Review on Increase of transmission capability of transmission line

N.S.Deshpande[1], Prof.M.R.Salodkar[2]

[1]*ME Student, Raisoni college of engineering, Amravati, MH, India*
[2] *Professor, Dept. of Electrical Engineering Raisoni College of engineering, Amravati, MH, India*

Abstract - *In recent days there is vast increase in the use of advanced technology in all fields. This increases the consumption and interns increase the demand. This demand is so high and increasing continuously that present rating transmission lines does not meet the demand. So some remedies have to make to overcome this problem. This paper tries to review the work done on enhancing the transmission capability by applying different methods and try to analyze the better way to do so.*

Key Words: **SVC, Transmission capability, Reactive power, OLTC, SSSC.**

1. INTRODUCTION

The main aim of power system is to provide secured and reliable power to consumers, for these systems were interconnected which results in increase in complexity of the system. Any fault occurs on such system may affect customer's life severely and also cause the loss of economy. Increase in the demand may causes severe outages and stresses in the system. Hence the power systems should be extended [7] [8].

Extending the power system is not convenient as it costs more and more time is required .One of the reasons is building new towers is not possible because of right-of- way (ROW) problems. Moreover developers have to get the approvals from forest, aviation, defence and power departments to get the land which is a very difficult task. Sometimes due to environmental and political reasons lines are forcefully turned to different routes [1]. So extension of power system is complex and filled with lot of uncertainties. Hence it is necessary to find another option to fulfil the demands.

To meet the demand at the start power system was extended by installing number of generators. Now this generated power has to be transmitted over the large distance so the voltage levels were increased. Demand can be fulfilled by proper utilization of existing transmission system and controlling the power flow in the system. This can be done by enhancing the transmission capability of transmission line. In this paper various work done on enhancing the transmission capability are studied and are compared.

2. RELATED WORK

In 2003 Jose R.Daconti and et al. [1] proposed that there are number of power transfer capability constraints for the transmission system such as thermal, system voltage, and operating constraints. They mentioned number of possibilities for the enhancement of transmission line.
By transmission line uprating, demand of the customer can be satisfied with low cost. It will take shorter time as compare to building new lines. This can avoid load shading during contingencies. They included methods line thermal and voltage uprating and upgrading of lines that is physical modulation of the lines. Voltage uprating causes much high increase in the rating as transfer capability of line increase with square of the line voltage. Amount of power transferred in a higher voltage level reduces the line current, line losses and voltage drops. It is more expensive than thermal uprating. Thermal uprating is convenient when loads are limited by thermal constraints .Various methods are used to do so such as raising of towers, moving of towers, increasing additional tower etc. It brings some impact on structural and substation equipments. They also mentioned that dynamic thermal monitoring is the as a good thermal uprating solution. Weather monitoring, tension monitoring, sag monitoring, line temperature monitoring, and the new PTI Thermal Rate technique are the dynamic line rating techniques. This improves the capability.

IN 2002 Rajiv Gandhi et al [2] stated that power transmission capability is affected by changing stability and thermal limits. One can see the changes in power transmission capability by improving stability limits and current uprating.

Ambient temperature, maximum permissible conductor temperature for the type of conductor used, wind velocity, solar radiation, solar absorption & emissivity coefficients are the factors which affects thermal rating of a line. Analysis of the variation in the thermal rating was observed with respect to changes in the above factors. It was seen that ambient temperature affects more on current carrying capacity of the line. Stability and thermal limits can also be enhanced by implementing new technology like FACTS devices. This increases the power transmission capability to its maximum limits economically. Taking maximum operating temperature limit to its maximum is one of the feasible solutions.

They also stated that methods like re-tensioning or re-conductoring and using of ground clearance margins physically available by adopting with alternate low sag conductor are economical to improve thermal rating of the lines. Enhancing thermal limits, uprating of existing transmission lines can be done with re-conductoring the existing line by conductor having high current carrying capacity, compatible sag– tension characteristics, and high temperature endurance. Etc

In 2010 A. Abu-Siada et al [3] proposed that on load tap changing (OLTC) transformer improves transmission capability of a system. OLTC transformer is the device which keep the voltage at load bus within the permissible limit irrespective of load change .From generating station to the receiving station, Static load affect power transfer capability .They discussed effect of different static loads on the maximum power transfer limit and stability limit. Power transfer depends on the degree of compensation, OLTC setting and load bus voltage. They used IEEE 6-bus test system with 6-nodes, 7 lines, two OLTC transformers, two generators and four loads. Out of two OLTCs one was varied at a time, for the maximum power transfer to the load centres. They showed that power transfer limit increases with increase in transformer tap ratio till the optimal power is reached for compensated and uncompensated load. It was observed that for different load models maximum power transfer was affected by OLTC tap ratio.

In 2011 Akhilesh A. Nimje et al [4] used Static Synchronous Series Compensator (SSSC) to improve transfer capability of system. With the change in the phase angle of injected voltage, changes in power system parameters like sending end voltage, transmission angle, active power, reactive power, and overall power factor were observed, without and with installed SSSC.

