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# OPTIMISATION OF PI COEFFICIENTS IN DSTATCOM NONLINEAR CONTROLLER FOR REGULATING DC VOLTAGE

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**Abstract -** *Today, loads used by various consumers are nonlinear such as industrial, residential, and commercial loads. All these nonlinear loads require harmonic current for their function; due to these harmonic components of load current power quality of the power system gets reduced. The power system network's efficiency is also reduced due to the same harmonic component of line current. Therefore, to eliminate harmonics from the power system network, active power filters have been widely used in recent days. Shunt active power filter produces harmonic current same as that produced by the nonlinear load but opposite in phase so that only the fundamental component of current flow from the supply mains and power factor of supply source maintained near unity. This paper uses a voltage-controlled voltage source inverter with the PWM method to control the converter's switching. Here the reference voltage signals are generated with the help of the d-q theory method, also called the instantaneous reactive power theory method. This paper shows the application of the proposed method for harmonic elimination under different load conditions, and simulations are done using MATLAB.*

***Keywords:-*** *Shunt Active Power Filter, PI controller and Power quality.*

## 1. INTRODUCTION

In recent years, various consumers have widely used nonlinear loads such as commercial and industrial. These nonlinear loads are the primary source of harmonic production in the power system network, which is undesirable [1]. Currently, the main objective of the power system engineers is to remove the unwanted harmonics from the entire power system to improve the power quality. Generally, the primary sources of the harmonics are adjustable speed drives, Switch-mode power supplies, and Power electronics converters. The purity of the Voltage and current waveform defines the quality of power. The power system network's power quality is also reduced due to disturbances such as voltage sag and voltage swell. Harmonics is the measure cause of the poor power quality [2]. Distortion of current and voltage waveforms are expressed in terms of the harmonics. Unwanted Harmonics are produced in the power line due to the nonlinear loads. Harmonic present in the line current produces extra voltage drop in the line impedance due to which source current and Voltage waveform also get distorted [4]. The main objective of our work is to design a shunt active power filter to reduce the total harmonic distortion and analyse the percentage of harmonic reduction in the source current due to the active power filter.

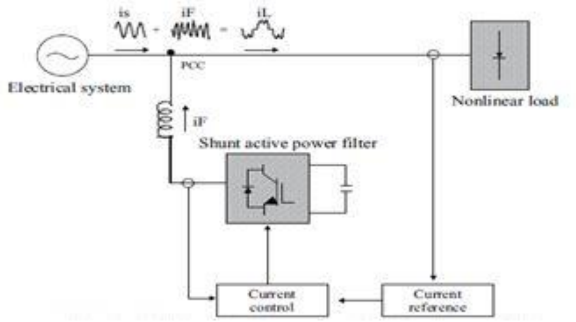

Figure1. Shunt active power filter

## 2. SHUNT ACTIVE POWER FILTER

Shunt active power filter with dc bus configuration is the same as the static compensator used to compensate reactive power in the power system network. A shunt active power filter is a power electronic device used to produce a harmonic current of the same magnitude and opposite in phase to that generated by the nonlinear load. The voltage source inverter is the primary source of the shunt active power filter, giving the necessary compensation [5].

## 3. OPERATING PRINCIPAL OF THE SAPF

The primary compensation principle of the shunt active power filter is shown in figure2. Shunt active power filters are connected with the load to continue monitoring and injecting the current into the system according to the load current. The active power filter generates reference compensating current monitoring load current [6]. The primary function of the shunt active power filter is to eliminate the harmonic current generated by the nonlinear load by injecting the same amount of current but opposite in the phase. SAPF uses the current-controlled voltage source topology converter based on the IGBT to compensate for the load harmonic current.

## 4. INSTANTANEOUS REACTIVE POWER THEORY

### 4.1 PI CONTROLLER

PI Controller is used for the non-integrating process, which gives the same output with the same disturbance and input. For the non-integrating process, the PI controller is the perfect one [7] in the control scheme, with various controller blocks such as limiter, sine wave generator, and switching signal generator. The dc-link regulates the highest value of

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the reference current. Capacitor voltages are compared with the set reference voltage value. The error between the actual capacitor voltage and the reference voltage is given as input to the PI controller for the current reference generation. The PI controller's output is considered the maximum value of the system current (Imax). The PI controller's output consists of two components: the fundamental active power component of the load current and the losses of the 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. Imax is multiplied with the unit vector in phase with the respective source voltage for obtaining the compensating current. Error signals are used to switch converter switches [8].

