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UTILIZING STATCOM FACTS DEVICE FOR MITIGATING VOLTAGE SAG AND SWELL IN TRANSMISSION LINES

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ABSTRACT
We looked at a lot of research on the topic and tried a lot of different solutions to the problem of reactive power loss in the transmission line and other parts of the electrical system. We used the shunt and series setup methods, where the compensator, like a capacitor, is linked to the inductive load both in parallel and in series. Because the stages of a capacitor change over time, there are always voltage and current transients. Our first step in solving the responsive force adjustment problem was to use FACTS (Flexible AC Transmission Systems) devices. Researchers have looked into a number of FACTS devices and found that STATCOMs (Static Synchronous Compensators) are the newest and best way to deal with reactive power problems. The STATCOMS were shown a range of tactics. The study was done in MATLAB, and the scientific result was found by using a number of different computer methods. A study of Flexible Alternating Current Transmission System (FACTS) devices, specifically the Static Synchronous Compensator (STATCOM) and the Static Var Compensator (SVC), is part of this work. With these tools, we've been able to fix problems with reactive power and transmission lines. The Static Synchronous Compensator (STATCOM) for a single-phase AC transmission line is looked at in this thesis, along with a full comparison and table of the results with the Static VAR Compensator (SVC). It was also possible to do a STATCOM study on a three-phase AC transmission line. Using the Static Synchronous Compensator and Pulse Width Modulation (PWM) techniques in the modeling of STATCOM is briefly talked about in this work. We did a thorough mathematical study to come up with the basic formula for STATCOM. The theses mostly talk about how to use STATCOM to balance reactive power when attached to either single-phase or three-phase AC transmission lines.

Keywords: Power quality, D-STATCOM, Voltage Sag, Voltage Source Converter (VSC), Energy storage system.

1. INTRODUCTION
This process of making and sending electricity is very complicated and needs many different parts to work together in order to be more efficient. A very important part of the transfer system is reactive power. It is important to keep the voltage steady so that moving electricity can flow through the lines. Because they have different needs, engines and other machines need different amounts of reaction power to run. It is important to manage reactive power properly in order to make air conditioning systems work better. This is called reactive power compensation. Two different points of view are used to look at the problem of adjusting for reactive power: reducing power use and keeping the voltage stable. Adjustments to the power component change the real power coming from the supply. Load compensation also includes effective voltage control and other things for different types of loads that change. To reduce voltage changes in a transmission line, something called voltage boost is used. These kinds of compensation can be used in two ways: series compensation

and shift compensation. These change how the system is set up to make VAR compensation better. Like a synchronous condenser, shunt compensation uses capacitors linked in parallel with the transmission line to either take in or send out reactive power. When an inductor or capacitor is linked in series to provide power, the circuit is called a series circuit. At the moment, shunt correction is used in a lot of FACT devices.

FACT devices are fixed gadgets that can change some aspects of how AC is sent and balance out reactive power. Some types of flexible AC transmission devices are the Thyristor Switched Reactor (TSR), the Static Synchronous Series Compensator (SSSC), the Thyristor Switched Capacitor (TSC), and the Thyristor Switched Series Reactor (TSSR). All of the equipment is stationary, so there is no dynamic effect. STATCOM is made up of a DC power capacitor, a converter (which can absorb reactive power and act as an amplifier when sending reactive power to the transmission system), a step-up transformer, series inductors, and other parts.

2. MOTIVATION

The following are the reasons why this job needs to be done:

- Better quality of power.
- Getting the system's power factor to be better.
- Network losses are kept to a minimum.
- Keeping from having to pay fines for using too much reactive power, especially in factories that use big induction motors.
- Cut costs as much as possible and make more money for your clients.
- Changes to make the power system's voltage control better.

Make it easier for people to get energy.

