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RESEARCH ARTICLE

A NEW INNOVATED FACTS CONTROLLER (SVC) FOR REACTIVE POWER COMPENSATION

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ABSTRACT

Power system has made a stunning entrance to the market.. The structured power systems has effected by different kinds of problems. Whether system stability problems or Power Quality issues, these issues need solving. Classically passive filters were used but nowadays active filters such as Static Var Compensator (SVC) has been chosen for the task. SVC is a device that regulates the voltage level or the reactive power in the system. It is used to maintain voltage stability, enlargement of critical clearing time. In this paper Simulation has been done with one example.

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INTRODUCTION

Role of Reactive Power Control In Power System: Reactive power importance is increasing with the growing demand for electrical power , in a power system network. The stability and reliability of the electrical power system depend on reactive power management. It is required to generate energy in a more efficient, reliable and cost-effective way. An effective way of delivering electrical energy includes technologies like FACTS (Flexible AC transmission system), SVC (Static voltage compensation), etc to maintain voltage stability, high power factor, and fewer transmission losses. Reactive power plays a very important role in the power system network.

Importance of Reactive Power: AC power supply system produce and consume two types of powers; they are active and reactive power. Real power or active power is the true power given to any load. It accomplishes useful work like rotating motors, lighting lamps, etc. Also, reactive power is the imaginary power or apparent power, which does not do any useful work. It is a by-product of AC systems and produced due to inductive and capacitive loads. It exists when there is a phase displacement between voltage and current. It is measured in units of volt-ampere reactive (VAR).

Reasons Why Reactive Power Is Important: There are mainly 3 reasons why reactive power is important.

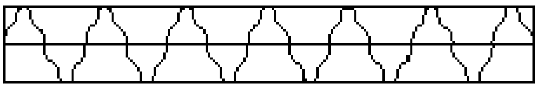
Voltage control: Fluctuations in voltage levels lead to poor functioning of the various appliances. High voltage damages the insulation of windings whereas low voltage causes poor performance of the various equipment like low illumination of blubs, overheating of induction motors, etc. If the power demand is more than that supplied by transmitting lines, current drawn from supply lines increases to a higher level, which causes the voltage to fall drastically at the receiving end side. If this low voltage is decreased further, it leads to the tripping of generator units, overheating of motors and other equipment failures.

To overcome this, reactive power should be supplied to the load by putting reactive inductors or reactors in transmission lines. The capacity of these reactors depends on the amount of apparent power to be supplied. If the power demand is less than reactive power supplied, the load voltage rises to a higher level which leads to automatic tripping of transmission equipment, low power factor, insulation failures of the cables and windings of various mechanical devices. To overcome this, additional reactive power available on the system must be compensated. Various compensation equipment is synchronous condensers, shunt capacitors, series capacitors, and other PV systems. These devices inject the capacitive reactive power to compensate inductive reactive power in the system. Therefore we can say that apparent power is required to maintain voltage levels within limits for the stability of the transmission systems.

Electrical Blackouts: Electrical blackouts, like that in France during 1978, many parts of India during 2012, have noticed insufficient reactive power on the electrical power system is the main reason for blackout situations. This is raised because the demand for apparent power is unusually high due to long-distance transmission. This ultimately leads to the shutting down of various equipment and generation units due to low voltages. To ensure proper working of the electrical system, a sufficient amount of reactive power must be present in it.

Proper working of various devices: Transformers, motors, generators and other electrical devices require reactive power to produce magnetic flux. This is because the generation of magnetic flux is necessary for these devices to do useful work. Reactive powerhelps to create a magnetic field in the motor but it leads to a decrease in the power factor. This is why a capacitor is placed to compensate for the inductive reactive power by supplying capacitive reactive power.

Problems/Losses in Power Systems



4.1 Figure

Harmonics: Distortion occurs when harmonic frequencies are added to the 60 Hertz voltage or current waveform, making the usually smooth wave appear distorted. Distortion can be caused by solid state devices such as rectifiers, adjustable speed controls, fluorescent lights, and even computers. At high levels, distortion can cause computers to malfunctions and cause motors, transformers and wires to heat up excessively. Distortion is probably the most complicated and least understood of all power disturbances.

Frequency deviations: Normal utility power in the United States is supplied at a frequency of 60 cycles per second, or 60 Hertz. On large interconnected utility systems such as SRP's, frequency is very stable and deviations are rarely a problem.