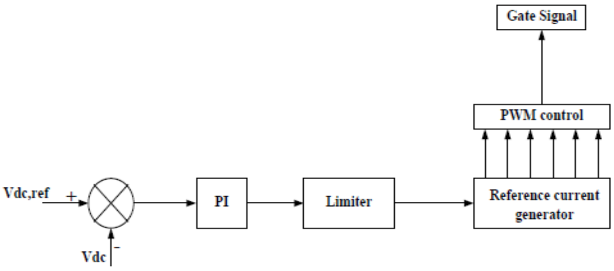
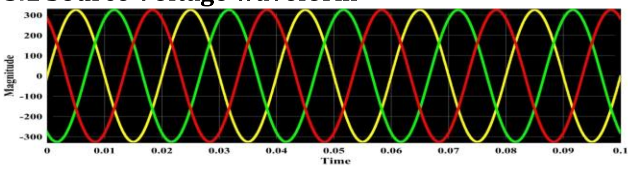


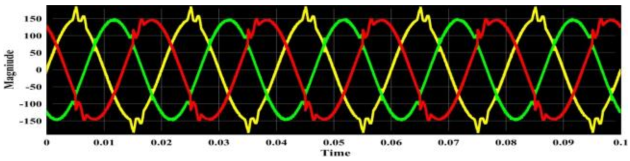

Figure2. PI controller

## 5. SIMULATION AND RESULTS

### 5.1 Source Voltage waveform




### 5.2 Source Current waveform Before Compensation




### 5.3 Source Current Waveform after Compensation

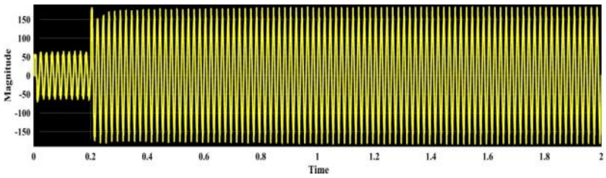



Figure. PHASE (A)

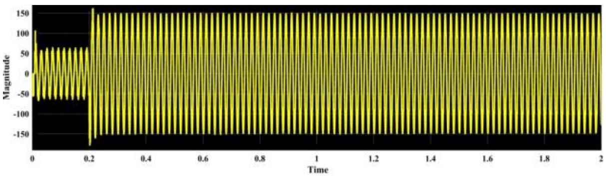



Figure. PHASE (B)

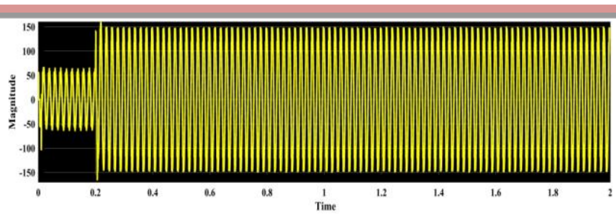



Figure. PHASE (C)

**FFT Analysis**

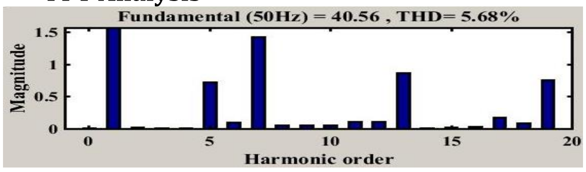



Fig. 3. Harmony Search (IAE Criteria)

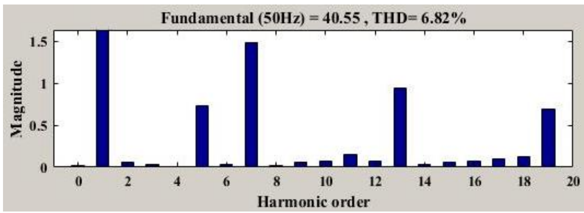



Fig. 4. Harmony Search (ISE Criteria)

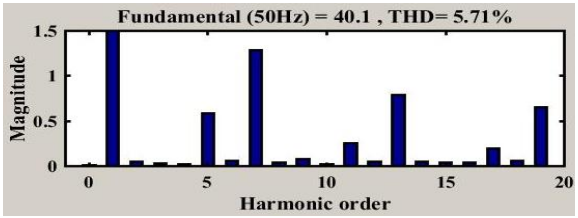



Fig. 5. Harmony Search (ITAE Criteria)

| HSA Parameter | IAE | ISE | ITAE |
|---|---|---|---|
| P | 622.37 | 576.363 | 472.37 |
| I | 692.302 | 876.146 | 952.148 |
| Kp | 895.259 | 978.326 | 992.326 |
| Ki | 985.365 | 965.251 | 914.366 |
| CURRENT THD (%) | 5.68 | 6.82 | 5.71 |

## 6. CONCLUSION

This paper discusses GSA and CSA control algorithms for a three-phase three wire DSTATCOM for power quality improvement. This DSTATCOM primarily aims to compensate reactive power and harmonic load and balance the source currents. The various control algorithms used instantaneous reactive power (IRP) theory to generate reference current. DSTATCOM provides reactive power required by the load; therefore, the source current remains at the unity power factor.

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