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Power Quality Improvement by Reduction of Harmonic using Shunt Active Power Filter

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ABSTRACT:

This paper focuses on the harmonic reduction by using shunt active power filter. The reduction in harmonics reflects as improvement in power quality. This paper includes the operation of shunt active power filter. It also includes the Simulink model and their results. It also describes the PI controller used in Simulink model. The total harmonic distortion is compared with filter and without filter. The permissible limit of THD is also followed as per IEEE.

KEYWORDS: Power Quality, THD, SAPF, Hysteresis current controller, Proportional Integral controller.

INTRODUCTION

In the last decade, the power quality issue has been the main problem of power companies. Power quality is the combination of voltage profile frequency, harmonics contain & reliability of power supply. From the definition, it is clear that voltage variations, harmonic pollution causes of poor power quality. Therefore, for better performance of equipment, we need to improve power quality of equipment.

There are many methods to improve power quality of equipment but here we are using shunt active power filter for reducing harmonics which automatically reduces power quality. A SAPF senses the load current & injects a current into the system to compensate current harmonics or reactive load.

SHUNT ACTIVE POWER FILTER

The SAPF is a device that is connected in parallel & cancel harmonics in current by injecting equal and opposite harmonic compensating current generated by load i.e. phase shifted by 180 degrees & components of harmonic currents contained in the load current are canceled by effect of AF & the source current remains sinusoidal & in phase with the respective phase-to-neutral voltage.

This principle can be applied to any type of load, considered as a harmonic source. Moreover, by using a proper control scheme, the APF can also compensate load power factor. In this way, the nonlinear load & APF can be seen as ideal resistor for a power distribution system.

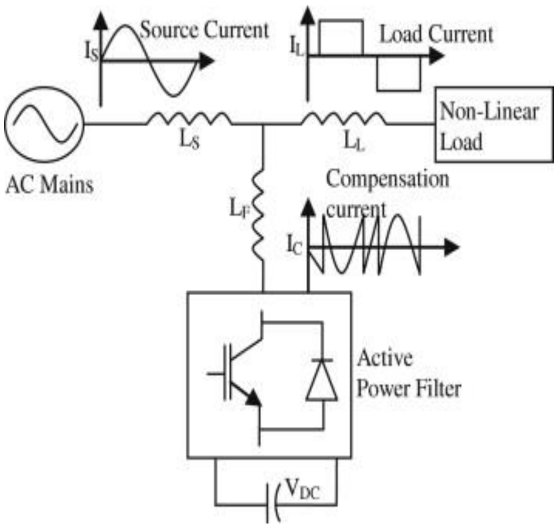

Fig.1: Basic scheme of shunt active power filter

HYSTERESIS CONTROL TECHNIQUE

HC control technique is used to determine the switching signal of APF. It is a two-level band theory.

When, current exceeds from upper hysteresis limit then upper band turned OFF &lower band turned ON & when limit current below from lower hysteresis lower band turned OFF, upper band turned ON. The disadvantage of fixed band HCC is its problem of variable switching frequency, harmonic distortion & noise in system. To avoid this problem, the concept of adaptive HCC has proposed. Adaptive HCC overcomes the problem of switching frequency & control the frequency band. HCC technique is used in APF because of its simplest function & easy implementation.

