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Improvement of Voltage Stability of Multi –Machine System Using FACTS

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ABSTRACT

This paper deals with power system applications that have been studied by examining the SVC and STATCOM controller applications. The detailed models of the STATCOM, SVC were implemented. These models include a detailed representation of the valves. The models are applicable for transient stability analysis and cover broader range of frequency oscillation and are also suitable for simulations in unbalanced power conditions.

KEYWORDS

SVC, STATCOM, D-FACTS, D-STATCOM, FACTS

1. INTRODUCTION

A power quality problem is an occurrence manifested as a non-standard voltage, current or frequency that results in a failure or a mis-operation of end-user equipment. Utility distribution networks, sensitive industrial loads and critical commercial operations suffer from various types of outages and service interruptions which can cost significant financial losses. With the restructuring of power systems and with shifting trend towards distributed and dispersed generation, the issue of power quality is going to take newer dimensions. In developing countries like India where the variation of power frequency and many such other determinants of power quality are themselves a serious question, it is very vital to take the positive steps in this direction. The present work is to identify the prominent concerns in this area and hence the measures that can enhance the quality of the power recommended

Electrical power losses in distribution system correspond to about 70% of total losses in electric power system. These electric losses can be considerably reduced through the installation and control of reactive support equipment such as capacitor banks, reducing reactive currents in distribution feeders and so on.

Voltage control is a difficult task bacause voltages are strongly influenced by random load fluctuation. Voltage profile can be improved and power losses can be considerably reduced by installing custom power devices or controllers at suitable location . These controllers which are also named distribution flexible ac transmission system (D-FACTS) are a new generation of power electronics based equipment aimed at enhancing the reliability and quality of power flows in low voltage distribution network.

This paper presents the enhancement of voltage sags/swell ; harmonic distortion and low power factor using distribution static compensator (D-STATCOM) .The model is based on the voltage source converter (VSC) principle. The D-STATCOM injects a current into the system to mitigate the voltage sags/swell to improve harmonic distortion and low power factor. The simulations were performed using MATLAB SIMULINK.

2. DESCRIPTION

2.1DESCRIPTION OF THE TRANSMISSION LINE

The power systems today are complicated networks with hundreds of generating stations and load centers being interconnected through power transmission lines. An electric power system can be subdivided into four stages:

1. Generation
2. Transmission
3. Distribution and
4. Utilization (Load)

The basic structure of a power system is as shown in fig. It is composed of generating plants, a transmission system and distribution system. These subsystems are interconnected through transformers T1, T2 & T3.

The power system is a highly non-linear system that operates in a constantly changing environment; loads, generator outputs, topology and key operating parameters change continually. When subjected to a transient disturbance, the stability of the system depends on the nature of the disturbance as well as the initial operating conditions. The disturbance may be small or large. Small disturbances in the form of load changes occur continually and the system adjusts to the changing conditions. The system must be able to operate satisfactorily under these conditions and successfully meet the load demand. It must also be able to survive numerous disturbances of a severe nature, such as a short circuit on a transmission line or loss of a large generator.

