Active power filters for mitigation of power quality issues in grid integrated system

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ABSTRACT: The necessity for power quality issues are higher quality, higher efficiency, and lower cost is must to avoid harmonics distortion. The active power filter is made used to improve the SPF and line inductance filtering waveforms to reduce the resonance between them. the non linear element like inductance, capacitance are used to control the voltage variations, current tracking for this we make use of decoupled control strategy which is of two loops one is outer(fast) loop other one inner(slow) loop linearigation control is used to control inner loops. PI controller is used for elimination of steady states errors.

INTRODUCTION:

Power electronics equipment plaes a vital role in all the industrial equipment, domastic machines. These machines and equipment has to be fulfilled with required power quality which is a direct impact on supplied voltage due to because of same distortion there is some negative effects on power system like additional losses known as copper lss, iron loss underground cables, transformer etc, The reason may be of ovr voltage and shunt capacitors with respect to its measuring the voltage and current.

Here we make use of passive filters due to harmonics distortion for mitigation purpose. But these have many drawbacks like sound being deep with their vibrating issues, performance of impedance in system, absorption of harmonic current etc..Inorder to overcome all these activities to get positive results on the input we make use of Active Power Filter(APF) introduces inject harmonics on voltage and current magnitude o remove harmonics to get appropriate results on phase angle and magnitudes of voltage and current. But APF also have disadvantage like high initial cost, high power losses etc...
Which may be a limitation for the application and usage of hybrid power systems? But inorder to reduce the limitations of APF we make use of hybrid filter which is in series connection with phase width modulation inverter. Usage of this type of mitigates the problem associating in passive and active filter giving better result. In case with high power system and non linear loads this shunt hybrid filter acts as cost effective. In order to reduce this harmonics we come across different technics for controlling purpose.

COMPONENTS USED:

i. Resistor and inductor
ii. Universal bridge(MOSFET OR IGBT)
iii. Active filters
iv. Three phase supply
v. Voltage controller and current controller.

i. RESISTOR AND INDUCTOR

RESISTOR:A resistor is a passive two terminals electrical component resistance that implement electrical resistance as a circuit element. These are used to reduce current flow, adjust signal levels to divide voltage etc….

INDUCTOR: Is a passive two terminal electrical component that stores electrical energy in a magnetic field when electric current is flowing through it.

ii. ACTIVE POWER FILTER

Is aanalog electronic fiter that uses active components such as a amplifier this improves the performance and predictability of a filter removing all the harmonics distortion of system.

iii. VOLTAGE CONTROLLER AND CURRENT CONTROLLER

VOLTAGE CONTROLLER

it is an electronic module based on either thyristors which converts fixed voltage, fixed frequency in to variable voltage and variable frequency

CURRENT CONTROLLER

The usefulness of PI control lies in their general applicability to most control systems. When the mathematical model of the plant is not known and therefore analytical design methods cannot be used, PI controls prove to be most useful. In practical cases, there may be one requirement on the response to disturbance input and another requirement on the reference input. Often these two requirements conflict with each other and cannot be satisfied in the single-degree-of-freedom case. By increasing the degrees of freedom, it can be reach up to the satisfaction of both. Finally, a very powerful computational approach with MATLAB to search optimal sets of parameter values to satisfy given transient response specifications(such as that the maximum overshoot in the response to the unit-step reference input be less than a specified value and the settling time be less than a specified value).
The standard approach to design is this: a mathematical model is built making necessary assumptions about various uncertain quantities on the dynamics of the system. If the objectives well defined in precise mathematical terms, then control strategies can be derived mathematically (e.g., by optimizing some criterion of the performance).

