Active power filters to improve the power quality for grid integrated system

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***ABSTRACT*: Nowadays the use of active power filters has been increased for the development of transmission in the power system at both distribution level and consumer level. This paper deals with compensation of power quality issues based on electronic devices which causes the high disturbance during transmission. Continuity of electricity is not only the parameter which decides the power quality but also it is decided by the supply voltage and current. The two serious power quality problems are current harmonic distortion and reactive power demand. To analyze these problems filters are introduced. Filter can compensate for power factor, load unbalance, and harmonic currents. This plays a major role in removing harmonics more effectively as well as it is used to remove the higher order and lower order harmonics. Active power filters are economical leading to saving in overall cost. For better operation of the system power quality mitigation techniques are developed. The required model is developed in MATLAB software using SIMULINK and power system set tool box.**

***Keywords*: Active power filters, power quality mitigation, harmonic**

INTRODUCTION:

Due to the intensive use of power converter and other non linear loads in industry and by the consumers in general hence current and voltage waveform can be deteriorated. The demand for the power electronic devices, ups, electric arc furnace and growing use of adjustable speed motor drives are increasing day by day.The power electronic devices at load side injects harmonic current and reactive power into the supply grid having effect on voltage and power quality hence operation of electronic interface is affected by polluting the electric distribution network. Presence of harmonics, waveform will seriously affect the power quality problems.

Passive filters are economical based on harmonic source present, the design of passive filters will vary. Though passive filters having many drawbacks it was used to eliminate harmonic distortion in current and voltage waveform. To solve the drawbacks active filters are introduced. Active filters place an important role in reducing the harmonic current and also compensate the reactive power by acting as harmonic current source to provide effective result.Since active power filter contains power electronic devices, harmonics can be distorted. In active power filters it is easy to tune the waveforms and they are small in size with less weight and produce the high gain.

BASICS OF FILTER CONFIGURATION:

Harmonic distortion in power system can put an end through these approaches:

1. Passive filters
2. Active filters

- PASSIVE FILTERS:

Passive filtering is the customary solution to reduce the harmonic distortion.Passive filters are inductance, capacitance and resistance elements tuned to control harmonics. They are generally classified into series and shunt passive filters. Series passive filters use high series impedance to block harmonics. Shunt filters divert harmonics by means of low impedance.

When the inductance and capacitance reactance of the passive filter become equal at particular harmonic frequency, shunt passive filter acts as low impedance thus it will be considered. And also passive LC filters have been used to remove line current harmonics and also to improve the power factor. But the passive filters have disadvantages like large size, fixed compensation etc. To solve these Active power filters were introduced.

- ACTIVE FILTERS:

Active filtering is a relatively new technology to utilize power electronics to produce specific current components to cancel the harmonic current components caused by the non linear load.

Active power filters have advantages over passive filters:

1. They do not cause harmful resonances with the power distribution systems.
2. They can suppress not only the supply current harmonics, but also reactive currents.

The working of APF consists of:

- ✓ Signal conditioning.
- ✓ Derivation of compensating signals.
- ✓ Generation of gating signals.

These are classified into:

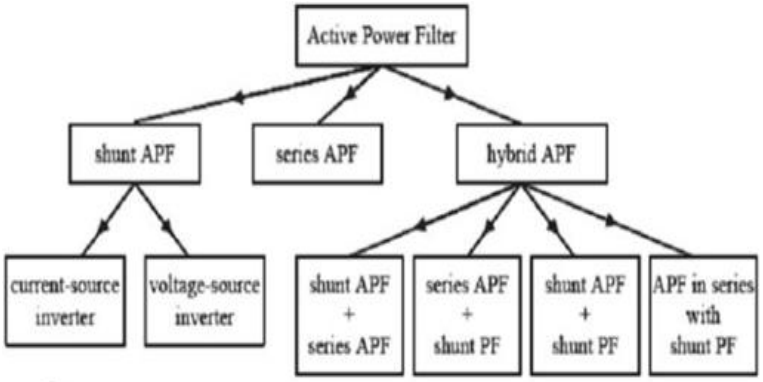


Fig 1. Classification of active filters

- Shunt active power filter.
- Series active power filter.
- Hybrid active power filter.

