

A SURVEY ON CONGESTION MANAGEMENT OF TRANSMISSION LINE BY DECIDING OPTIMAL LOCATION OF FACTS DEVICE

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Abstract: Nowadays, several important issues related to power system have been discussed worldwide. Some of the serious issues are the power quality, transmission load ability, congestion management reduce power losses and voltage stability. To overcome these issues, best approach is using FACTS devices. Congestion management schemes used today have negative impacts on energy markets, such as disruptions and monetary penalties, under some conditions. To mitigate these concerns various congestion management methods have been proposed, including dispatch and curtailment of scheduled energy transmission. In the restructured electric energy industry environment, new congestion management approaches are being developed that strive to achieve the desired degree of reliability while supporting competition in the bulk power market. Congestion management is one of the technical challenges in Power system. In electricity market transmission congestion happens when there is not enough transmission ability to transmit the power without any restrictions for transmission of a line. To detect the optimal placement of Unified Power Flow Controller (UPFC) to voltage drop compensation and reduce congestion. To find the location of shunt part of UPFC, we proposed new indices to voltage drop compensation. Also congestion rent contribution method used to determine the location of series part of UPFC.

Keywords: UPFC, FACTS, Matlab Simulink.

I.INTRODUCTION

Deregulated power in the industry, open access is provide to transmission system. Due to transmission open access the flow in the lines reaches power transfer limit and thereby creating a condition known as congestion. The congestion may be caused due to various reasons such as transmission line outages, generator outages and system demand. Transmission congestion has impact on entire system as well as on the individual market such as: sellers, buyers. Congestion results in increase in locational marginal prices and creates market power. Therefore it becomes necessary to manage congestion and it is done by independent system operator.

The congestion can be managed by using various fact devices. The unified power flow controller is a tool in implementation of flexible AC Transmission Systems. It provides for the equivalent of static Vars compensation and series injection using back-to-back force commutated converters. The ongoing deregulation of the electric utility brings out opportunities and challenges. Conceptually, the power market introduced in deregulated power system is similar to a commodity market. This competitive electricity market has resulted in growing prominence of transmission congestion.

Congestion occurs whenever the preferred generation/demand pattern of the various market players require the provision of transmission system to provide. Under ideal conditions of the transmission unconstrained markets, the various buyers and seller satisfy their required deals. But in practical applications, the constraints in the transmission network are considered such as physical, operational constraints .so the buyers and sellers are unable to meet desired deals without violating one or more constraints. Therefore the congestion results from insufficient transfer capabilities between the various buyers and sellers.

II.FLEXIBLE AC TRANSMISSION SYSTEM

Flexible AC Transmission System (Facts) is a new integrated concept based on power electronic switching converters and dynamic controllers to enhance the system utilization and power transfer capacity as well as the stability, security, reliability and power quality of AC system interconnections.

A. Static Var Compensators (SVC)

Static Var Compensators to provide high performance steady state and transient voltage control compared with classical shunt compensation. Static Var Compensators are also used improve the transient stability, damp power swings and reduce system losses by using reactive power control

B. Static Synchronous Compensator (STATCOM)

STATCOM's are GTO (gate turn off type Thyristor) based SVC's. They do not require large inductive and capacitive components to provide inductive or capacitive reactive power to high voltage transmissions systems as required in Static Var Compensators (SVC).STATCOM requires less area. Another advantage is the higher reactive at low system voltage statcom can be considered as a current source independent from the system voltage. Schematic diagram of STATCOM is shown in figure

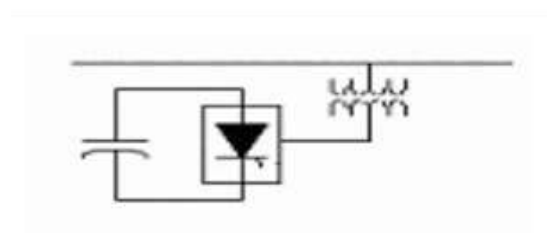


Fig.1. Schematic diagram of Statcom

C. Static Synchronous Series Compensator (SSSC)

Voltage sourced converter (VSC) based series connected FACTS controller known As SSSC. It can inject a voltage with controllable magnitude and phase angle at Line frequency and found to be more capable of handling power flow control, improvement of transient stability margin and improve damping of transient. The schematic diagram of SSSC is shown in figure