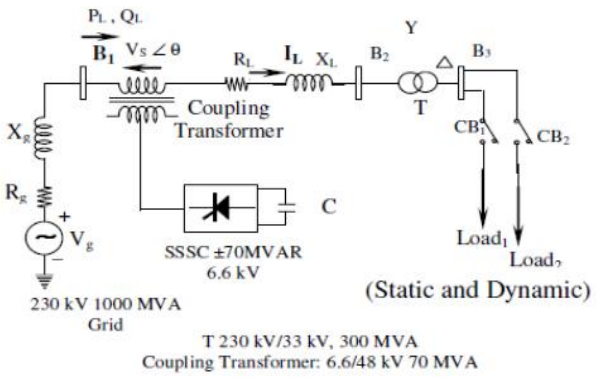

Fig -1 A system with SSSC

They considered a system with radial transmission line connected to bus B2.It had 300 MVA of main transformer, a voltage source 230KV 1000 MVA short circuit level and a SSSC of capacity ± 70 MVAR. After simulation and testing it was seen that there is change in active and reactive power with change in the magnitude of injected voltage.

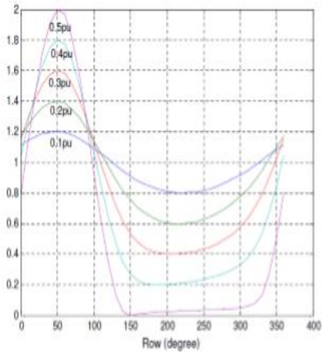

Chart -1: P at receiving end

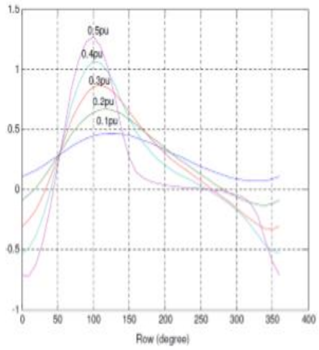

Chart -2: Q at receiving end

Charts shows that there is improvement in the active power with change in magnitude of injected voltage. Real power to reactive power ratio increased after compensation. They concluded that SSSC was used to reduce reactive power flow by compensation. When magnitude of voltage was increase 0.2 per unit within the range of angle variation from 0 to 90 degree real power is enhanced and hence transmission capability of the line is enhanced

In 2012 Abu-Siada et al [5] worked for different approaches for enhancing transmission capability. They studied over Eastern Gold Fields (EGF) area of the Western Power network in Western Australia basically there was saturated type of static war compensator (SR SVC) they studied for better replacement for the SR SVCs by STATCOM TSVC and upgrading of 220KV transmission line by 275KV.They found that Enhancing transmission capability by using TSVC instead of other options is cheap but STATCOM gives the better dynamic response and upgrading is too costly.

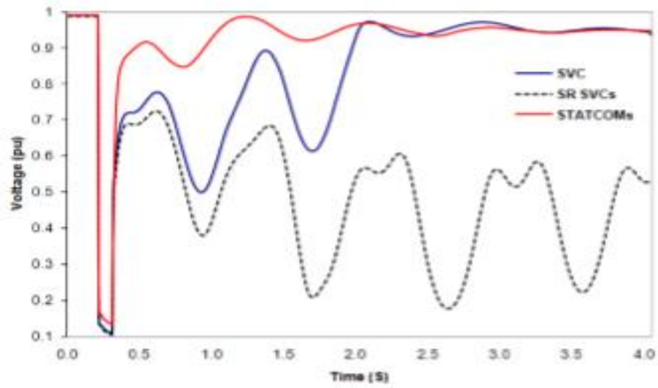

Chart -3: Power transfer capability profile.

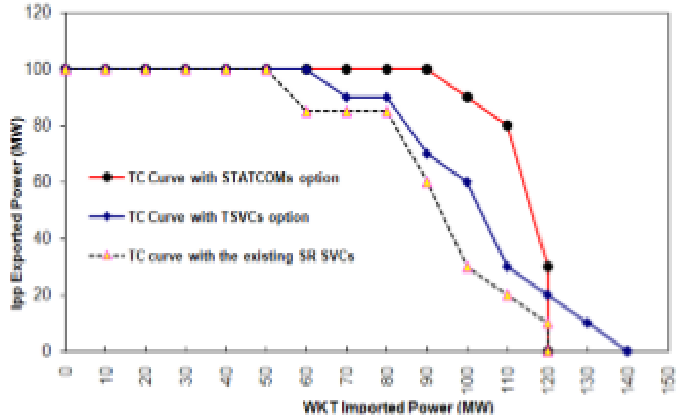

Chart -4: Voltage Profile

In 2011 Md. Nazmus Sahadat et al [6] stated that use of thyristor controlled shunt connected compensation devices has been increased for dynamic power compensation and enhancement of real power transmission capacity, as there is vast growth in interconnections. They applied SVC to a simple power system. They used PSAT toolbox of MATLAB for simulation. They considered 2 machine 4 bus -system.

