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Three Phase Shunt Active Power Filter Using Simulink

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ABSTRACT

In AC power grids for harmonic emission reduction and reactive power compensation, activity filters have become very common. The network with non-linear loads such as power converters is equipped with an active power filter for optimizing THD. Shunt type or series type. It also enhances voltage control and unbalance in flicks. For most active control filters, the instantaneous power principle also known as p-q theory is used. This paper explains Shunt active power filter for a 3-phase wire AC network. The proposed shunt active power filter uses principle of instantaneous reactive rower to remove harmonics from source streams. On the Matlab/Simulink method, the simulation results are shown.

Keywords : p-q theory, Voltage Source Inverter (VSI), PWM, THD and Active Power Filter (APF)

I. INTRODUCTION

Harmonic is a term that threatens not only utility companies, but customers as well. Pollutants in sinusoidal AC networks are both current and voltage harmonics. These harmonics lead to many unwanted phenomena. Non-linear loads are the primary source of harmonics. Two forms of non-linear loads are identified and unidentified [1]. The defined non-linear load category is the high voltage converters, cycloconverters, high-power thyristor rectifiers. And they can conveniently observe the harmonics and their influence on the grid by the utilities. These defined loads can be seen and removed individually from the harmonics injected at point of common coupling (PCC). The unidentified kind of non-linear load is a low power diode rectification, low power equipment with power electronic components.

Mostly, harmonics are caused by electrical machinery, transformers, measurement devices, consumer equipment. It attacks the computer directly and reduces its efficiency. Initially, passive filtering was a common approach in the implementation of active filtering techniques to reduce efforts. The active power filter uses electrical power swapping for harmonic currents. Injected into the line, produced harmonic currents cancel the original components of the harmonics. The two basic types of active power filters are the Shunt and Series active filter which respectively suppress voltage and current harmonics [3]. Among other available control strategies for active power filters, the instant reactive power theory is very common. In order to eliminate current harmonics, the p-q principle is implemented with the three-phase shunt active filter, linked directly to the power grid. Using MATLAB/Simulink, the technique is applied.

II. RELATED WORKS

Since their basic compensation principles were proposed around 1970, active filters have been studied by many researchers and engineers aiming to put them into practical applications.

In [1] discusses the current state of active filters, including the author's personal opinion and expectations, based on state-of-the-art electronic power technology and their potential prospects for the 10th century. In near future, the term of active filters will cover a much wider sense than that of active filters in the 1970s did. The function of active filters will be expanded from voltage flicker compensation or voltage regulation into power quality improvement for power distribution systems as the capacity of active filters becomes larger.

In [4] suggested the widespread instantaneous reactive power principle in ac networks in 1983. It is also known as the principle of immediate reactive energy or p-q. This theory applies to three-stage cable, four-stage wire and single-stage networks. The first step in p-q theory involves the algebraic change of the 3-phase voltages and currents from a-b-c to alpha-beta-0. To complete this mission, Clarke's transformation is used. On the same plane, the axis a, b and c are fixed. They are 120° apart. They are 120° apart. The alpha and beta axes are 90 degrees apart.

In [5] standard technologies for harmonic and reactive power compensation were usually passive filtering. Due to its simplicity and precise control, active filtration is taken into account with advances in power electronics. In order to advice industrial engineers in product selection in view of their device and machine limitations, this paper presented a few active and passive filter topologies. Active and passive filter topology mathematical models were introduced and applied in programming language C to create simulation models.

In [6] produces a brand-new control computation based on the principle of the space vector for three-phased power filters. In addition to all the benefits, the low-pass filter classes can be further reduced, the addition and multiplication times calculated, and measurement speed can be improved. If this type of filter is used with the same circuit parameter, it could improve the compensation efficiency and provide a lower harmonic current. The outcome of the simulation shows that it has fabulous static, complex compensation and functional values. This three-phase active power filter, based on widespread theory of instantaneous reactive power, has a basic controlling principle and can efficiently simplify the current estimation of the instructions.

Power electronics systems have developed in [8] and have been used for different applications. The power quality issue in the electric grid is also caused by this unit. In the utility arc furnaces, fluorescent non-linear lamps with variable frequency motors, personal computer (VFD), emit current harmonics. Efficiency of electricity is a critical problem for the user and the distributed side. Active power filter that improves power and compensates for reactive power. This paper discusses the harmonic problem caused by non-linear load.

In [10] shows the specification and simulation for the harmonic and power factor correction of several non-liner loads of a single-phase shunt active power filter. In Matlab Simulink, the device comprises an unregulated corrector and an AC controller with an active filter that compensates the harmonic current injected by the load. The AC controller has a nonlinear load. The active filter is built on a one-phase inverter for complete bridges. The spectral analysis of the supply current reveals that load harmonics were effectively offset by the active filter. The effect on the output of the active filter is also presented by changing the switching frequency.