- SHUNT ACTIVE POWER FILTER:

It consists of a controllable voltage or current source. The operation of shunt APF is based on injection of compensation current which is equal to distorting current, thus eliminating the distorted current.

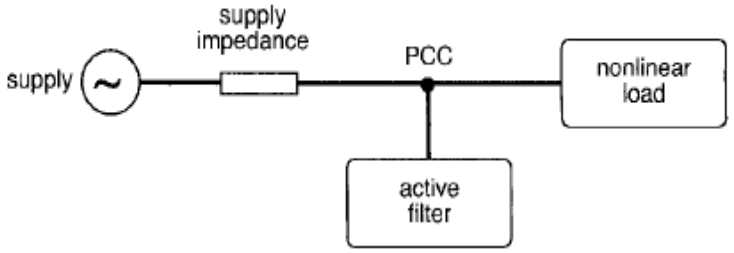


Fig 2. Shunt active filter

POWER QUALITY:

It can be defined as the interaction of electrical power with electrical equipment. It includes reactive power, harmonic distortion and load unbalance. If the electrical equipment malfunctions, is unreliable, or is damaged we would say that the power quality is poor. It determines the fitness of electrical power to consumer devices. As the population is increasing day by day such harmonicdevices also increase in return, hence in order to mitigate the harmonics, Active power filters are being used and it will be the feasible solution.

POWER QUALITY PARAMETERS:

REACTIVE POWER AND POWER FACTOR:

• 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 enables to undergo the electromagnetic field used to make a motor operate, and also 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)

SOLUTIONS FOR POWER QUALITY IMPROVEMENT:

There are two ways for the reduction of power quality problems. Firstly, the load conditioning, this ensures that the equipment is made less sensitive and effective for power disturbances. The second technique is, to installline-conditioning systems that suppress the power system disturbances. Passive filters are commonly used to restrict the harmonic currents in the power distribution system. As their performances are restricted to only few harmonics and resonance can also be introduced in the power system. Hence in search of new technique, active filters are flexible alternative to compensate the disturbances of current and voltage in the distribution system. For this purpose SAPF is proposed and by PI controller technique the performance of HAPF is improved.

I. SHUNT ACTIVE POWER FILTER:

Shunt active power filter plays a major role in compensating reactive power in power transmission systems. These compensate load current harmonics by injecting equal-but opposite harmonic compensating current but phase will be shifted by 180°

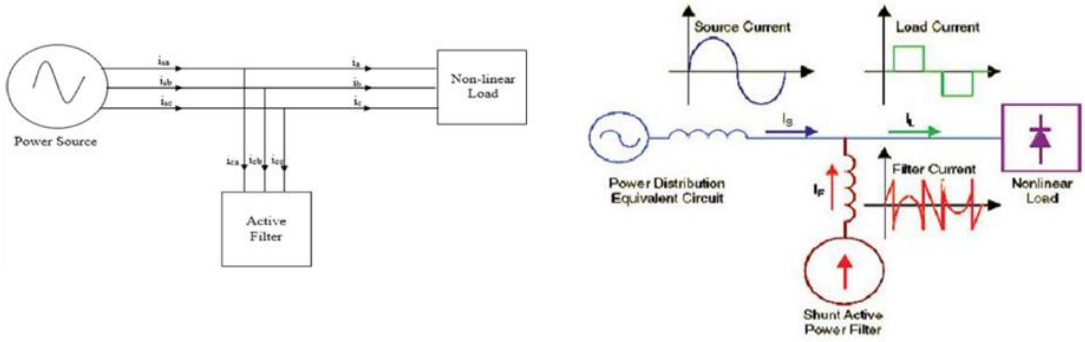


Fig 6. Shunt active power filter

It is controlled to supply a compensating current I to the utility, so that it cancels current harmonics on the ac side and makes the source current in phase with the source voltage.

II. PI CONTROL SCHEME:

If the mathematical model of the plant is not known and the analytical design cannot be used, PI controller controller will be useful. In some cases, the controller will be on the response to distribution input and on the reference input. In the single degree of freedom case these two conflict with each other and cannot be satisfied. In order to reach the required satisfaction we can increase the degree of freedom. To satisfy the given transient response, an approach with MATLAB is very powerful. This approach can be directly used to design high performance control system.