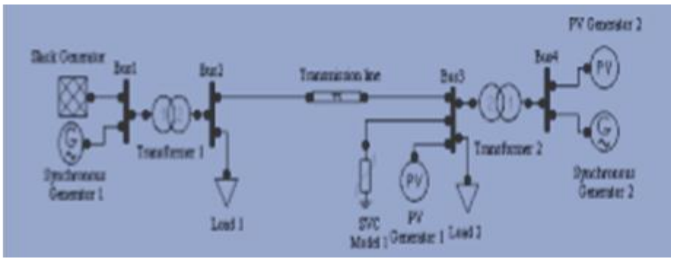

Fig -2: Single line diagram with SVC

They measured the voltage and power at the bus where SVC was applied and they found the following results.

Table -1: Bus voltage analysis

Bus No.	Bus Voltage without SVC (KV)	Bus Voltage with SVC (KV)
2	208.30	223.42
3	208.95	235.75

Table -2: Bus power analysis

From Bus	To Bus	Power Flow without SVC (MW)	Real power flow with SVC (MW)	Increment in real power flow (MW)
2	3	116.95	118.07	1.12

From proposed technique applied to a simple power system, they observed that real power flow increases in the network. Bus voltages of the network get improved. They also performed Stability analysis of the system after experiencing fault as well as consequent fault clearance by time domain analysis. They got satisfactory results. They concluded that real power transfer capability is enhanced with SVC mounted.

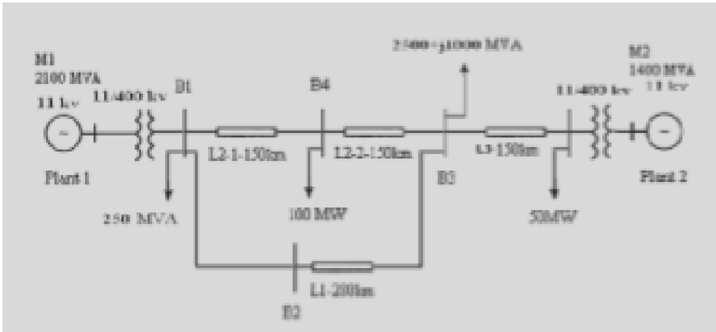

Fig -3: Single line diagram of 4 bus system

In 2013 Aarti pateriya et al [7] represented a paper showing how Phasor SVC can be used to enhance the transmission capability. They simulated two machine 4 bus power system in matlab environment. They connected phasor SVC to a simple 400 KV transmission system to one of the buses and measured the voltage and power at different buses.

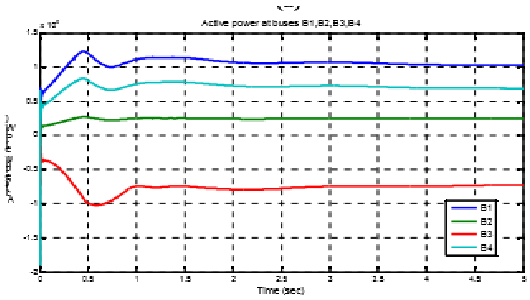

Chart -5: Active power with SVC

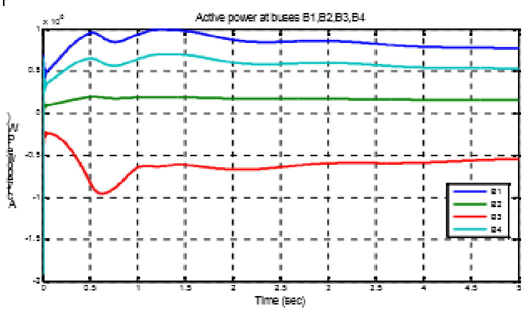

Chart -6: Active power without SVC

They applied SVC at bus B3.They analyzed that power flow and voltage at the bus is more when SVC is mounted, than when it was not there. They concluded that power system losses are reduced and voltage was injected at bus 3 when

SVC was mounted. It increased the transmission capability of the system.

3. ANALYSIS

After reviewing papers related to transmission capability enhancement it was found that to fulfill the demand on the customer side it is necessary to extend the transmission lines. But because of certain problems like Right of way (ROW) it not possible. The option left is to enhance transmission capability of transmission line. Various methods are available.

Voltage and thermal uprating and Upgrading of transmission line with various new conductors .But voltage uprating is somewhat costly than thermal. Upgrading of transmission line is also costly. On load tap changing (OLTC) transformer is also one of the methods. OLTC was able to improve transmission capability but continuous operation of changing tap ratio is not at all good enough from the equipment point of view. They may cause damage to the equipments in the system. Use of FACTS technology is also one of the ways to improve the transmission capability. It was proved to be most promising. Various devices line SSSC, STATCOM, SR SVC, TSVC can be used .series compensated SSSC can improve transmission capability but it makes the protection scheme complex, compensator cost is very high. Series capacitor may cause faulty operation in distance relay if compensation and location of capacitor is not proper. Hunting and fault current increases. On other hand STATCOM improves the dynamic performance. But costing of installation of STATCOM is high than SVC.SVC reduces the total active power loss. It improves voltage quality, enhances system stability and improves the transmission capability.

4. CONCLUSION

It was observed although there are various methods for enhancing transmission capability; use of FACTS devices is the beneficial from performance and cost point of view.

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