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CONTROL TECHNIQUE IMPLEMENTATION OF DSTATCOM IN A DISTRIBUTED POWER GENERATION SYSTEM

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Abstract

Present research work, an implementation of DSTATCOM (Static Distribution Compensator) in a distributed power generation system using a control technology based on compound monitors is discussed. The proposed control technology is used to extract the critical components from the distorted generator load currents. These extracted components are used to estimate the currents from the reference source to generate the DSTATCOM gate signals. This control technique is implemented to mitigate increased reactive power demand and distortion in terms of harmonics and load balancing under linear / nonlinear loads. DSTATCOM performs satisfactorily for these consumption loads with a regulated generator voltage at a point of common coupling (PCC) and a self-sustaining DC connection. Of course, optimizing the parameters of an algorithm inspired by nature is the main way to improve its performance. The deployment used to transfer and create new solutions is also a factor to consider in increasing its capacity. In this work, the efficiency of the Gravitational Search Algorithm (GSA) and Cuckoo Search Algorithms (CSA) were verified using the MATLAB Simulink model. IGBT is used as an ignition switch with very low switching loss and very simple shutdown. In this work, THD is evaluated, and the obtained perturbations in current waveforms are minimized by DSTATCOM. The distribution system is simulated and validated with DSTATCOM and the control system used to improve power quality.

Keywords: DSTATCOM, MATLAB, Microgrid, Power Control.

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1. INTRODUCTION

Power quality issues encompass a broad spectrum of challenges that affect the consistency, reliability, and efficiency of electrical power. These issues manifest in various forms and can arise from multiple sources within the power system.

According to the IEEE dictionary "Power quality is the concept of achieving the desirable output for device service by supplying advantageous power and grounding to the sophisticated equipment"[1]. There are several obstacles to be met by the electrical power network in order to provide customers with reliable performance. The problem caused by the power quality is condenser bank failure, over voltages, voltage loss, and increased current due to harmonics, etc.

The utilization of solid-state converters in systems leads to an increase in power quality issues because they are prone to power quality issues themselves and they often produce issues reducing the quality of power, as they include solid state converters. The power quality concerns have become important by the use of solid-state devices in power electronics. There are several reasons for energy efficiency that can be classified in terms of current, voltage variation etc. as organic and man-made. Natural causes include faults, lightning and climatic conditions, such as tornadoes, equipment incapacity, etc. One of the main problems in any system, however, is the presence of harmonics caused by multiple loads' nonlinear behavior.

2. METHODOLOGY

Modern AC transmission techniques face ethical problems relating to power quality, particularly due to the use of sensitive materials in certain agricultural, residential, industrial and wind implementations. These problems with the power quality are known as voltage and pose performance problems in transmission systems. Custom power devices (CPDs), namely DSTATCOMs (static allocation compensators), DVRs (continuous voltage restorers) and UPQCs (continuous power quality conditioners), are utilized to alleviate some of the demand-driven concerns. Such CPDs make extensive use of DSTATCOMs to alleviate current-based power quality problems. There are a variety of problems with current-based power efficiency, such as poor power factor, poor voltage control, unbalanced flows and decreased neutral current. Hence, the DSTATCOM setup is chosen based on the problem in exercise.

2.1 Principle of Operation of D-STATCOM

The main objective of DSTATCOMs is to alleviate the current-based power quality problems facing a manufacturing operation. A DSTATCOM alleviates most of the current performance issues such as elastic energy, unbalance, static flow, harmonics (if any) and adjustments inherent in the customer supply or otherwise in the scheme, and provides sinusoidal regulated supply constraints with its DC grid voltage power.

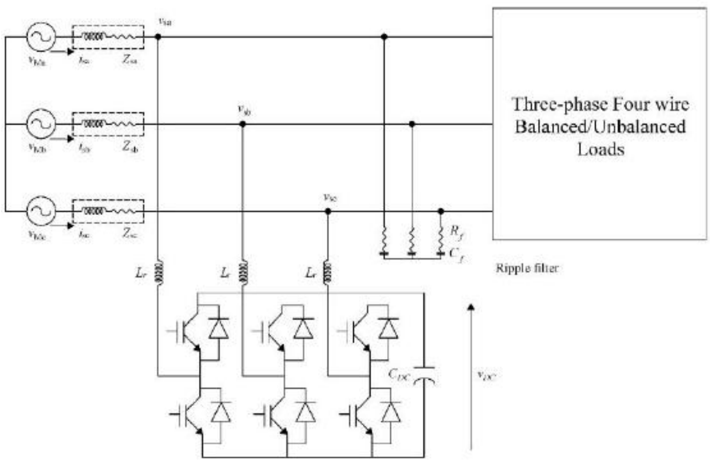

Figure 1. Block diagram of compensation by DSTATCOM

2.2 Principle of Control Algorithm

A DSTATCOM control algorithm's main objective is to use feedback responses to determine objective flows. Such reference currents along with corresponding sensed parameters are used in PWM current detectors to obtain measurements of PWM gating from the VSC used as a DSTATCOM for adjusting devices (IGBTs).