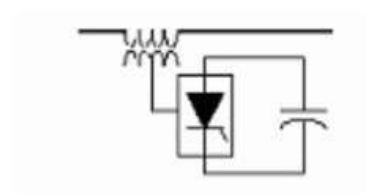


Fig 2. Schematic Diagram Of Sssc

D. Thyristor Controlled Series Compensators (TCSC)

TCSC is an extension of conventional series capacitors but only addition of Thyristor-controlled reactor with it. Connecting a reactance in parallel with a series capacitor enables a continuous and rapidly variable series compensation system. The main advantages of TCSC's are increased real transfer power, power oscillations damping, sub-synchronous resonances damping, and power flow line control.

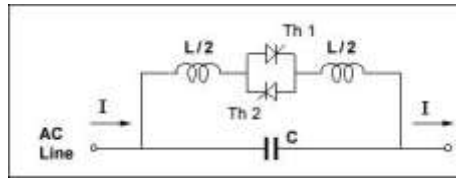


Fig 3. Schematic Design Of Tcsc

E.Unified Power Flow Controller (UPFC)

UPFC is combination of shunt connected device (STATCOM) and as series branch (SSSC) in the interval its DC link. This device is most versatile FACTS device. It cannot only perform the function of STATCOM TCSC and phase prevents faults, they can mitigate the effects of faults and make electricity supply more secure by reducing the number of line trips.

For example, a major over voltage loading of the transmission line results in tripping of the transmission line. SVC's or STATCOMs FACTS devices balance the over voltage and avoid to trip the line. Line tripping, used for a number of years to improve transmission line economics by resolving angle regulator but provides addition flexibility by combining some of the function of the above controllers.

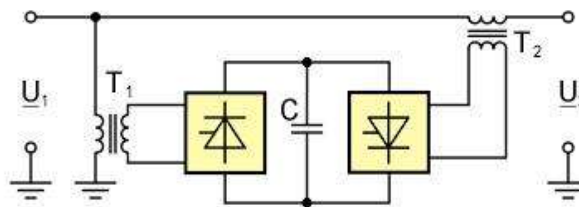


Fig 4.schematic Diagram Of Upfc

III. OBJECTIVE FOR PLANNING FACTS

To improve the performance of the power system, proper location and parameter setting of FACTS controllers is required. For the optimal utilization and cost of FACTS controllers, optimization can be done based on one of the following without violating the power system constraints:

- Reduction in the real power loss of a particular line
- Reduction in total system real power loss
- Reduction in the total system reactive power loss
- Maximum relief of congestion in the system
- Increase in Available Transfer Capability

IV. FACTS APPLICATION TO POWER SYSTEM

In the last two decades, researchers have been using various algorithms like GA, PSO, HSA for solving the optimal power flow problems and for finding the impact of FACTS on the performance of a power system. Generally in power flow studies, the FACTS devices, such as SVC and TCSC, are usually modeled as controllable impedance and the devices like STATCOM and UPFC are modeled as controllable sources. Various techniques have been proposed and implemented by different researchers to obtain optimal location and parameter setting of FACTS devices to improve the performance of a power system in terms of congestion management, improvement in ATC, stability, reliability and security. Algorithms like HSA and GA can be used to determine optimal location of FACTS devices like TCPAT, UPFS and SVC in a power system to improve the

