A REVIEW ON VOLTAGE STABILITY IMPROVEMENT USING SVC IN TRANSMISSION LINE

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Abstract: **Power system stability is defined as the ability of power system to preserve it's steady stability or recover the initial steady state after any deviation of the system's operation. In this paper previous various studies for shunt FACTS device-SVC is used in a two area power system for improving the power system stability is presented. SVC plays an important role in improving the transient stability, increasing transmission capacity and damping low frequency oscillations.**

Keywords –**Long transmission line, SVC, power system stability, three phase fault**

I. INTRODUCTION

At present the demand for electricity is rising phenomenally especially in developing country like India. This persistent demand is leading to operation of the power system at its limit. On top of this the need for reliable, stable and quality power is also on the rise due to electric power sensitive industries like information technology, communication, electronics etc. In this scenario, meeting the electric power demand is not the only criteria but also it is the responsibility of the power system engineers to provide a stable and quality power to the consumers. These issues highlight the necessity of understanding the power system stability. In this course we will try to understand how to assess the stability of a power system, how to improve the stability and finally how to prevent system becoming unstable.

1.1 Basic Concepts and Definitions of Power System Stability

Power system stability is the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most of the system variables bounded so that practically the entire system remains intact [1], [2]. The disturbances mentioned in the definition could be faults, load changes, generator outages, line outages, voltage collapse or some combination of these. Power system stability can be broadly classified into rotor angle, voltage and frequency stability. Each of these three stabilities can be further classified into large disturbance or small disturbance, short term or long term. The classification is depicted in Fig. 1.1 [2].

1.1.1Rotor angle stability

It is the ability of the system to remain in synchronism when subjected to a disturbance. The rotor angle of a generator depends on the balance between the electromagnetic torque due to the generator electrical power output and mechanical torque due to the input mechanical power through a prime mover. Remaining in synchronism means that all the generators electromagnetic torque is exactly balanced by the mechanical torque.

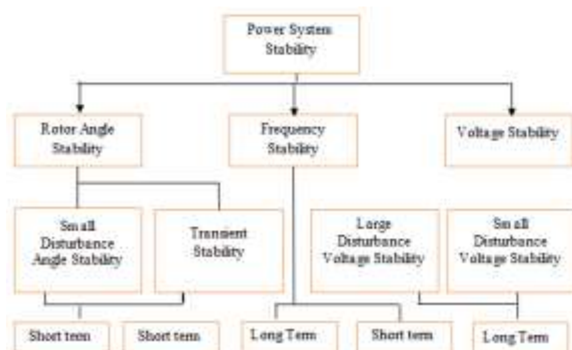

Fig. 1.1: Classification of power system stability

1.1.2 Small-disturbance or small-signal angle stability

It is the ability of the system to remain in synchronism when subjected to small disturbances. If a disturbance is small enough so that the nonlinear power system can be approximated as a linear system, then the study of rotor angle stability of that particular system is called as small-disturbance angle stability analysis.

1.1.3 Large-disturbance or transient angle stability

It is the ability of the system to remain in synchronism when subjected to large disturbances. Large disturbances can be faults, switching on or off of large loads, large generators tripping etc. When a power system is subjected to large disturbances they will lead to large excursions of generator rotor angles. Since there are large rotor angle changes the power system cannot be approximated by a linear representation like in the case of small-disturbance stability

1.1.4 Voltage stability

It is the ability of the system to maintain steady state voltages at all the system buses when subjected to a disturbance. If the disturbance is large then it is called as large-disturbance voltage stability and if the disturbance is small it is called as small-disturbance voltage stability. Unlike angle stability, voltage stability can also be a long term phenomenon. In case voltage fluctuations occur due to fast acting devices like induction motors, power electronic drive, HVDC etc then the time frame for understanding the stability is in the range of 10-20 s and hence can be treated as short term phenomenon.

The main difference between voltage stability and angle stability is that voltage stability depends on the balance of reactive power demand and generation in the system where as the angle stability mainly depends on the balance between real power generation and demand.

1.1.5 Frequency stability

It refers to the ability of a power system to maintain steady frequency following a severe disturbance between generation and load. It depends on the ability to restore equilibrium between system generation and load, with minimum loss of load. Frequency instability may lead to sustained frequency swings leading to tripping of generating units or loads.

