Review Paper on FUZZY CONTROLLED SERIES ACTIVE POWER FILTER IN SINGLE PHASE SYSTEM FOR MITIGATION OF HARMONICS

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Abstract - *:: In this paper we developed a single phase series active power filter for reduction of harmonics in grid with non-linear load, power electronic equipment Active power filter (APFs) are capable of compensating power quality problems that have the ability to dynamically adjust their modes of operation in response to change in load or in the power system . The series active power filter is specially conceived to deal with problems related to the power system waveform and voltage amplitude among this solution. Despite the ability to compensate voltage sag, voltage swell, voltage harmonics and voltage imbalance in three phase system the series active power filter has not been widely adopted. The lack of interest in this equipment can be largely justified because of some limitations presented by the SeAPF conventional topology and also by its high cost. In this paper is presented a novel topology as well as the controlled algorithm of a single phase SeAPF that is connected directly to the power grid without the use of external power sources.*

***Key Words*: Single Phase Series Active Power Filter, Active Power Filter, Harmonics, Power Quality, Voltage Swell, Voltage Sags**.

1. INTRODUCTION

Nowadays, electronic equipment is a part of the everyday life of any home, we live in such a technologically advanced era. Moreover with the technology development of industry as well as more ambitious demands in terms of quality and quantity, industry. However, these sophisticated domestic and automated devices, when connected to the power grid (PG), produce a high harmonic current content, causing electricity quality problems that therefore have a monetary impact on consumers. Variable speed drives, soldering machines and other high-power electronic equipment as well as TVs, computers, Printers, electronic ballasts lamps, fridges and smart phone chargers are some examples with a steady presence in the industry and at home. Many of these devices are similar to an uncontrolled diode rectifier followed by a DC-Link, which causes a high current harmonic content. Therefore, these current harmonics, while following the line impedances, cause harmonic distortions in the PG voltage, which makes it a serious problem for electricity generators and in particular, for consumers.

Furthermore, the PQ occurrences result in enormous financial losses. According to roughly 30% of the most vulnerable industry sectors may pay a PQ cost of around 4% of their turnover, with voltage sags and temporary disruptions accounting for about 60% of the cost. When compared to the European economy as a whole, the total PQ cost was estimated to be above 150 billion Euros in October 2015. Despite the fact that the PQ issues are primarily caused by consumers, particularly industrial customers, there is a compromise between producers and consumers. The manufactures agree to keep voltage harmonics to a minimum in order to supply electrical energy within specific parameters (EN 50160 Standard).

2. LITERATURE REVIEW

1.Fei jiangi, Yinvi Li , Chunming Tu , Qi Guo and Hongjiang Li suggested that :
The series voltage source converter (SVSC) is commonly used in power electronic equipment such series active power filters, dynamic voltage restorers, and unified power flow controllers. While the SVSC is more susceptible to the effects of fault current, its applications are more diverse are increasing, posing significant hurdles to the grid's safe functioning. The topology has changed dramatically in recent years. The series voltage source converter with fault current limitation (SVSC-FCL) and its control approach hub for research. In this study, it is proposed that SVSC-FCL based SVSC be divided into two

groups: The existing topology enhancement group and the control scheme optimization group. The SVSC-research FCL's difficulties and viewpoints are discussed in depth. The goal of this work is to show current research progress on SVSC-FCL and to add to the multi-functional power pool electronic devices.

2. Bruno Exposto, Helder Carneiro, Carlos Couto, João L. Afonso suggested that: how to make a Shunt Active Power Filter with a current-source inverter. The Active Filter is controlled using the p-q Theory and the "Sinusoidal Currents at Source" algorithm. Two modulation approaches were used to simulate the Active Power Filter: Periodic Sampling and Carrier-Based Pulse Width Modulation (CBPWM). The simulations were run with two different loads to evaluate the Active Filter's performance. A RL balanced load was used as the first load. The second load was a non-linear load, such as a complete bridge rectifier with an RL load on the DC side. Using the two modulation strategies, we were able to determine the performance of the Active Filter when adjusting current harmonics and power factor.

3. Abdul Wadood, Chang Hwan Kim, Saied Gholami Farkoush, Tahir Khurshaid, Kumail Hassan Kharal, Suggested that: It is a critical issue and a challenge for industry, especially for engineers, to send an accurate, reliable, and adaptable electricity to consumers without any distortion. Many power problems develop during transmission, affecting the functioning and efficiency of the power system. There are various concerns with power quality, including harmonics, which have an impact on power system operation and should be addressed first. Among the several forms of harmonic filters, active power is considered to be a very profitable and cost-effective option. The simulation of an active power filter for harmonic reduction using MATLAB/Simulink software is shown in this research.

3. BACKGROUND

1. PASSIVE FILTER: In other words, they "filter out" undesired signals, with an ideal filter separating and passing sinusoidal input signals based on frequency. Passive filters are often built with simple RC (Resistor-Capacitor) networks in low frequency applications (up to 100kHz), and RLC (Resistor-Inductor-Capacitor) components in higher frequency applications (above 100kHz).Passive filters have no signal gain since they are made up of passive components like resistors, capacitors, and inductors and have no amplifying elements (transistors, op-amps, etc.). As a result, their output level is always less than the input. Filters get their names from the frequency range of signals that they let pass through them while blocking or "attenuating" the rest.