In [11] uses active filters to increase the power output on the power supply side. This is a two-part simulation, 1) using the process of controlling hysteresis to reduce the third harmonic on the load-side. 2) To minimise the 3rd harmonics on the load-side, use MOSFET and gate drivers' models. Owing to use of the nonlinear loads, the losses from the harmonics on the load side will be high and the power factor will thus minimise costs by unit. By using both of the above methods we can reduce losses since the third harmonics in this system are too few.

In [12] defines an enhanced dynamic output shunt active power (APF) filter. The APF transition reaction is too slow when the value of the load current varies rapidly, the line current suffers from a complex distortion. This distortion allows the line current to increase its harmonic content, which depends on a time constant. The APF current dynamics rely on the inverter time output consisting of the APF output inductance and the resulting load and grid impedance. In the proposed APF transient circuit, the non-causal predictive current compensation enhanced efficiency. A updated output inverter is used in the second approach.

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III. Three Phase Shunt Active Power Filter

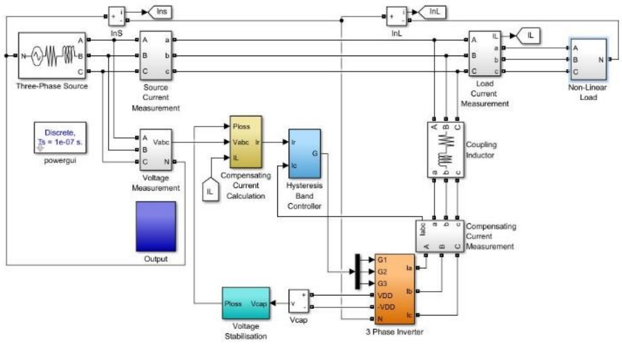

Figure 1: Proposed System

The harmonic current problem in the power system is solved. It also offsets three-stage reactive power and balances (if load is unbalanced). The transformation of p0,p and q is used by Clarke, the constant part p is filtered and the compensating part p0,p and q is found. Then, the reverse-Clarke transformation determines the compensating current. The compensating current is pumped to the network using the HBCC system using a three-phase inverter. This shunt active power filter provides a harmonic and reactive load component. Compensate p0 also means a three-phase balance of load.

IV. Simulink Simulation

Underneath are several waveforms without an active power filter shunt and with an active power filter shunt.

Fig. 2, 3, 4 indicates respectively a, b, c compensating currents. The unwanted current components are included in these currents. This means that the VSI can pull these currents from the source.

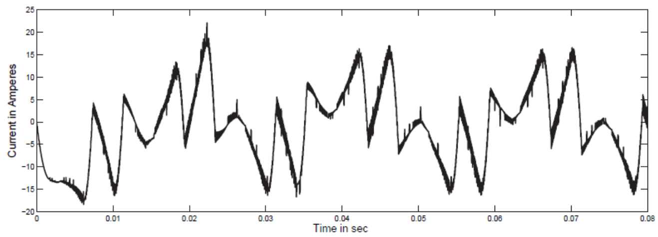

Figure 2: a phase reference compensating current

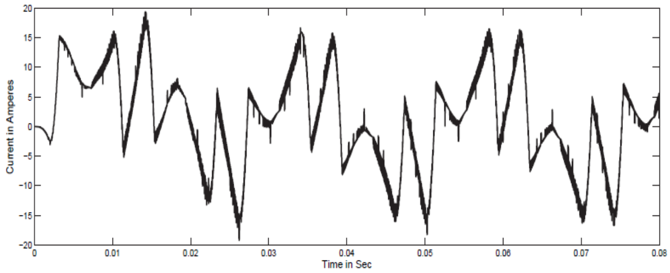

Figure 3: b phase reference compensating current

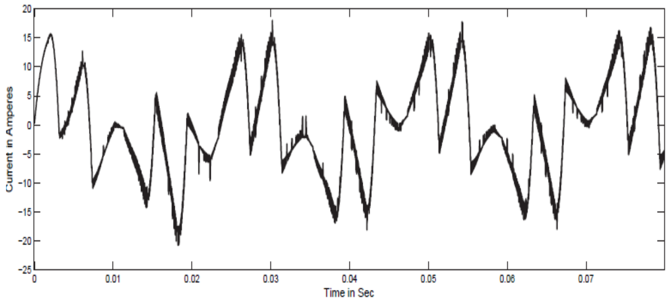

Figure 4: c phase reference compensating current

Large energy storage capacitor with automatic voltage regulator is used instead of DC voltage source. PI controller maintains capacitor voltage to desired value [5]. As seen from Fig. 5 after few seconds capacitor voltage settles to 700 volts. The advantage of active power filter is that it does not have any active source at DC side. So no active losses in active power filter. Only switching losses are present due to high switching frequency.