3. LITERATURE SURVEY

We started our process by doing a lot of research on reactive compensation methods. Then, we put the skills that we know how to do well into action. We found that there are several pieces of technology called FACT (Flexible Alternating Current Transmission) that can help make up for reactive power. After a thorough review of many studies and polls, we have found that the Static Synchronous Compensator is the best way to change reaction power. In FACTS devices, STATCOM is an important regulator that helps keep the voltage steady. The first STATCOM was put into use in Japan in 1980 [10]. It had 20MVar of capacity and used power-commutated thyristors. KEPCO and Mitsubishi Motors worked together to make an 80MVar STATCOM in 1991.

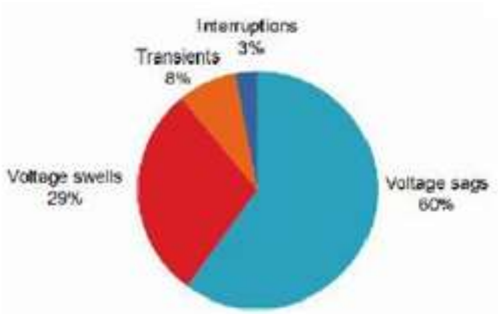
There are different types of STATCOM, but the inverter, which is also called a Voltage Source Inverter (VSI) in a 3-stage design, is the key part that is used in most situations. The main idea behind VSI is to use a direct current (DC) power source, like a charged capacitor or a DC power supply device, to make a controlled three-stage output voltage/current at the key frequency of an AC power supply. The framework makes it easier for dynamic or flexible power to move between the DC and AC systems. It also controls the AC bus voltage by changing the output voltage and current's magnitude and phase angle.

4. CHALLENGES

There were many problems we ran into while doing the job. Still, with the help of the resource person and constant direction from our project supervisor, we were able to solve all of our problems. Of course, we had to deal with a lot of small and big problems. Here are some examples, along with a study of the ways we found to solve them. While that STATCOM study was being done in Multisim. We tried to connect the three-phase transformer to the power grid but failed, so we had to give the inductive load unstable power. We were able to fix this problem after doing the polarity test on the generator. It doesn't work as an inverter when reactive power is sent to the system, and it doesn't work as a rectifier when too much reactive power is taken out of the power system while a capacitive load is connected to it when the circuit is fully linked. After talking to a professional, we found that pulse width modulation (PWM) must be used to turn on all of the thyristors in the converter. The trouble we were having affected the whole STATCOM output. The STATCOM wasn't able to provide the full three-phase sine output. We were able to get the whole three-phase sinusoidal pattern from the AC output of the converter by using the trial-and-error method. This was done by changing the inductor and putting the capacitor's starting value to 50 V on the DC side of the converter. Because of this, the STATCOM can now make reactive power and send it to the power grid.

5.PROBLEM STATEMENT

Transmission lines have impedance, and most tools in a developing system need to trail VAR (volt-ampere reactive). This means that reactive power has to be used. This, in turn, changes how stable the framework's edges and transmission lines are. Too many voltage drops cause bigger problems that need to be fixed by the power source. This puts too much stress on the infrastructure that carries this creative force, which leads to blackouts in the power grid. Therefore, it is clear that adjusting for reactive power not only cancels out these effects but also makes it easier to deal with faults and other problems. There has been more attention lately on the methods used for compensation, and as better tools have been added to the progress, compensation has become more useful. To reduce the lines' commitment to moving the receptive force, they should be placed as close as possible to the generators or heaps. In a dispersion or transmission substation, shunt adjustment can be used close to the load.



Percentages of problems in power quality

6. POWER QUALITY

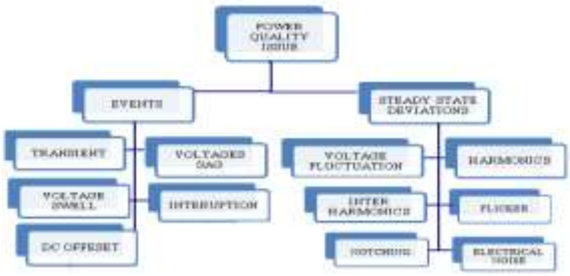
Overview:

Powerful electric In the last few years, the term "power quality" has become more important in the area of power engineering. Power quality refers to how well a bus voltage can maintain a sinusoidal pattern at the set voltage and frequency. Power quality zones can be set up based on where the problem is coming from, like converters or nonlinearity in magnetic circuits, as well as the signal wave's properties, like harmonics, flicker, or frequency spectrum (radio frequency interference). What is power quality? Power quality is how electricity and electrical products work together. This problem starts with the power quality, which has a direct effect on how well electrical technology works in that situation. There are different definitions of the term "power quality" on different pages. There are other words that can be used instead of it, like "quality of service," "voltage stability," "current stability," "power supply quality," and "consumption reliability."

- Low-level problems with the power quality The panel for lighting power distribution and the circuit for the service entry.
- Small problems with the power quality Panels that distribute power for HVAC equipment.
- Concerns about the high quality of power Panels give drives speeds that can be changed.

Power Quality Issues

Power quality problems have many names and descriptions. Surges, spikes, transients, blackouts, noise, voltage sag, voltage swell, interruption, dc offset are some common descriptions .In order to increase the reliability of a power distribution system, many methods of power quality problems have been following:



7. OBJECTIVES

- Using Flexible AC Transmission System Devices to lower reactive power is the main goal of this project. We worked hard to improve the STATCOM (Static Synchronous Compensator) and the SVC (Source Voltage Converter), two FACTS (Flexible Alternating Current Transmission System) devices. The most current and effective ways to fix reactive power are these two solutions.
  - Through the use of shunt and series compensation methods and basic

mathematical equations, the main goal is to get a theoretical understanding of reactive power compensation.

- In a single-phase alternating current system, both STATCOM (Static Synchronous Compensator) and SVC (Static Var Compensator) can be used to make up for reactive power.
- To use Simulink to test how well STATCOM and SVC work in a single-phase AC system.
- There should be a comparison between STATCOM and SVC.
- How to use STATCOM to fix reactive power issues in a three-phase AC setup

8. STATCOM

A Static Synchronous Compensator (STATCOM) is a static component device that is part of the FACTS device family. In single-phase or three-phase alternating current circuits, it can either take in reactive power or give it out. To fix the reactive power of a communication network, a Static Synchronous Compensator can be used. It also helps keep the communication system from having problems like voltage sag (unexpected voltage spikes), voltage sag (unexpected voltage drops), transients, and other similar things happen.

Three-phase inverters like SCRs, MOSFETs, or IGBTs make up a STATCOM. It also has a DC capacitor that absorbs reactive power when charging and supplies reactive power when discharging, a connection reactor that connects the inverter output to the AC supply side, and channel components that direct the high-frequency signals made by the PWM inverter. The energy saved in the DC side capacitor is used by the inverter to make a three-phase voltage. It's hooked up to the power source. As the voltage is linked to the AC power source, an inductor is used. This paper is the main set of rules for how STATCOM should work.

As shown in Figure 6, a D-STATCOM is made up of a two-level voltage source converter (VSC), a dc energy storage device, and a coupling transformer that is connected to the distribution network in parallel. With this setup, the gadget can keep up or provide dynamic and flexible force that can be changed. The D-STATCOM is mostly used for controlling voltage, fixing power factor problems, and reducing harmonics. A managed converter is used in this device to make sure that the voltage stays stable.

Basic model of a Distribution STATCOM

9. CONCLUSION

This piece talks about how the Distribution Static Synchronous Compensator (DSTATCOM) can help reduce voltage sags and swells. Simulations can be done with or without DSTATCOM being added to the distribution system to get better power quality levels. Based on the simulations, the DSTATCOM can fix situations where the voltage drops or rises. The goal of this thesis is to use DSTATCOM to lower the Voltage Sag and raise the Power Quality by 25% when the fault resistance is 0.20. Together with DSTATCOM, it also aims to improve Power Quality by 30% when the fault resistance is 0.40. It seems likely that DSTATCOM makes the power quality better and gets rid of voltage sag in the distribution network.

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