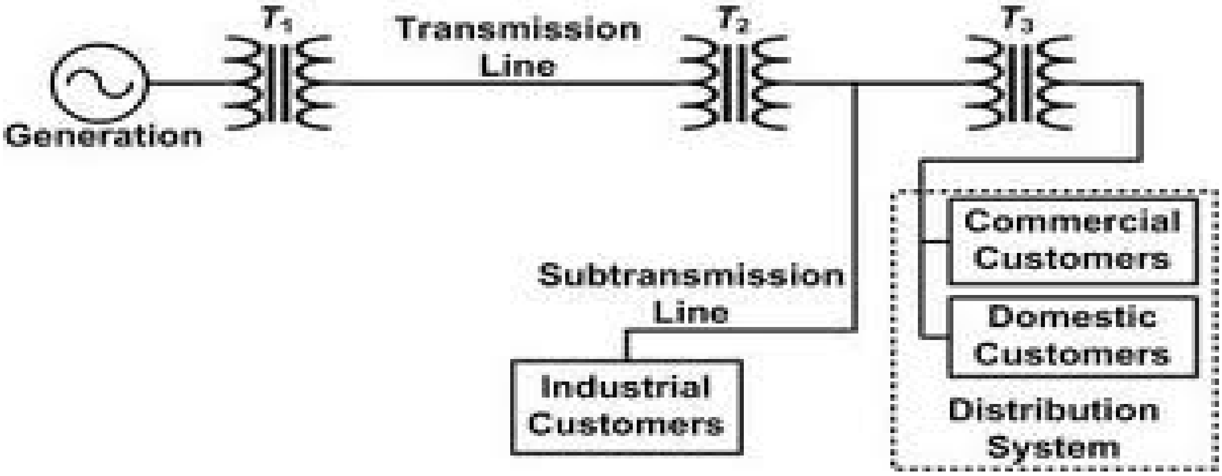

FIG 1: TYPICAL POWER SYSTEMS

Now-a-days it is becoming very difficult to fully utilize the existing transmission systems assets due to various reasons, such as environmental legislation, capital investment, rights of ways issues, construction costs of new lines, deregulation of policies, etc. Electric utilities are now forced to operate their system in such a way that makes better utilization of existing transmission facilities. Flexible AC transmission system (FACTS) controllers, based on the rapid development of power electronics technology, have been proposed in recent years for utilization of existing transmission facilities. With the development of FACTS technique, it become possible to increase the power flow controllability and enhance power systems stability. Recently, flexible alternative current transmission system (FACTS) controllers have been proposed to enhance the transient or dynamic stability of power systems.

During the last decade, a number of control devices under the term FACTS technology have been proposed and implemented. Application of FACTS devices in power systems, leads to better performance of system in many aspects. Voltage stability, voltage regulation and power system stability, damping can be improved by using these devices and their proper control. There are various forms of FACTS devices, some of which are connected in series with a line and the others are connected in shunt or a combination of series and shunt.

The FACTS technology is not a single high power controller but rather a collection of controllers which can be applied individually or in co-ordination with other to control one or more of the inter-related systems parameters like voltage, current, impedance, phase angle and damping of oscillations at various frequencies below the rated frequency. Among all FACTS devices, static synchronous compensators (STATCOM) plays much more important role in reactive power compensation and voltage support because of its steady state performance and operating characteristics.

The fundamental principle of a STATCOM installed in a power system is the generation ac voltage source by a voltage source inverter (VSI) connected to a dc capacitor. The active and reactive power transfer between the power system and the STATCOM is caused by the voltage difference across the reactance. The STATCOM can also increase transmission capacity, damping low frequency oscillation and improving transient stability. The STATCOM is represented by a voltage source, which is connected to the system through a coupling transformer .The voltage of the source is in phase with the ac system voltage at the point of connections, and the magnitude of the voltage is controllable . The current from the source is limited to a maximum value by adjusting the voltage. Mathematical modelling and analysis of static compensator (STATCOM) is presented in this. It explains the use of STATCOM for improvement of transient stability and power transfer.

2.2SIMULATION MODELS OF SYSTEM

The system described in this section illustrates modelling of a simple transmission system containing two hydraulic power plants. The FACT device (SVC, STATCOM) and power system stabilizers (PSS) are used to improve voltages stability and power oscillation damping of the system. The power system illustrated in this paper is quite simple. However, the phasor simulation method allows simulating more complex power grids.