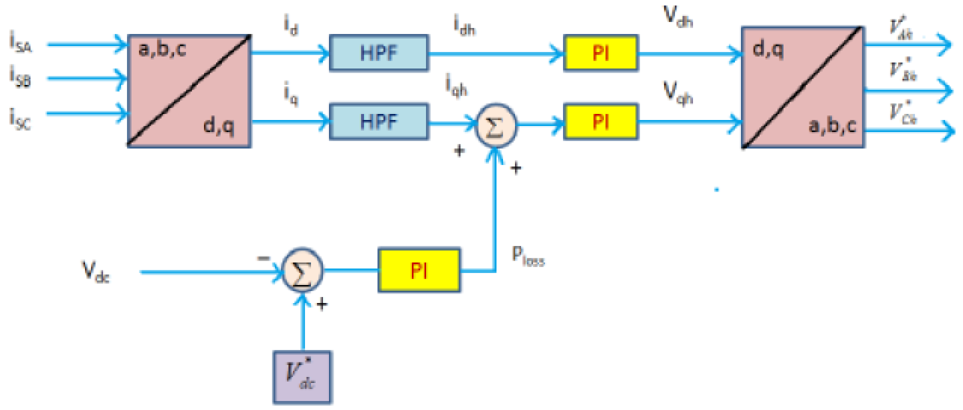
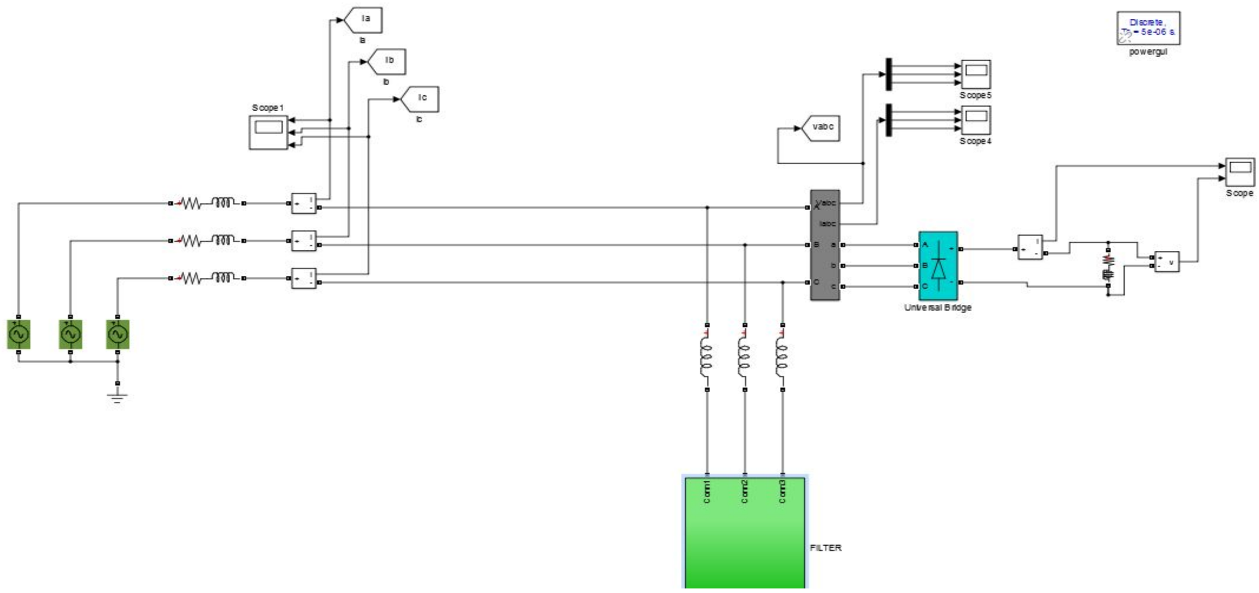


Fig.4.8: PI controller.

In Fig 8.the three phase supply currents ISA, ISB, ISC are measured and transformed into synchronous reference frame (d-q) axes rotating at the fundamental angular speed. Power p and q contain two components i.e. dc and ac. A dc components arising from the fundamental component of the source current, and an ac component due to its harmonic components. The ac components idh, iqh are extracted by two high pass filters and then, the harmonic component of the source current are obtained by applying the inverse transformation. To provide the inverter power losses and to maintain the DC voltage with in desired value, a dc component PLoss is added to the ac component of the imaginary power. It is generated by comparing the DC capacitor voltage with its reference value and applying the error to a P-I controller



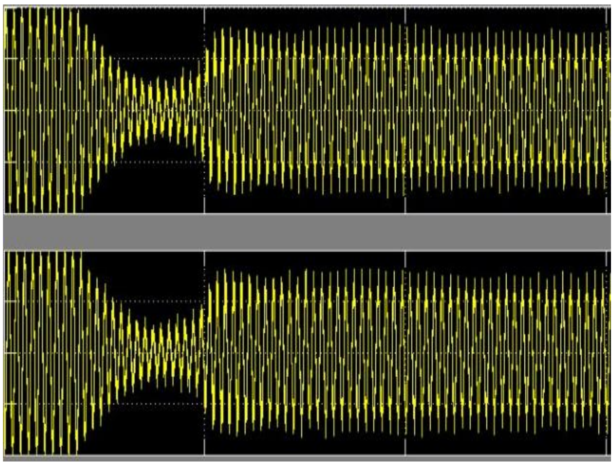


Fig1.input current

POWER QUALITY

IMPROVEMENT OF POWER QUALITY:

Power quality is defined by the parameter that includes reactive power, harmonic pollution and load unbalance. The best ideal electrical supply would be a sinusoidal voltage waveform with constant magnitude and frequency. But in reality due to the non-zero impedance of the supply system, the large variety of loads may be encountered and of other phenomenon such as transients and outages, the reality is often different.
If the power quality of the network is good, then any load connected to it will run satisfactorily and efficiently. The power quality of the network is bad, then loads connected to it will fail or will have a reduced lifetime, and the efficiency of the electrical installation will reduces. Installation running cost will be high and operation may not be possible at all.

Power quality improvement

i. Using passive filter
ii. Using active filte
iii. Using hybrid filter

1. POWER QUALITY IMPROVEMENT USING LC PASSIVE FILTER

During last decade, passive LC filters have been used to eliminate harmonic currents and to improve the powr factor of ac mains. However, these passive filters have many drawbacks such as tuning problems and series and parallel resonances. To avoid this resonance between an existing passive filter and the supply impedance, typical shunt or series active filter topologies had been proposed in the literature.