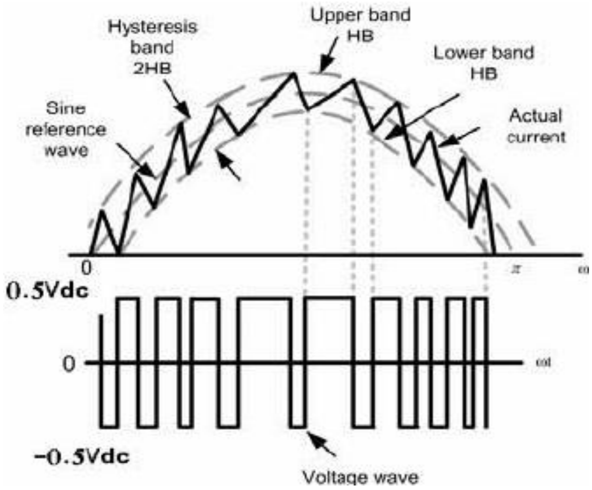

Fig.2: Hysteresis current control technique

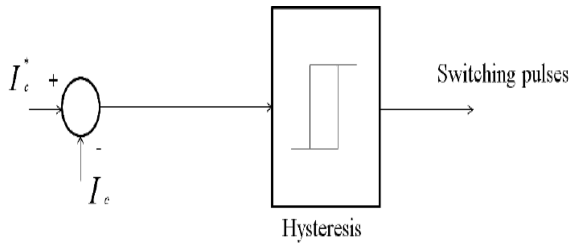

Fig.3: Hysteresis current control technique

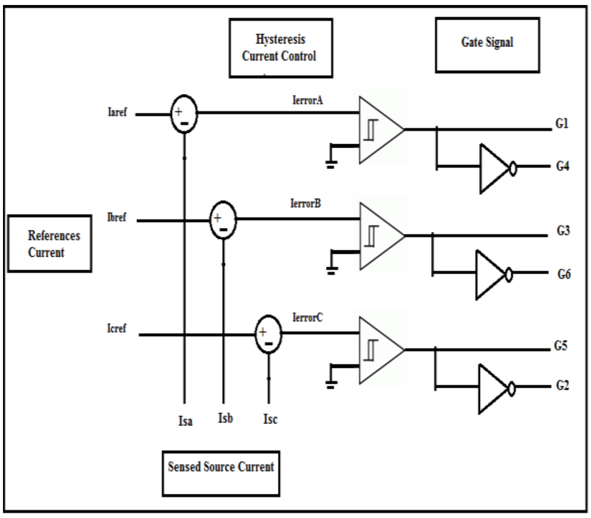

Fig.4: Simulink diagram of hysteresis current controller

PI CONTROLLER

PI controller is used for the process of non-integrating that means the process which gives the same output with the same disturbance & the input. For the non-integrating process, PI controller is the perfect one. In the control scheme various controller blocks such as limiter, sine wave generator, switching signal generator. Highest value of the reference current will be regulated by the dc link. Capacitor voltage are compared with the set reference voltage value. The error between the actual capacitor voltage & reference voltage is given as input to the PI controller for the reference current generation. Output of the PI controller is considered as the maximum value of the system current (Imax).

Output of the PI controller consist two components:

1. Fundamental active power component of the load current.
2. The losses of active power filter.

For maintaining the constant voltage across the capacitor, the output of the PI controller is taken as the peak value of the system current. For obtaining the compensating current, Imax is multiplied with the unit vector in phase with the respective source voltage. Error signal are used for the switching of the converter switches.

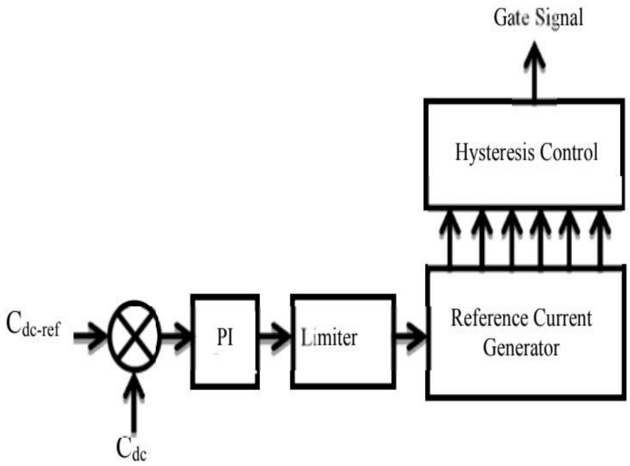

Fig.5: Block diagram of PI controller

SIMULATION & RESULT

In this research work SAPF is simulated with 3ϕ source, a nonlinear load, a voltage source converter & a PI controller. All these components are modeled separately to simulate the system.