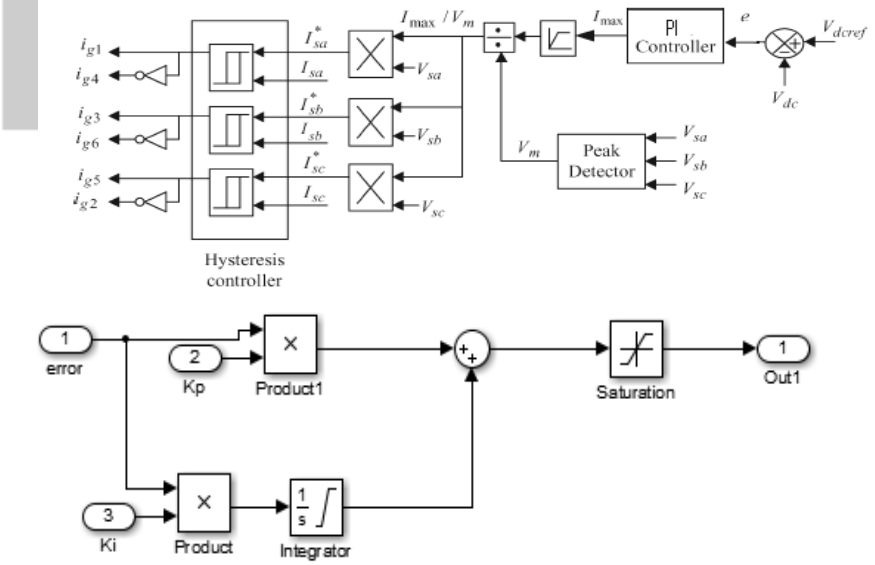
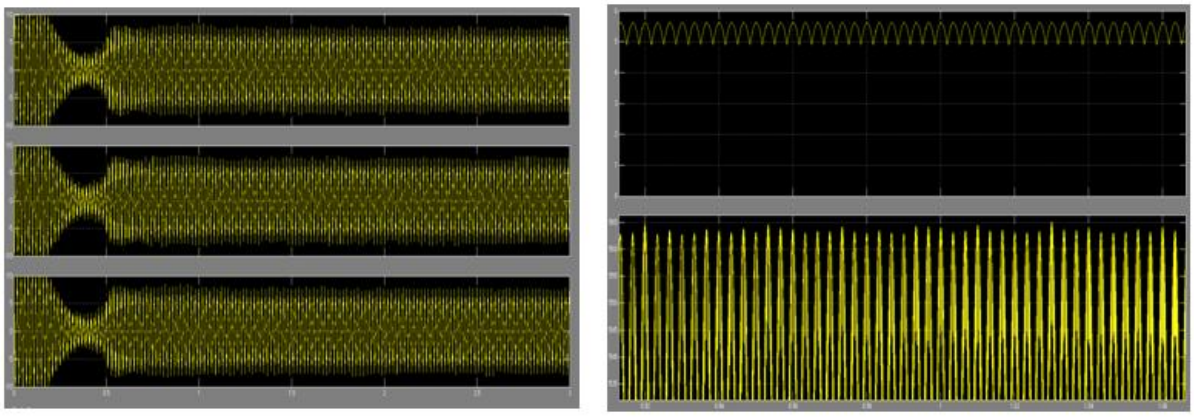


Fig 7. APF control scheme with PI controller

The error signal will be fed into PI controller and the output obtained from it will be considered as peak value of the reference current. The hysteresis based, carrier less PWM current controller, both the reference current and actual current are given to generate switching signals. The operation of switches will be decided by the differences of both these currents. After the proper isolation and amplification these switching signals are given to the switching devices. Due to this action, current flows through the filter, harmonic current and reactive powerof the load will be compensated so that only active power will be drawn from the source.

MATLAB/ SIMULINK RESULT:



Waveforms by using active power filter

CONCLUSION:

This paper begins with the brief discussion of shunt active power filter which has been demonstrated to compensate the harmonic currents and the power factor produced by the loads. The current at the source side is made almost sinusoidal and in phase with the system voltage. The voltage harmonics can also be prevented by this current. Under the steady state and transients, APF simulation using MATLAB simulink is useful for the detailed behavior of the system for harmonic and unbalance compensation. The review shows that there is a significant increase in interest of active filters. Due to increasing concern about power quality, the control circuits constitute the total cost of active filters.

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