voltage stability index and to reduce the losses [1]. The same algorithm has been proposed to simultaneously find the real power allocation of generators, the type, rating and best location of FACTS controllers so that overall cost which includes the generation cost of power plants and investment cost of FACTS is minimized [2]. Reference [3] deals with the comparison of TCSC and SSSC for optimal location of these devices to remove congestion under normal and contingency problem to enhance power transfer capability and voltage profile. In [4] a new algorithm for optimal location of FACTS is proposed to maximize FACTS device owner's surplus. Reference [5] deals with a novel approach for optimal placement of multi-type FACTS devices based on GA to improve the voltage stability margin of power system and reduce losses. In [6] an approach to find out the optimal placement and the optimal parameter setting of UPFC to enhance the security of power system by eliminating or minimizing the overloaded lines and the bus voltage violations is proposed. O.L. Bekri has done a research work on effects of SVC and TCSC on voltage stability. It is found that these devices significantly increase the loading capability of power system [7].

Provided optimal location, FACTS devices can be used to achieve the optimal power flow without any constraint violation and thus to increase the utilization of the lowest cost generation in power system [8]. In [9] a new method to seek optimal location and capability of FACTS devices based on sensitivity analysis and extended equal area criterion is proposed for enhancing static voltage and transient stability. Reference [10] deals with optimization based on location, size and number of FACTS devices. The proposed placement approach reduces the congestion in transmission lines. In [12,13,15,19] a PSO and GA techniques are used for finding the optimal location and parameter setting of multiple TCSCs for increasing Power system Loadability. In [14] a GA based method is proposed for optimal placement of UPFC to control active and reactive power flow and bus voltages simultaneously. In [16] BelkacemMahdad has focused on location and control of FACTS to increase system loadability and reduction in losses. Paper [17] has done a comparison of optimal location of UPFC applied to linear and nonlinear load model is done. It is found that the optimal location for UPFC is at receiving end bus for linear load and it is at sending end bus for non-linear model. A few researchers have proposed an effective method for finding the optimal choice and allocation of FACTS in minimizing the overall system cost which comprises of generation cost and initial investment cost of FACTS [18]. Optimal placement of multiple FACTS devices controls the overall reactive power requirements. But the mathematical complexity and hence the solution time increases for reactive power planning of large power networks with multiple FACTS devices.

A simple GA can be applied to obtain a feasible and optimal solution for reactive power planning, optimal location and parameters of FACTS devices [20,21]. S.Gerbex has compared three methods SA, TS and GA applied to optimal location of FACTS in a power system. The optimizations are made on three parameters: the location, the type and the sizes. TCSC, TCVR, TCPST, SVC and UPFC were modelled and compared for steady state studies. Results show that the three algorithms converge to similar optimal solutions [22]. In [23] the author has done a work on comparison of single and multi-type FACTS devices for optimal location to increase the loadability of the system. M Karami used GA technique to optimize the stability of power system by means of maximizing distance to collapse point. The continuation power flow method is employed to determine the collapse point and critical area of power system [24]. It has been proved that the centre of a transmission line is the optimal location of shunt FACTS devices, or reactive power support and the proof is based on the simplified line model. M.H.Haque investigated this location based on the actual model and proved that if it is placed slightly off centre the power transfer capability increases[25].

In [26] Dr.N.D.Ghawaghawe and Dr.K.L.Thakare have suggested the criterion for optimal location of TCSC and computation of its reactance value based on sensitivity analysis. This also improves the loadability of the system. In [27] G. Swapna has also used sensitivity approach to improve Transfer Capability through optimal placement of TCSC and SVC. In [28] the comparison of FACTS devices is done based on their effectiveness to improve the performance of a Power System.

V.CONCLUSION

In this review, the status of power system with and without FACTS has been discussed and scrutinized. The features of various types of FACTS controllers and their potential to enhance system stability has also been discussed. The sensitivity indices for deciding the optimal location of FACTS to improve the performance of power system has been addressed. The scope of FACTS technology, in present complex power system was reviewed in detail. In addition, utility experience and major realworld installations and semiconductor technology development have also been summarized. The algorithms which can be used for optimization are also discussed.

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