Chapter 8
Comparative Critical Analysis of Artificial Intelligent Technique and Conventional Control Technique Applied in Series Filter for Harmonic Reduction

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ABSTRACT

Series active filters, besides the dc voltage regulators, incorporate controller such as voltage controller and hysteresis band controllers, etc.. The conventional PI controller suffers from the significant drawback of having a high content of ripples and the low speed due to variable switching frequency caused by the usage of hysteresis controllers. In order to overcome this shortcoming, two different control strategies (i.e., sinusoidal fryze voltage control and adaptive tabu search-sinusoidal fryze voltage control strategy) have been developed in this research work. The performance of SAFs has been analyzed by using these current control strategies. The proposed ATS-SFV control strategy based voltage controller yielded better performance as compared to those obtainable from the SFV control strategy. The comparisons of the proposed strategies among themselves facilitate a need-based selection of them for the supply system. To realize these control strategies, MATLAB/Simulink-based models have been developed for simulation.

INTRODUCTION

Over the years, there has been a continuous proliferation of a nonlinear type of loads due to the intensive use of electronic power control in all branches of industry as well as by the general consumers of electric

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energy. This robust state control of ac power using thyristors and other semiconductor switches is widely employed to feed controlled electric power to electrical loads, such as adjustable speed drives (ASD's) furnaces, computer power supplies. Such controllers are also used in HVDC systems and renewable electrical power generation. Nowadays, the power electronic converters are capable of processing the massive amount of power, and due to their advantages such as increased efficiency and ease of control, have caused a dramatic increase in the number of power electronic loads in the industry/system (Abraham D. le Roux, 2003).

Unluckily, power electronic loads have an inherently nonlinear nature, and they, therefore, draw a distorted current from the mains supply. That is, they draw non-sinusoidal current, which is not in proportion to the sinusoidal voltage. As a result, the utility supplying these loads has to provide large reactive volt-amperes. Also, the harmonics generated by the load pollute it. As nonlinear loads, these solid-state converters draw harmonic and reactive power component of current from ac mains. The injected harmonics, reactive power burden, unbalance, and excessive neutral current cause low system efficiency and reduced power factor. They also cause disturbance to other consumers and interference in nearby communication networks, excessive heating in transmission and distribution equipment, errors in metering, and malfunctioning of utility relays. The inflatable tariffs levied by utilities against excessive VARs and the threat of stricter harmonics standards have led to extensive surveys to quantify the problems associated with electric power networks having nonlinear loads. i.e., the load compensation techniques for power quality improvement (Akagi, 2005) (D.Puangdownreong, 2002) (H. Fujita, 2000).

The main objective of this chapter is to research and to compare the power conditioning capabilities of the Series Active Power Filters and the Hybrid Active Power Filters based on it. Although these power filters are capable of filtering and compensating various current and voltage disturbances, the inspection is restricted to the filtering of the current and voltage harmonics and the compensation of the voltage dips. The inspected disturbances are three-phase and balanced.

The objective is to research the operation and characteristics of the filters, and in addition to this, to compare the current harmonics filtering performance of these power filters in steady-state operation and in dynamic load changes using similar operating conditions. The research work is carried out using mathematical analysis, computer simulations.

BACKGROUND

The recent advances in several key areas of power electronics technology are such as power semiconductor devices, power converter circuits, and control of power electronics. The structure and characteristics of IGBT, SIT, SITH, and MCT devices provide a better understanding before switching over to the active power filtering scheme. The control technique of the power converter is one of the prominent parts of the converter operation (D.Puangdownreong, 2002) (Abraham D. le Roux, 2003).

As the evolution of the high power self commutated switches (GTO 4500V, 3000A, 1KHz; BJT 1200V, 800A, 10KHz; IGBT 1200V, 400A, 20KHz (Khalid, Applied Computational Intelligence and Soft Computing in Engineering, 2017). the interest has increased in the study of active power line conditioners for reactive power and harmonic compensation.

There are a number of papers available on shunt passive filters and active power filters. But the review in this chapter is limited to some key papers and recent Publications in this field. Influence of load characteristics and the line impedance on the stability of an active filter and real-time optimization of