2. ACTIVE POWER FILTER: In this section, we'll go over some of the fundamentals of active filters for generation and distribution grids. It's worth noting that there are also power electronics compensators for transmission grids that have distinct properties, such as dampening sub synchronous resonance, power flow regulation, and improving power system stability. The Flexible AC Transmission System (FACTS) is the name for these compensators, and their study is beyond the scope of this chapter. Back to active power filters, they can be thought of as regulated current or voltage sources that can compensate for a variety of power quality issues such as harmonic and unbalanced components, power factor, voltage sags or swells, dampening low-frequency harmonic oscillations, and so on. Furthermore, they are employed as an interface for renewable energy sources in a new distributed generation idea or even to make decentralised microgrid installation more dependable.

3. SERIES ACTIVE POWER FILTER: A coupling transformer connects the series active filter (shown in Fig.1) to the utility grid. The elimination of voltage harmonic components on the load side is achieved by inserting a series active filter between the ac source and nonlinear loads. The coupling transformer is used to inject voltage harmonic components into the utility grid. Between a nonlinear load and the electrical grid, series active filters primarily function as a voltage regulator and harmonic isolator. The series active power filter injects a voltage fundamental component in series with the supply voltage, allowing it to function as a controlled voltage source that compensates for voltage sags and swells on the load side.

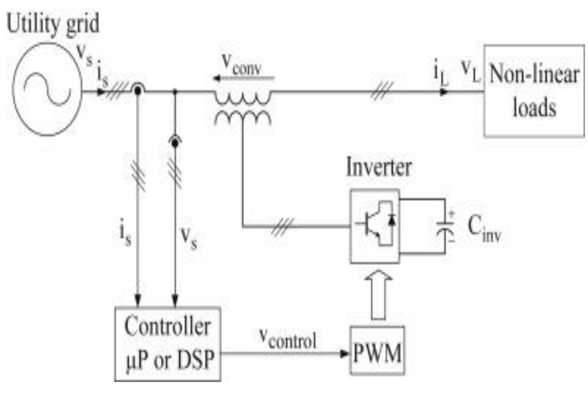

Fig1. Block dig of series active filter

4. PROPOSED WORK

The APFs are made up of an acquisition system and a control system, which work together with the power converter to enable autonomous PQ mitigation. The SeAPF, in specific, is competent of lessening the larger part of the issues associated to the voltage of the PG, as shown by the power quality problems (i.e momentary interruptions,sags,swells,voltage,fluctuation,notches,transients and voltage unbalance).

The SeAPF works in the same way as an ideal voltage source, supplying a voltage in phase opposition to the PG's harmonic content allowing the load's voltage waveform to be sinusoidal with this notion in mind, the first solutions to reduce PQ difficulties were devised in 1970. As in the "traditional" single-phase SeAPF topology with coupling transformer between the APF and the PG, as well as an auxiliary external power supply on the DC-Link, emerges at this time. These features offer galvanic isolation between the APF and the PG via the transformer, as well as the ability to correct for long-term under voltages and over voltages caused by the external power supply. However, because the SeAPF injects voltage harmonics through the coupling transformer, it results in high losses and overheating, shortening the SeAPF's life cycle.

Furthermore, the usage of transformers and external power sources increases the size and cost of this equipment, making it less appealing for purchase.

As a result of these factors, a new topology is provided in this research, as seen in Fig.2. (proposed topology).This revolutionary SeAPF architecture eliminates the superfluous and costly components of the traditional design, making it more efficient and compact. The control system, on the other hand, needs to be more advanced. The implementation of control algorithms, on the other hand, does not appear to be a barrier due to the technical improvement of microcontrollers, which now have a high processing capacity, additional memory, and peripherals. To accomplish so, a synchronization method would be required to maintain a reference voltage that is immune to PG distortions and to control the SeAPF DC-Link to the reference voltage. It is feasible to manage the SeAPF to eliminate PQ difficulties and give energy to the loads with a sinusoidal voltage waveform by combining this with the information collected from the system sensors.

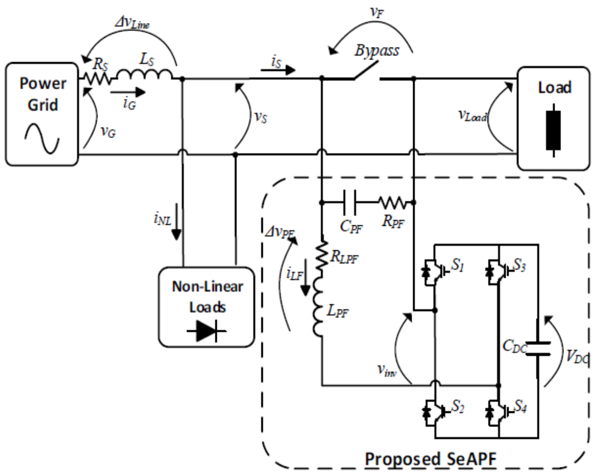

Fig2. Proposed topology of SeAPF

5. CONCLUSION

A single-phase Series Active Power Filter (SeAPF) has been presented and experimentally proven without an external power source in the DC-Link and without a Power Grid (PG) coupling transformer. To synchronize the control signals with the PG and calculate the compensation voltage, the control method relies on a PLL circuit. The SeAPF performs a pre-charging of the DC-Link capacitor without affecting the load voltage during the first connection to the PG. During steady-state operation, the SeAPF compensates for PG voltage harmonics, resulting in a sinusoidal load voltage. The SeAPF regulates the DC-Link capacitor voltage during PG voltage sag and swell transients and employs this element to give or absorb energy to compensate for the sag or swell, keeping the load voltage within nominal limits. The modeling and experimental results demonstrate that the SeAPF with the proposed topology is functional and feasible. Some upgrades to the laboratorial prototype are required for future work in order to make the hardware more resilient and allow testing at the 230 V rms nominal voltages.

6. REFERENCES

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