Static VAR compensators, regarded as the first FACTS controllers, have been used in North American transmission systems since late 1977 in western Nebraska 3. The aforementioned transmission SVC device was installed to provide “automatic, continuous voltage control.”Since then, there is a lot of transmission SVCs commissioned around the world, and many transmission SVCs applied in North America. The term “transmission system SVC” is used because SVCs are also applied at the distribution level to compensate for local voltage fluctuation problems due to industrial load operation 4.The heart of the SVC is an ac power semi-conductor switch commonly known as the “thyristor valve” that is used in principle to replace mechanical switches to achieve rapid, repetitive, and in some cases continuous control of the effective shunt susceptance at a specific location in a transmission system by a set of inductors and capacitors 5.For example, the fixed capacitor (FC) in parallel with a thyristor-controlled reactor (TCR), the valve continuously and “smoothly” controls the reactor to achieve a “net susceptance” that is varied to maintain the transmission system voltage to a desired value orange.

In recent years, power demand has increased substantially while the expansion of power generation and transmission has been severely limited due to limited resources and environmental restrictions. As a consequence, some transmission lines are heavily loaded and the system stability becomes a power transfer-limiting factor. Flexible AC transmission systems (FACTS) controllers have been mainly used for solving various power system steady state control problems. However, recent studies reveal that FACTS controllers could be employed to enhance power system stability in addition to their main function of power flow control. The literature shows an increasing interest in this subject for the last two decades, where the enhancement of system stability using FACTS controllers has been extensively investigated.

Power Flow Model Of Static Var Compensator And Enhancement Of Voltage Stability, H. B. Nagesh And P. S. Puttaswamy, *International Journal Of Advances In Engineering & Technology, May 2012*

Voltage stability analysis is the major concern in order to operate any power system as secured. In this context there are many research work has been carried out to improve the voltage stability. This study demonstrates the use of latest Power System Analysis Toolbox (PSAT) package for network analysis of alternative means of improving existing transmission system voltage stability.

This paper presents the investigation on enhancement of voltage stability using FACTS controllers such as Static Var Compensator (SVC) device. The proposed method explains how voltage stability can be improved with the continuation power flow methods in case of increasing loading of contingency. Voltage stability assessment on standard IEEE-14 system has been simulated to test the effectiveness of increasing load ability. This paper presents the simple method for identifying the weak bus and also optimal value of reactive power support needed for that. A comparative study between the base case and SVC are presented to demonstrate the effectiveness of SVC. The propose methodology found advantages because it is simple, faster and very convenient to apply for voltage stability analysis.

Voltage Stability Improvement Using Static Var Compensator In Power Systems Mark NdubukaNwohu,*Leonardo Journal of Sciences Issue 14, January-June 2009*

This paper investigates the effects of Static Var Compensator (SVC) on voltage stability of a power system. The functional structure for SVC built with a Thyristor Controlled Reactor (TCR) and its model are described. The model is based on representing the controller as variable impedance that changes with the firing angle of the TCR. A Power System Computer Aided Design /Electromagnetic Transients including DC (PSCAD/EMTDC) is used to carry out simulations of the system under study and detailed results are shown to access the performance of SVC on the voltage stability of the system.

Power System Stability Enhancement Using Facts Controllers: A Review M. A. Abido, The Arabian Journal for Science and Engineering, Volume 34, Number, November 2008

Flexible AC transmission systems (FACTS) controllers have been mainly used for solving various power system steady state control problems. However, recent studies reveal that FACTS controllers could be employed to enhance power system stability in addition to their main function of power flow control. The literature shows an increasing interest in this subject for the last two decades, where the enhancement of system stability using FACTS controllers has been extensively investigated. This paper presents a comprehensive review on the research and developments in the power system stability enhancement using FACTS damping controllers. Several technical issues related to FACTS installations have been highlighted and performance comparison of different FACTS controllers has been discussed.

In addition, some of the utility experience, real-world installations, and semiconductor technology development have been reviewed and summarized. Applications of FACTS to other power system studies have also been discussed. About two hundred twenty seven research publications have been classified and appended for a quick reference.