There are several control parameters in the DSTATCOM Tests Literature 108, which are categorized as architectures of time and frequency-domain energy and energy issues as well as mitigation strategies. There are more than a number of time-domain architectures for the DSTATCOM commands. A few of the control mechanisms which follow are

- Unit template technique / PI controller-based theory
- Power balance theory (BPT)
- I cosθ-control algorithm
- Current synchronous detection (CSD) method
- Instantaneous-reactive power theory (IRPT), also known as P-Q theory or αβ theory
- Synchronous reference frame (SRF) theory, also known as d–q theory
- Instantaneous symmetrical component theory (ISCT)
- Singe-phase P-Q theory
- Singe-phase D-Q theory
- Neural network theory (Widrow's LMS-based Adaline algorithm)

3. RESULTS AND DISCUSSION

The system is simulated under nonlinear load configuration for which the approach of PI controller based DSTATCOM. The main objective is to minimize the odd harmonic components using Cuckoo search Algorithm technique and Gravitational search Algorithm. The above simulation can be performed under three criteria i.e., IAE, ISE and ITAE. From Table 5.2 is clear that criteria ISE gives minimum THD as compare to IAE and ITAE.

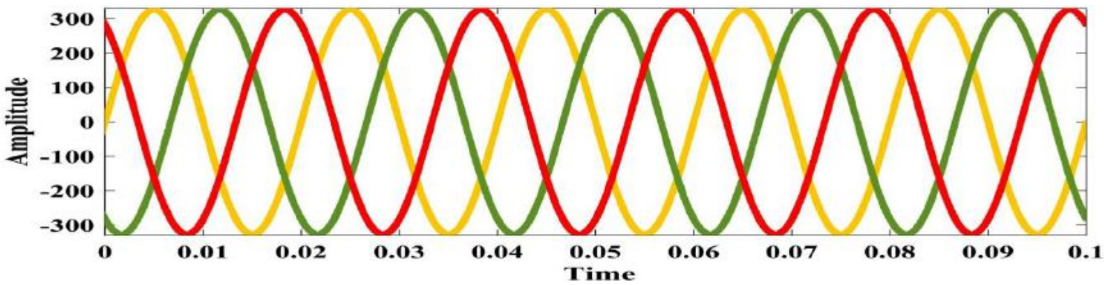

Figure 2. Waveform of source voltage

Fig. 2 shows the waveform of source voltage when nonlinear load is only connected in the system and it is clear that there is no harmonics generated in the source voltage. Fig. 3 shows the waveform of source Current when Shunt Active Power Filter cannot be connected in the circuit for filtering the harmonic current components which can be generated due to nonlinear load. From the above figure it is clear that the current harmonic can be generated by the connected nonlinear load

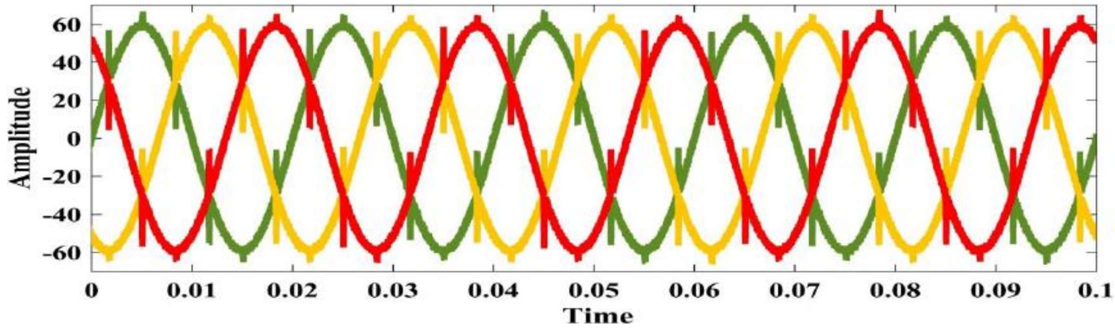

Figure 3. Waveform of source current

Table 1. Cuckoo Search Algorithm Parameter

CSA Parameter	*IAE*	*ISE*	*ITAE*
P	62.36	41.32	82.59
I	48.35	40.19	52.47
Kp	22.29	71.32	82.32
Ki	23. 52	47. 14	84.39
CURRENT THD (%)	8.05	5.02	6.59

Table 2. Gravitational Search Algorithm Parameter

GSA Parameter	*IAE*	*ISE*	*ITAE*
P	62.89	52.14	79.55
I	25.52	40.15	62.37
Kp	41.91	55.24	68.22
Ki	43. 52	49. 15	72.25
CURRENT THD (%)	7.21	4.89	6.09

Table 1 shows the whole parameter value which we have taken a run a whole Matlab model during a whole Matlab simulation period. From Table 5.1 it is clear that the current THD will be simultaneously reduced in the ISE criteria as compared to the other criteria i.e., IAE and ITAE. Table 2 shows the whole parameter value which we have taken a run a whole Matlab model during a whole Matlab simulation period. From Table 5.2 it is clear that the current THD will be simultaneously reduced in the ISE criteria as compared to the other criteria i.e., IAE and ITAE, P, I, Kp and Ki are the simulation PI Controller parameter which can be optimized by the help of Cuckoo Search Algorithm optimization techniques and Gravitational Search Algorithm optimization techniques.

4. CONCLUSION

The power quality issue generated by altered charges in electrical power systems has been profoundly changing crucial manufacturing processes. The power quality problems generated by load distortion in electrical equipment have increasingly disrupted vital operational processes. Static VAR compensators are mandated to tackle these issues on the utility and charge parties. STATCOM strategies offer decent alternative approaches for reactive power impairments including faster reactions, minimum harmonic material and lower device volume with the advantages of faster reaction, minimum harmonic and lower device dimensions STATCOM technologies are a good alternative. D-STATCOMs have outstanding capabilities and the ability to provide a certain reactive power, irrespective of required voltage shifts, faster response and lower system intensity. In this research work, VSC 3 leg 6 pulse converters is being used to administer reactive power to the PCC on the line. The overall harmonic distortion before compensation was 19.26% and after compensation is 4.89%..

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