Performance Evaluation of Adaptive Tabu Search Algorithm Optimized Sinusoidal Fryze Voltage Control based Hybrid Series Active Power Filter

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Abstract: A novel hybrid series active power filter to eliminate harmonics and compensate reactive power is presented and analyzed. The proposed active compensation technique is based in a hybrid series active filter using adaptive tabu search algorithm in the conventional Sinusoidal Fryze voltage control technique. The paper analyzes the proposed hybrid series active power filter when connected with load of 3-phase diode bridge rectifier with R-L branch directly. This paper intends to show the improvement between the performance of conventional scheme and ATS-optimized scheme. Simulation results obtained using MATLAB/Simulink confirm the viability of the proposed compensation technique.

Keywords: Harmonics, Series active filter, Passive filter, Hybrid power filter, Sinusoidal Fryze voltage control, Adaptive Tabu search algorithm.

1. Introduction

The compensation techniques applied in active and passive filters to eliminate current harmonics, voltage harmonics and to compensate reactive power have already been presented and published in the technical literature [1, 2, 3]. Shunt, series and hybrid active filter topologies have been conferred and demonstrated to be a feasible alternative for industrial compensation [5], [7]. Even though passive filters LC are most frequently used to compensate current harmonics, it is well recognized that they are not the most excellent solution, since they generate resonance problems, affect voltage regulation, and bring into being high inrush currents. Shunt active filter is a improved option for current harmonic and reactive power compensation; however its application in high power load compensation is still limited due to power semiconductors restrictions [2].

The series active power filter exertions as a voltage controlled source whereas the shunt active approach acts as a current controlled source. The series approach compensates for voltage distortion, unbalances, and regulation (sags and swells) [4]. Other well known topology is the hybrid filter [1], [7], [9], which uses a combination of active and passive filters, and is a good and successful alternative for current harmonics compensation. Now days, advance soft computing techniques are used widely in automatic control system or for optimization of the system applied. A few of them are such as adaptive tabu search [10]-[14], optimization of active power filter using Genetic algorithm[15]-[18], power loss minimization using particle swarm optimization[19], neural network control [20]-[24] applied in both machinery and filter devices.

This paper presents a dynamic compensation scheme that has been optimized using Adaptive tabu search algorithm enforced with a hybrid series active power filter, and is intended to compensate line current harmonics and reactive power generated by static converters.

The paper has been organized in the following manner. The APF configuration and the load under deliberation are discussed in Section II. The control algorithm for APF is discussed in Section III. Optimization using adaptive tabu search has been presented in Section IV. Comparative evaluation using MATLAB/Simulink results are discussed in Section V and finally Section VI concludes the paper.

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2. System Description

As shown in Figure 1, Hybrid Series Power filter improves the power quality and compensates the harmonics within the system. The series active filter ideally behaves as a controlled voltage source in such some way that the load voltage will have solely positive-sequence at the fundamental frequency component.

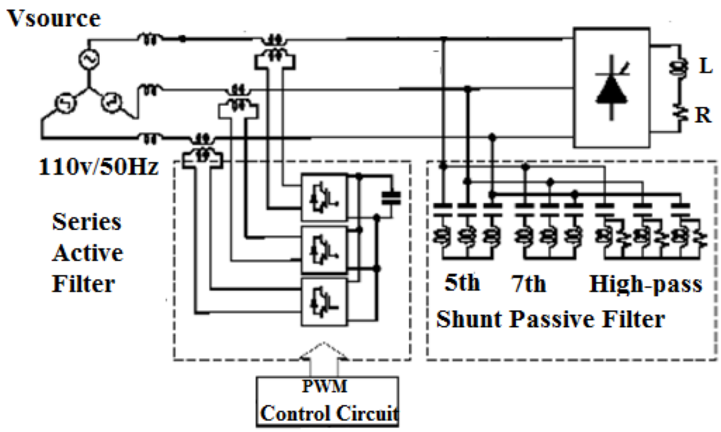

Figure 1. Hybrid Series Active Power filter

The voltages on the sources are given by V_{sa}, V_{sb}, and V_{sc}. Conversely, the relation among the supply voltage, the load voltage, and also the active filter voltage is given by

$$\begin{bmatrix} V_{Sa} \\ V_{Sb} \\ V_{Sc} \end{bmatrix} = \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} \begin{bmatrix} V_{Ca} \\ V_{Cb} \\ V_{Cc} \end{bmatrix} \quad (1)$$

The fundamental series active filter voltages are synthesized by three single-phase converters with a standard dc capacitor. The reference voltage for these converters is calculated by the "PWM Control circuit block that has active filter controller" shown in figure 1.

We know that thyristor rectifier shown behaves sort of a current source; the voltage source may be split into its fundamental voltage source and harmonic voltage source. The series active filter behaves just like the controlled voltage source $\dot{V}_c$ and also the shunt passive filter may be represented by equivalent impedance z_F. As per the fundamental compensation principle, the series active filter ought to synthesize the active impedance presenting zero impedance at the fundamental frequency and a high resistance k at the source or load harmonic frequencies.

The harmonic current running in the source is dependent on the both the load harmonic current $\dot{I}_{Lh}$ and the source harmonic voltage $\dot{V}_{Sh}$. z_s presents the source impedance of the system.

It is given by

$$i_{sh} = \frac{Z_F}{Z_F+Z_S+k} I_{Lh} + \frac{\dot{V}_{sh}}{Z_F+Z_S+k} \quad (2)$$

Where

$$i_{sh} \cong 0 \quad \text{if} \quad k \gg z_{S,} z_F \quad (3)$$

The output voltage of the series active filter is given by;