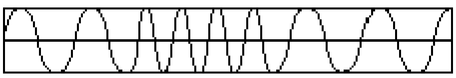


Figure.4.2 deviations

However, on smaller power systems, especially those supplied by on-site generators, frequency deviations can cause electronic equipment to malfunction and affect the speed of motor driven clocks.

Transients: Transients are sudden deviations from normal voltage or current levels. Transients typically last from 200 millionths of a second to half a second. Transients are typically caused by lightning, electrostatic discharges, load switching or faulty wiring. Transients can erase or alter computer data, resulting in difficult-to-detect computational errors. In extreme cases, transients can destroy electronic circuitry and damage electrical equipment.

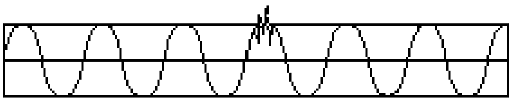


Figure.4.2. Transients

Noise: Electrical noise, is a rapid succession of transients tracking up and down along the voltage waveform. The magnitude of these rapid transients is usually much less than that of an isolated transient. Noise often originates in electrical motors and motor control devices, electric arc furnaces, electric welders, relays, and remote atmospheric discharges such as lightning. Although less destructive than a large rapid transient, electrical noise can cause computers to malfunction and can interfere with the operation of communications equipment.

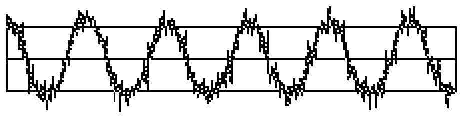


Figure.4.2 noises

Voltage sags: A voltage sag is a short duration decrease in voltage values. Voltage sags longer than two minutes are classified as undervoltages. Common causes of voltage sags and undervoltages are short circuitson the electric power system, motor starting, customer load additions, and large load additions in the utility service area. Sags can cause computers and other sensitive equipment to malfunction. Undervoltage conditions can damage certain types of electrical equipment.

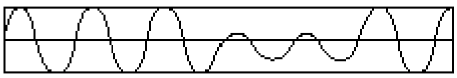


Figure.4.2 sags

Interruptions: Interruptions occur when voltage levels drop to zero. Interruptions are classified as momentary, temporary, or long-term interruptions. Momentary interruptions occur when service is interrupted, but then is automatically restored in less than 2 seconds. Temporary interruptions occur when service is interrupted for more than 2 seconds, but is automatically restored in less than 2 minutes.

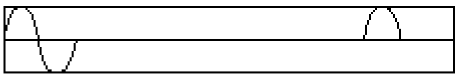


Figure.4.2 interruptions

Long-term interruptions last longer than 2 minutes and may require field work to restore service. In some cases, momentary outages may go unnoticed or cause no apparent problems.

However, even momentary outages can last long enough to shut down computers and disrupt the operation of sensitive electrical equipment.

Voltage swells: A voltage swell is a short duration increase in voltage values. Voltage swells lasting longer than 2 minutes are classified as overvoltages. Voltage swells and overvoltages are commonly caused by large load changes and power line switching. If swells reach too high a peak, they can damage electrical equipment. The utility's voltage regulating equipment may not react quickly enough to prevent all swells or sags.

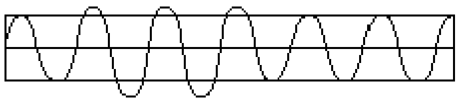


Figure.4.2 swells

Flicker: Flicker can be defined as small amplitude changes in voltage levels occurring at frequencies less than 25 Hertz. Flicker is caused by various fluctuating loads such as arc furnaces and electric welders. Flicker is rarely harmful to electronic equipment, but is more of a nuisance because it causes annoying, noticeable changes in lighting levels.

Objectives of SVC: A static VAR compensator is a set of electrical devices for providing fast-actingreactive poweron high voltage electricity transmission networks. SVCs are part of theflexible AC transmissionsystem device family. They regulate voltage, power factor, harmonics and stabilize the system. A static VAR compensator has no significant moving parts (other than internal switchgear). Prior to the invention of the SVC, power factor compensation was the preserve of large rotating machines such as switched capacitor banks. The SVC is an automated impedance matching device, designed to bring the system closer to unity power factor. SVCs are used in two main situations:

- Connected to the power system, to regulate the transmission voltage.
- Connected near large industrial loads, to improve power quality.
-

Working Principle of SVC: In transmission applications, the SVC is used to regulate the grid voltage. If the power system's reactive load is capacitive or leading, the SVC will use thyristor-controlled reactors to consume VARs from the system, lowering the system voltage. Under inductive or laggingconditions, the capacitor banks are automatically switched in, thus providing a higher system voltage.

