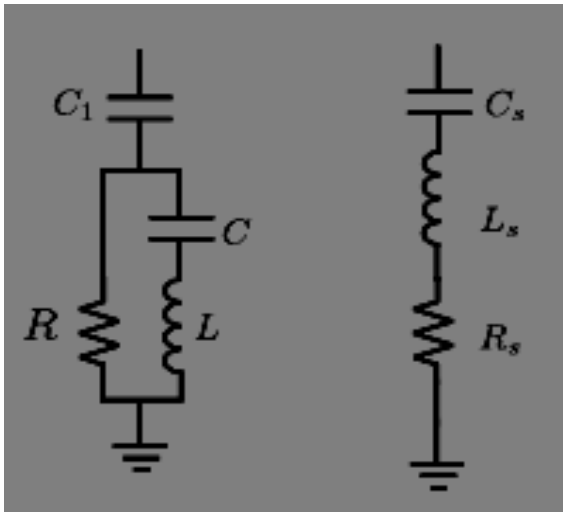

Figure 5: C Type Filter

The C-type filter is a capable second-order filter that suppresses harmonic currents and has less loss than a series filter or band pass filter. The reason for this is that the L and C components resonating with the resistor are parallel to the base frequency. Therefore, the base current is reduced to a minimum through a dense resistance cycle. Another advantage is that the C-type filter performs better at suppressing higher harmonics because the tuning frequency is higher than its intrinsic flat impedance characteristics.

II. CONCLUSION

From the study of the reference document, we have found that using a hybrid system combined with active and passive filters can achieve better compensation and better power quality.

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