The test system consists of three generators and three PQ bus (or load bus). This system which has been made in ring mode consisting of six buses (B1 TO B6) connected to each other through three phase transmission lines L12=450km, L14=300km, L15=450km, L26=300km, L23=450km, L25=200km, L24=250km, L36=250km, L35=250km, L45=350km and L56=150km,respectively.And the constant loads are connected of 700 MW at bus-4, 500 MW at bus-5 and 250 MW at bus-6 and variable dynamic load 2500+j1000 MVA at bus-6 as shown inFig.4.14.System has been supplied by three power plants with the phase-to-phase voltage equal to 11 kv. Active and reactive powers injected by power plants 1, 2 and 3 to the power system are presented in per unit by using base parameters Sb=2100 MVA and Vb=400KV, the power plants 1(G1), 2(G2) AND 3(G3) generated 1400MVA ,2100MVA and 700 MVA respectively.

Here also used HTG turbine and regulators subsystem and power system stabilizer as explained above in 6- bus system. The 400 kV 6-bus test systems observe the impact of the FACTS on system stability and power transfer capability. Load flow has been performed with machine G1 defined as a swing bus (V=11000V, 0 degrees), machine G2 defined as PV generation bus (V=11000V , P=534 MW). After the load flow has been solved, the reference mechanical powers and reference voltage for two machines have been automatically updated in the two constant blocks connected at the HTG and excitation system inputs: pref1=0.750827pu (1051 MW), Vref1=1.0 pu; pref2= 0.761905 pu (1600MW), Vref2=1.01 pu; pref2=0.761905pu (534 MW), Vref3=1.01pu.

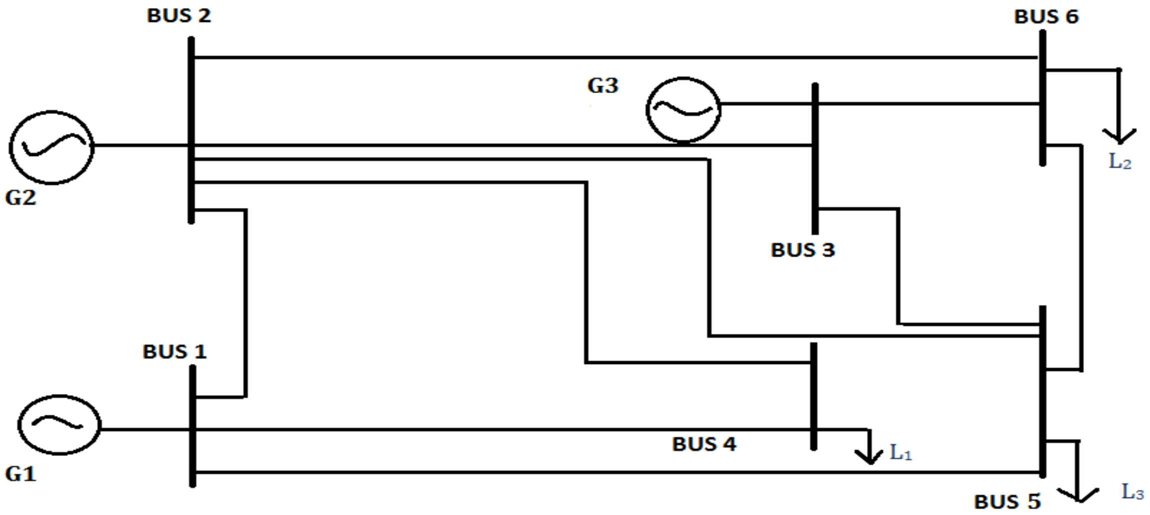

FIGURE: 2

Conclusion

This paper deals with applications of the SVC and STATCOM. The detailed models of the SVC and STATCOM were implemented and tested in MATLAB / simulink environment. The models are applicable for voltage stability analysis and cover broader range of power transfer capability.

The effect of FACTS (SVC and STATCOM) installed in power transmission path are analyzed in this paper, and the conclusions are as follows:

1. The FACTS can improve voltage stability limit observably and FACTS give better performance for power transfer capability for 4- bus system transmission capacity increased 67.27 MVA (SVC) and 820.9 MVA (STATCOM).

2. The STATCOM give superior performance than SVC for reactive power, voltages and power transfer capability for both 4-bus and 6-bus system.

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