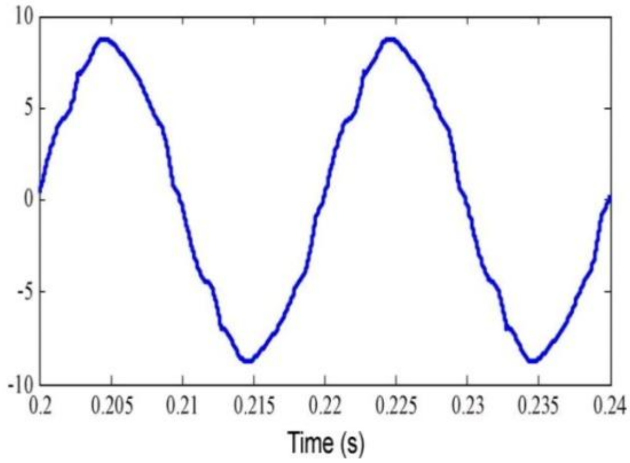

Fig.6: Source current with the passive filter

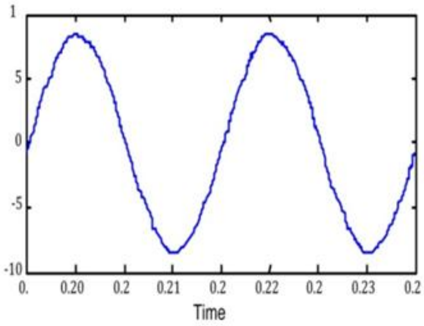

Fig.7: Source current with AF

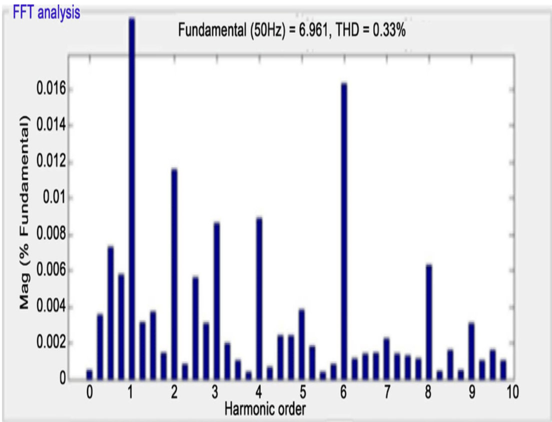

Fig.8: Spectrum of THD without APF

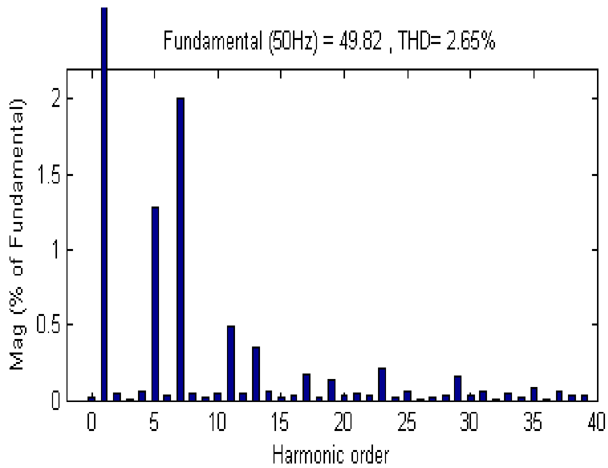

Fig.9: Spectrum of THD with APF

CONCLUSION

The conclusion of this research paper is that the SAPF is very effective to compensate the reactive power & harmonics mitigation technique. SAPF compresses the harmonics by simply injecting the equal in magnitude but opposite in phase harmonics compensating current. SAPF can compress the harmonics current in the range of below 5% which is provided by IEEE standard. It is verified by simulation results.

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