SOCIALIST REPUBLIC OF VIET NAM
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SUMMARY OF DOCTORAL THESIS

Thesis title: **DEVELOPING ADAPTIVE CONTROL SOLUTIONS OF THREE-PHASE VOLTAGE SOURCE SHUNT ACTIVE POWER FILTER FOR IMPROVING POWER QUALITY**

Major: Automation and Control Engineering

Code: 9520216

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Formation course: 2015

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1. Thesis summary

In order to improve the efficiency of the active power filter, exploiting the adaptability of the active power filter to stabilize the power quality of the source-load system, the author chooses a research direction and designs the thesis "Developing adaptive control solutions of three-phase voltage source shunt active power filter for improving power quality".

The author's research focuses on the adaptability of the APF when the load fluctuates, improves the transient response of the system, increases the Power Factor, and reduces the THD index due to the influence of non-ideal loads. Specifically, the author has built a simulation model in the discrete domain, and the simulation results, comparing the advantages of sampling current control (SCC) algorithm with direct current control (DCC), in chapter 2. The author has linearized the nonlinearity using the Sliding Mode control to once again determine the simple in designing the system, but adaptability to nonlinear loads

is not high, and needs to be developed. Then, the Fuzzy – PI controller has been applied in the APF for improving PF problem, as well as getting improvement the adaptation of the APF through reducing THD, in chapter 3. In chapter 4, the author has continued improving the dynamic response in the system, this study also proposes a predictive current compensation method to control to reduce the THD of the mains current in the condition of the grid voltage distortion and balance the grid current when the grid voltage is in unbalance. Through simulation and experimental results, the THD of grid current in the condition of grid voltage distortion and wide variation has been significantly reduced when using the predictive current compensation algorithm.

2. **The new contributions of the thesis**
    - Designing the simulation model of a three-phase active filter system
    - Improved APF using sliding mode control
    - Implement the experimental model with capacity of 5kW
    - Solution to stabilize the voltage of Cdc linked capacitors using Fuzzy-PI controller
    - Increasing Power factor using phase control algorithm for APF
    - The grid-connecting solution reduces dynamic THD in the event of sag-voltage and harmonic distortions or grid-imbalance or current harmonic distortions.
    - Development of an adaptive solution for a three-phase active power filter under nonlinear loads using a predictive current compensation algorithm.
3. **Achievable results, scientific and practical significance**

With the thesis's objectives, the main content focuses on researching, developing and proposing an adaptive control model for a three-phase shunt active power filter. In addition to the studies of building mathematical models and simulation models, the author also implements a research model for practical application of eliminating high-order harmonic for nonlinear loads with a limited capacity of 5kW. This study has also developed a grid connection technique for three-phase active power filter, which proposes an algorithm to maintain the stability of the quality parameters of the circuit during the grid connection, the need is to reduce THD in the process, this work is based on a PLL controller in a three-phase grid-connected APF. The grid current control for stable grid connection with positive

phase magnitude. The two input voltages of the PLL controller are adjusted according to the operating modes of the system to maintain stability for the quality requires of the system. The synchronous angle of the PLL increases steadily without any sudden jump even under voltage drop and during switching in the presence of hard switch (STS). When both the phase and amplitude of the load voltage are adjusted synchronously with the APF voltage before switching to the grid- connecting mode, the output voltage and current have some distortion at the beginning of the synchronization, but this has been minimized by the Fuzzy-PI control technique which makes the phase and amplitude of the load voltage connected to the grid in turn at the point of transition from off-grid mode to grid-connecting mode without having any distortion. The RMS voltage value method is used to detect voltage fluctuations in the grid. When the STS is in operation, the load voltage approaches the desired voltage quickly with no voltage spikes and no current overshoot using the recommended operating sequence for efficient operation. This content is very valuable in maintaining the stable working state of the system when changing power sources for the load in emergency situations and or situations related to the use of backup energy.

The author has also studied and proposed a control method to reduce the THD of the grid current in the condition of distorted grid voltage and balance the grid current when the grid voltage is unbalanced of the three-phase grid-connecting APF. The THD of the grid current is generated by the grid voltage harmonics by considering the phase delay and the amplitude attenuation caused by the low pass filter (LPF), at which point the prediction algorithm is introduced to compensate for the loss. the computational delay and the loss caused by the passive filter circuits. Through simulation and experimental results, THD of grid current in the condition of grid voltage distortion and wide variation has been significantly reduced with the predictive adaptive harmonic compensation method.

The scientific significance of the thesis is confirmed through research results published by 03 Scopus articles, and one article presented and published at the International conference on INISCOM'21 (International Conference on Industrial Networks and Intelligent Systems). One article presented and published at the prestigious national conference (REV-ECIT 2015), and others published in national and International journals.

4. Thesis structure

The layout of the dissertation consists of introduction, 5 chapters and conclusion as follows:

Introduction

Chapter 1. Overview of control techniques in active power filters

Chapter 2. Three-phase power system under active load and active power filters

Chapter 3. Performance Improvement of APF using Fuzzy-PI controller

Chapter 4. Adaptive control solutions for three-phase active power filters

Conclusion

Ho Chi Minh City, July 1st, 2022

Science supervisor		**PhD. candidate**
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