Power System Stability Improvement Of Long Transmission Line System By Using Static Var Compensator (Svc)*Pardeep Singh Virk, Vijay Kumar Garg , Int. Journal of Engineering Research and Applications , Vol. 3, Issue 5, Sep-Oct 2013, pp.01-03*

This work discusses how SVC has successfully been applied to control dynamic performance of transmission system and regulate the system voltage effectively. Present time power systems are being operated nearer to their stability limits due to economic and environmental reasons. Maintaining a stable and secure operation of a powersystem is therefore a very important and challenging issue. Shunt FACTS devices play an important role in improving the transient stability, increasing transmission capacity and damping low frequency oscillations. In this paper shunt FACTS device-SVC is used in a two area power system for improving the power system stability. MATLAB software has been used in this study.

Power System Stability Improvement Using Facts Devices *Alok Kumar Mohanty, Amar Kumar Barik , International Journal of Modern Engineering Research (IJMER)*

Flexible AC transmission systems (FACTS) controllers have been mainly used for solving various power system steady state control problems. Flexible AC transmission systems or FACTS are devices which allow the flexible and dynamic control of power systems. Enhancement of system stability using FACTS controllers has been investigated. This paper is aimed towards the benefits of utilizing FACTS devices with the purpose of improving the operation of an electrical power system. Performance comparison of different FACTS controllers has been discussed. In addition, some of the utility experience and semiconductor technology development have been reviewed and summarized. Applications of FACTS to power system studies have also been discussed.

Voltage Control And Dynamic Performance Of Power Transmission Using Static Var Compensator *M Asrar Ur Rahman1and M Sabah ul Islam, International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS), 2014, Vol 1, No.4, 141-151*

This paper presents how static var compensator (SVC) can be utilized to control transmission system dynamic performance for system disturbance and effectively regulate system voltage. Static var compensator (SVC) is basically a shunt connected static var generator whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific power variables, typically, the control variable is the system bus voltage. Voltage control and the increase in system load ability are the main applications of SVC in this paper. Firstly, to design a controller for SVC devices on a transmission line, a single machine infinite bus (SMIB) is modeled. A state space model is developed in the MATLAB/SIMULINK to show the improvement in the dynamic performance of the system.

Modelling, simulation and performance analysis of factscontroller in transmission line,*DiptiMohanty,Aziz Ahamad, M. A. Khan,International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 5, May 2013*

For the development and improvement of dynamic performance of the modern power system, Flexible AC Transmission Systems (FACTS) devices have been used since 1970s. FACTS devices use power electronic components to improve system performance. FACTS controller includes Fixed Capacitor Thyristor Controlled Reactor (FC_TCR), Static Synchronous Compensator (STATCOM), Thyristor Controlled Series Compensator (TCSC), Static Series Synchronous Compensator (SSSC), Static VAR Compensator (SVC), Unified Power Flow Controller (UPFC), which are used in the transmission and distribution system to improve power transfer capability and to enhance power system stability.

The Unified Power Flow Controller (UPFC) is the most complex power electronic equipment and is able to control, simultaneously or selectively, all the parameters affecting power flow in the transmission line. It can independently control both the real and reactive power flow in the line. This paper shows the results that show the performance of the system for each of the FACTS devices in improving the power flow in the transmission line. All the simulations are carried out by using MATLAB/SIMULINK software. The simulation result shows the performance of FACTS devices in transmission line.

Voltage Stability In Electric Power Systems*, FarzadZhalefar, June 2012*

Several catastrophic power system blackouts have occurred worldwide. Some of these system collapses are reported in the literature. Various reasons have been declared for these failures. Economical limitations due to power system restructuring restrictions, inadvertent operation of protective relays and inefficient design of conventional load-shedding schemes are some of the most important reasons initiating these blackouts. This paper has focused on monitoring of voltage stability as one of the features which is in danger these days due to incremental usage of power systems all over the world. For this purpose, some different kinds of voltage stability views have been explained. Then, some methods for voltage stability analysis have been mentioned in brief.

Increase of voltage stability and power limits using a static var compenstor Roberto Alves, Miguel Montilla y Ernesto Mora

This paper presents an application of a Static Var Compensator (SVC). A SVC is one of the controllers based on Power Electronics and other static devices known as FACTS (Flexible AC Transmission Systems) Controllers which it could be used to increase the capacity and the flexibility of a transmission network. The system under study is an interconnected network located in the southeast region of Venezuela. The objective of study was to increase the power flow, under the thermal capacity, through an overhead transmission lines, using a voltage stability approach. The simulations were carried out with the program ATP/EMTP (ElectroMagnetic Transients Programs), which allows the analysis of the response of the SVC and the adjustments of its control systems

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