2. POWER QUALITY IMPROVEMENT USING ACTIVE FILTER

Active filter suffer from high kilovolt-ampere rating. The boost-converter forming the shunt active filter requires high dc-link voltage in order to effectively compensate higher order 11 harmonics. On the other hand, a series active filter needs a transformer that is capable to with stand full load current in order compensate for voltage distortion.

3. POWER QUALITY IMPROVEMENT USING HYBRID FILTER

Hybrid filters provide cost-effective harmonic compensation particularly for high-power nonlinear load. A parallel hybrid power filter system consists of a small rating active filter in series with a passive filter. The active filter is controlled to act as a harmonic compensator for the load by confining all the harmonic currents into the passive filter. This eliminates the possibility of series and parallel resonance.

POWER QUALITY PARAMETERS (TERMINOLOGY)

REACTIVE POWER AND POWER FACTOR (COSφ):

In AC supply, the current is usually phase-shifted from the supply voltage. This leads to different power definition.
• **The active power** P [KW], it is responsible for the useful work, which is associated with the portion of the current which is in phase with the voltage.
• **The reactive power** Q [KVAR], it sustains the electromagnetic field used to make a motor operate, is an energy exchange (per unit of time) between reactive components of the electrical system (capacitors and reactors) and source. It is associated with the portion of the current which is phase shifted by 90° with the voltage.
• **The apparent power** S [KVA], which is a geometrical combination of the active and the reactive powers, can be seen as the total power drawn from the network.

The ratio between the active power and the apparent power is referred to as the power factor (cosφ) and is a measure of efficient utilization of the electrical energy. Unity power factor (cos φ that equals to 1) refers to the most efficient transfer of useful energy. A cosφ , which is equals to 0 refers to the most inefficient way of transferring energy.

VOLTAGE UNBALANCE

Fortes cue has shown in the symmetrical components theory that any three phase system can be expressed as the sum of three symmetrical sets of balanced phasors i.e. the first set having the same phase sequence as the initial system (positive phase sequence), the second set having the inverse phase sequence (negative phase sequence) and the third one consisting of three pharos in phase (zero phase sequence or homopolar components). A normal three phase supply has the three phases of same magnitude but with a phase shifted by 120°. Any deviation (magnitude or phase) of one of the three signals will result in a negative phase sequence component and/or a zero phase sequence component. The definition of voltage unbalance is usually expressed as the ratio between the negative phase sequence component and the positive phase sequence component. This parameter is expressed in percentage. (strictly speaking, the homopolar part should also be considered in the definition. However, as it is the negative phase sequence that is the most relevant for causing damage to direct on line motors by creating a reverse torque, historically the unbalance definition is often limited to the one expressed in this paragraph).

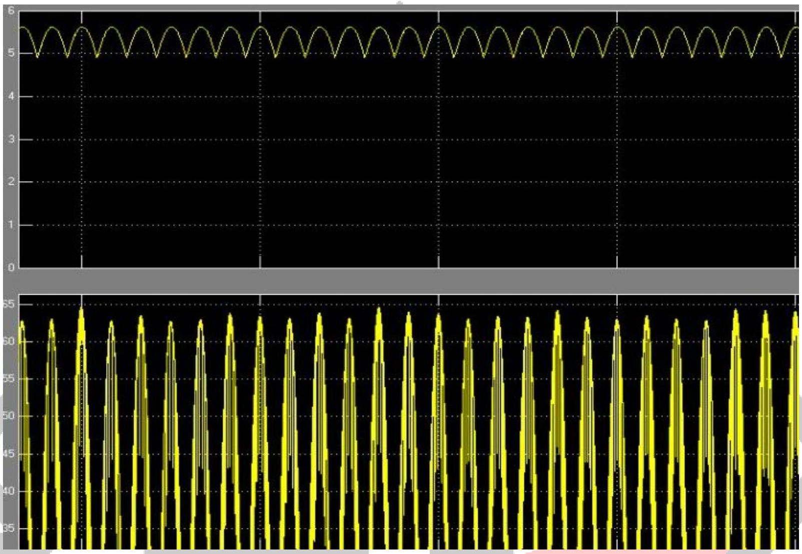


Fig2.output waveform

CONCLUSION

This project work presents design of shunt hybrid power filter and thyristor controlled reactor for a distribution system. The hybrid filter reduces the harmonics as compare to open loop response. This hybrid filter is tested and verified using MATLAB program. The major part of compensation is supported by the passive filter and the TCR while APF improves the filtering characteristics and damps the resonance, which can occur between the passive filter. The objective of APF is to generate the current that is equal but opposite to harmonic and reactive current, thereby achieving sinusoidal supply current in phase with the supply voltage. A P-I controller is implemented for three phase shunt hybrid power filter, the P-I controller extracts the reference current from the distorted line current and hence improve the power quality parameters such as harmonic current and reactive power due to nonlinear load. Here the output waveforms of with filter circuit and without filter circuit are implemented. The harmonic current control is obtained from the simulation response.

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