Comparative Analysis of THD By Using Various Controller

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Abstract: In this paper, we used the basic system and PI system by using UPQC as a controller. The active filters are used to compensate for the voltage and current. The main two types of active filters are shunt APF and Serie APF. Shunt APF is used for current compensation, and series are used for voltage compensation. The combination of Serie APF and Shunt APF produces a Unified power quality conditioner. The nonlinear load is used with an R-L load with a diode bridge rectifier.

Keywords - Basic system, Synchronous frame theory, PI system, UPQC controller, Active filter- (Shunt APF, Series APF).

I. INTRODUCTION

Power quality is the main issue in day-to-day life like voltage sag, and voltage swell, this is the thinks to degrade the power quality. In this paper we compare two systems first is a basic system and the second is a PI controller with UPQC system. In the first basic system, there are no control technics or tools used so that time what are the THD rage will come that will be seen in this paper and when we used the second system in this there are synchronous reference frame theory is used. There are active filters for shunt compensation means current compensation, which is called Shunt APF, and Series compensation means voltage compensation which is called Shunt APF. The DC-link is used for constant real power exchange. PI controller controls the DC link. In this paper, we compare both system outputs based on Total harmonic distortion.

II. OBJECTIVES

A. Study the basic system and there THD
B. Study the Unified Power Quality Conditioner (UPQC) and their Control Techniques
C. Compare the basic system and PI controller with the UPQC system on the basis of THD
D. Identification of total harmonics distortion (THD) reduction

III. TECHNIQUES AND TOOLS

A. Control techniques of UPQC

a) Synchronous reference frame theory

This method of reference current generation is developed in time domain based reference current generation. This theory is extensively used due to simplicity of calculations and uses only algebraic calculation. The three phase load current (iLₐ, iLₜ, iLₐ)are transformed into the two instantaneous active (id) and reactive (iq) components in a rotating synchronous frame with the positive sequence of the system voltage.
The basic working principle of SRF method uses a direct (d-q) and inverse (d-q) park transformation method, which allow the evaluation of a specific harmonic component of the input signals. The reference frame transformation is evaluated by converting a three-phase a-b-c stationery reference frame system to the synchronous reference frame system d-q-0 whose two-phase direct axis (d) and quadratic axis (q) component rotate in space at synchronous speed We, which is the angular electrical speed of the rotating magnetic field of the three phase supply given by We = 2πfs, where f is the frequency of the supply. If the θ is the transformation angle, then the current transformation from a-b-c to d-q-o frame is calculated as

\[
\begin{bmatrix}
    i_d \\
    i_q \\
    i_0
\end{bmatrix} = \frac{2}{\sqrt{3}} \begin{bmatrix}
    \cos \phi & \cos \left(\phi - \frac{2\pi}{3}\right) & \cos \left(\phi + \frac{2\pi}{3}\right) \\
    -\sin \phi & -\sin \left(\phi - \frac{2\pi}{3}\right) & -\sin \left(\phi + \frac{2\pi}{3}\right) \\
    \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}}
\end{bmatrix}
\begin{bmatrix}
    i_a \\
    i_b \\
    i_c
\end{bmatrix}
\]

The sine and cosine functions help to maintain the synchronization with supply voltage and current. The d-q transformation output signals are dependent on the load current and the performance of the PLL. The PLL circuit provides the rotation speed of the rotating reference frame. The \(i_d\) - \(i_q\) currents are sent through low pass filter for filtering the harmonic components of the load current, which allow only fundamental frequency components. The LPF is second order Butterworth filter used for eliminating the higher order harmonics.

B. Tools

a) PI Controller

The PI controller focus on different errors like set point and process point variable. In the PI controller, there are two different parameters it is Proportional and Integral controller. The Proportional value decides the current error. The integral device is the sum of the recent errors. Both action sum is used to adjust the process of the plant by tuning the two controllers of the PI controller action designed for specific process requirements.

IV. RESEARCH METHODOLOGY

Synchronous reference frame theory are used and Active power filters can be used to filter out harmonics in the power system which are significantly below the switching frequency of the filter. The active power filters are used to filter out both higher and lower order harmonics in the power system.

There are two types of active power filter

a) Shunt APF
b) Series APF

a) Shunt APF

Shunt APF are connected in shunt manner with AC line, and they improve power factor quality of the system also shunt is used for to compensate current of R-L load means nonlinear load and balance the imbalance load with an injection of current.

b) Series APF

Series APF is connected in a series manner with AC line, there is series transformer act as a voltage source to reduce voltage distortion At that time voltage will imbalance then the system will be inject voltage and system get balanced. series are used for voltage compensation.

V. RESEARCH PAPERS


In this paper FACTS devices are used for maintained power quality at permissible limit without UPQC the THD is 23.61% and with UPQC 4.64% also voltage level improved DC link voltage will maintain using PI controller UPQC is more efficient.


In this paper synchronous reference, and frame-based control methods are used to solve power quality problems. It compensates for the reactive power with voltage and current harmonics under unbalanced load current conditions.


In this paper the DC link will be controlled using PI controller and make DC link voltage constant.
VI. SIMULATION, WAVEFORM, OUTPUT (THD)

a) Basic System

Fig. 1 Simulation diagram

Fig. 2 Load voltage

Fig. 3 Source current
b) PI controller with UPQC

Fig. 4 THD of Load voltage

Fig. 5 THD of Source current

Fig. 6 Simulation diagram
Fig. 7 Load voltage

Fig. 8 Source current
Fig. 9 THD of Load voltage

Fig. 10 THD of Source current
### VII. VALUES OF COMPONENTS

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Parameters</th>
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<th>Value</th>
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<td>1</td>
<td>Three phase input</td>
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<td>400 V</td>
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<td>2</td>
<td>Linear transformer</td>
<td></td>
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<tr>
<td>3</td>
<td>Series RC filter</td>
<td>Resistance</td>
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<td>Capacitance</td>
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<td>Series Inductance filter</td>
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<td>5e-6 Sec</td>
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<td>6</td>
<td>Frequency</td>
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<td>Hysteresis current controller</td>
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### VIII. CONCLUSION

A. In this paper, we compared the two systems first one is the basic system which is the load voltage THD which is 11.96%, and the source current THD is 26.08%.

B. In the second system, we used a Synchronous frame control system and active filter with UPQC, and the control tool in PI which will control DC link that time the load voltage THD is 4.21% and source current THD is 1.86%.

C. We could include that PI controller with UPQC is a more effective method.

### IX. ACKNOWLEDGEMENT

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### X. REFERENCE