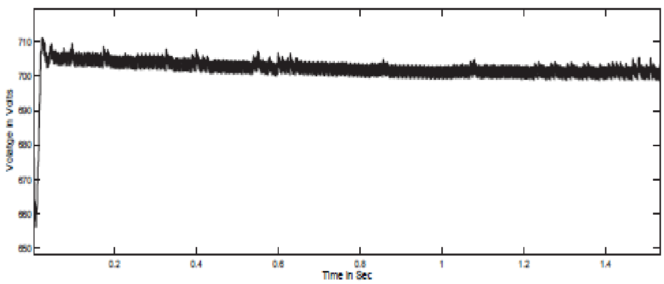

Figure 5: DC Capacitor voltage

Fig.6, 7 and 8 shows source currents of phase a, b, c with APF . It is observed that nearly all dominant harmonics are eliminated by APF, which result in nearly sinusoidal three phase current waveform. THD of these currents is found to be within IEEE-519 standards.

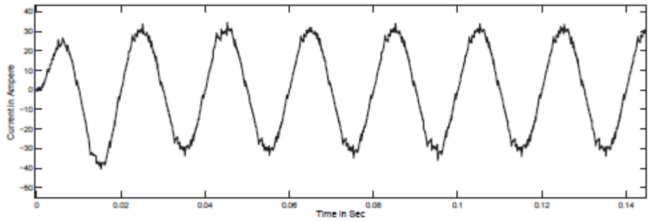

Figure 6: a phase source current with shunt APF

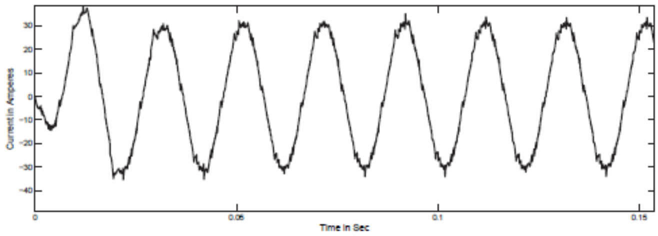

Figure 7: b phase source current with shunt APF

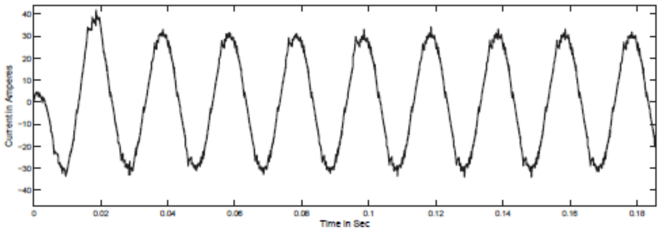

Figure 8: c phase source current with shunt APF

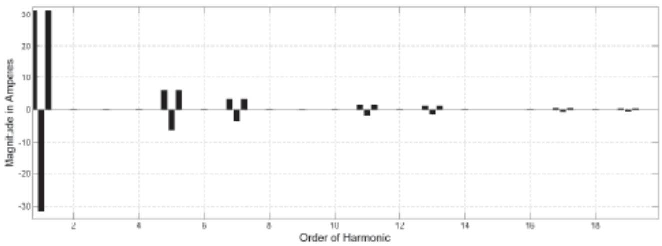

Figure 9: Harmonic spectrum of source current without APF

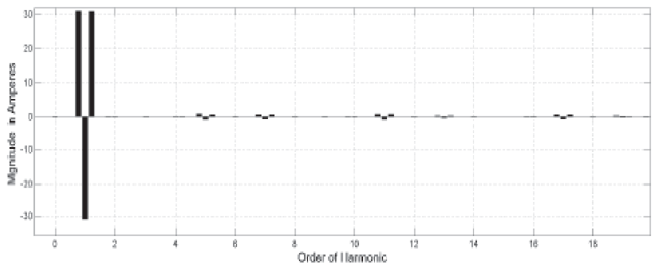

Figure 10: Harmonic spectrum of source current with APF

The comparison of harmonic spectrum in Fig.9 and 10 clearly shows the reduction in the harmonics after application of active power filter.

V. CONCLUSION

This paper presents a system to reduce existing harmonics by the use of a shunt active power filter in the three-phase wire AC network. The instantaneous principle of reactive force is used as a system basis. The result demonstrates the precision of theory with respect to the extraction of harmonic and reactive current materials. One of the simplest methods of current control for comparison current matching is the Hysteresis band PWM approach used in this paper. The DC side voltage constant is held by the automatic voltage regulator established in this paper for an active filter. The proposed active power filter will minimise the current supply THD by less than 5 percent to satisfy the standards of IEEE-519. This system also offsets the load demand for reactive fuel.

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