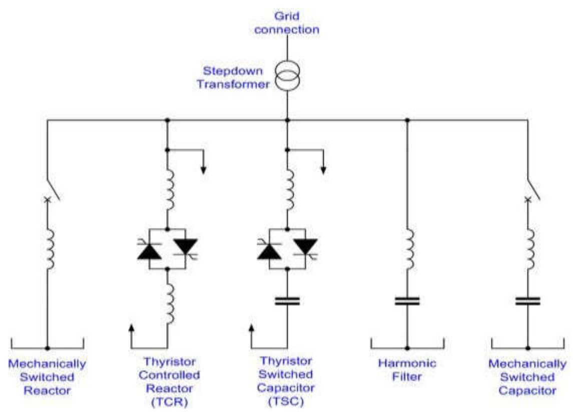


Figure 6.1 Static Var compensator configurations

By connecting the thyristor-controlled reactor, along with a capacitor bank step, the net result is continuously variable leading or lagging power. In industrial applications, SVCs are typically placed near high and rapidly varying loads, for example arc furnaces, where they can smooth flicker voltage.

Advantages of Static Var Compensator

- It increases the power transmission capability of the transmission lines.
- It improves the transient stability of the system.
- It controls the steady state and temporary overvoltages.
- It improves the load power factorand therefore, it reduces the line losses and improves system capability.
- It gives fast response to change in power system.
- Less costly, high capacity, faster and more reliable.
- It reduces harmonics and voltage fluctuations.
- It provides load balancing function.

Applications of SVC

- SVC provides fast acting reactive power.
- To fast theresponse time.
- To enhance the transient stability margin.
- To enhance voltage.
- To reduce the voltage variation.
- To controlvoltage and stabilize the frequency.
- SVC is used to regulate the grid voltage.
- If the power system's reactive load is capacitive or leading, SVC will be used to the thyristor-controlled reactors to consume VARs from the system and lowers the system voltage and if the reactive load is inductive or lagging, SVC will be used to the thyristor controlled reactors to generate VARs to the system and increase the system voltage.

RESULTS AND SIMULATION

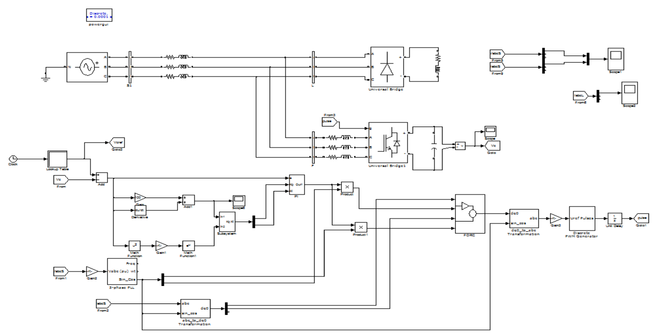


Figure 9.1. Simulation design of the proposed system

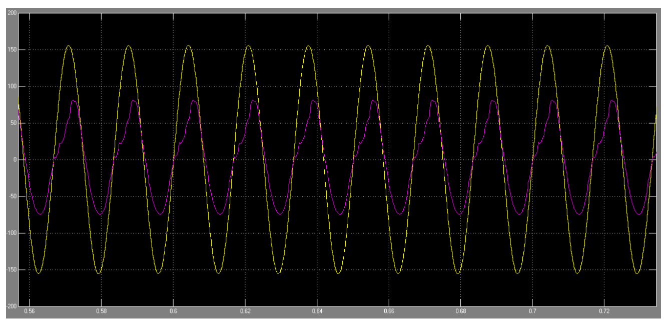


Figure 9.2 Voltage and current waveforms of grid side

CONCLUSION

By the proposed paper, it is possible to totally cancel the oscillation in both the active and the reactive power, or reduced the oscillation amplitude in the reactive power. Meanwhile, the current amplitude of the faulty phase is significantly relieved without further increasing the current amplitude in the normal phases. The advantage and features of the proposed controls can be still maintained under various conditions when delivering the reactive power.

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