Proceedings of National Conference on Multidisciplinary Engineering Sciences and Information technology (NCMESIT, 2020) in Marudhar Engineering College on the 23rd & 24th of November 2020
World Journal of Research and Review (WJRR)
ISSN: 2455-3956, Special Issue, November 2020 Pages 53-55

Power System Engineering Development using FACT Devices

Rahul Mishra, Mohit Kumawat, Pushpendra Singh, Mohit Jain

***Abstract*— A combination of lack of investment and environmental issues results in lack of building of new transmission infrastructure. This leads to a requirement for better utilization of existing transmission network. Flexible AC transmission system (FACTS) controllers are widely used for this purpose. However, due to their cost the wide spread use of such devices is limited. Thus the problem exists of where/how to use these resources (devices) in a modern network setting, which is operated under competitive trading. FACTS technology has opened up new opportunities for controlling power and enhancing the usable capacity of present, as well as new and up graded lines. These opportunities arise through the ability of FACTS controllers to control the inter-related parameters that govern the operation of transmission system including series impedance, shunt impedance, current, voltage, phase angle and damping of oscillation at various frequencies below rated frequency. FACTS technology is not a single high-speed controller, but rather a collection of controllers, which can be applied individually or in co-ordination with others to control one or more of the interrelated system parameters. But for the efficient control of these parameters proper co-ordination and exact placement of different FACTS devices in the system imperative.**

***Index Terms*— Flexible AC transmission system (FACTS), controllers, shunt impedance.**

I. INTRODUCTION

Due to ever increasing load demand and reduced right of way, modern power transmission systems are forced to carry increasingly more power over long distances. Consequently, the transmission system becomes more stressed, which, in turn, makes the system more vulnerable to stability and security problems. With the emergence of high power semiconductor switches, a number of control devices under the generic name of flexible ac transmission system (FACTS) have come under active consideration to achieve the above objective.

A technically attractive solution to above problems is to use some efficient controls with the help of FACTS (Flexible AC Transmission Systems) devices.

FACTS controllers, by virtue of their fast controllability, are expected to maintain the stability and security margin of highly stressed power systems. A number of control strategies for FACTS controllers have been suggested for this purpose. However, to achieve the good performance of these controllers, proper placement of the controlling devices in the grid is as important as an effective control strategy. Hence, it is imperative that proper placement strategy must precede the installation of any such device.

II. LOCATION OF FACTS DEVICES

FACTS devices by controlling power flow in lines can help to maintain the improved stability, better security, low system losses, reduced cost of production. But it is important to ascertain the location for placement of these devices depending upon the parameters to be controlled.FACTS devices can be placed keeping in mind the following parameters.

- Power system security
- Power system transfer capability
- Optimal reactive power dissipates
- Voltage stability

III. MID-POINT VOLTAGE REGULATION FOR LINE SEGMENTATION

The late E.W. Kimbark pointed out that with shunt capacitor voltage support at the mid-point of the transmission line (which he proved to be the optimum location),[4] it is possible to transmit twice the power of the uncompensated line and to extend the steady-state stability limit from 90°to 180°**.** This conclusion canbe extended to the FACTS devices. When the thermal limit is above twice the transmission power of the line, the FACTS device canprovide savings if its cost is below that of a second transmission line. Another reason for mid-point siting is related to the voltage limit set by equipment and transmission design. Asexemplified by the UPFC, FACTS devices are increasinglyexpected to control reactive power, which is accomplishedby raising or lowering the terminal voltages of the FACTS device [9]. For a given voltage limit, the mid-point siting controls a larger reactive power simply because each side of the FACTS device addresses only half the line impedance and not the full line impedance as in the case of the transmission line end-siting.Hence, it is imperative that proper placement strategy must precede the installation of any such device

IV. VARIOUS METHODS FOR PLACEMENT OF FACTS DEVICES

Some of methods for placement of FACTS devices are as follow:

Line flow index method[1],Effective voltage phasor approach(EVPA)**,**Real power flow performance index and

Rahul Mishra, Assistant Professor, Department of Electrical Engineering, Vivekananda Institute of Technology, Jaipur, Rajasthan India.
MohitKumawat,Student, Vivekananda Institute of Technology, Jaipur, Rajasthan India.
Pushpendra Singh, Student, Vivekananda Institute of Technology, Jaipur, Rajasthan, India
Mohit Jain, Assistant Professor, Department of Electrical Engineering, Vivekananda Global University, Jaipur India

sensitivity analysis[6],**Loss sensitivity indices for placement of FACTS devices[7],L indices[8],Heuristic methods[5],Residue method, Eigen solution free model of modal control analysis.**

A.Voltage phasor approach

A voltage collapse proximity index (VCPI) [1] using voltage phasors approach (VPA) for identifying critical transmission paths with respect to the real or reactive power loading has been proposed in. In this strategy, a voltage stability index termed as transmission path stability index (TPSI) has been defined as the difference between the halved voltage phasor magnitude of relevant generator and the corrected voltage drop along a transmission path. The corrected voltage drop of a line segment is defined as the projection of the receiving end bus voltage of that segment on the voltage phasor of the generator which is the starting point of that transmission path as evident from Figure1 and is given by

$$\Delta V'_{ai} = (V_i - V_{i+1}\cos\delta_{i,i+1})\cos\delta_{1,i}$$

Where i varies from the generating bus 1 to bus n-1.

The total corrected voltage drop $\Delta V'_a$ is given as sum of the corrected voltage drop V'_{ai} long a transmission path. The TPSI is given by

TPSI = 0.5 $V_g - \Delta V'_a$

Where V_g is generator voltage phasor magnitude and V'_a is sum of corrected voltage drops along a transmission path. A transmission path is a sequence of various connected buses. A bus or line segment is one that joins two continuous nodes.An active power transmission path (APTP) is defined as a sequence of connected buses with declining phase angles starting from a generator bus. Similarly, reactive power transmission path (RPTP) is defined as a sequence of connected buses with reducing voltage magnitudes, again starting from a generator bus. When the value of TPSI index reaches zero, the power transfer on that transmission path becomes unstable due to voltage collapse.

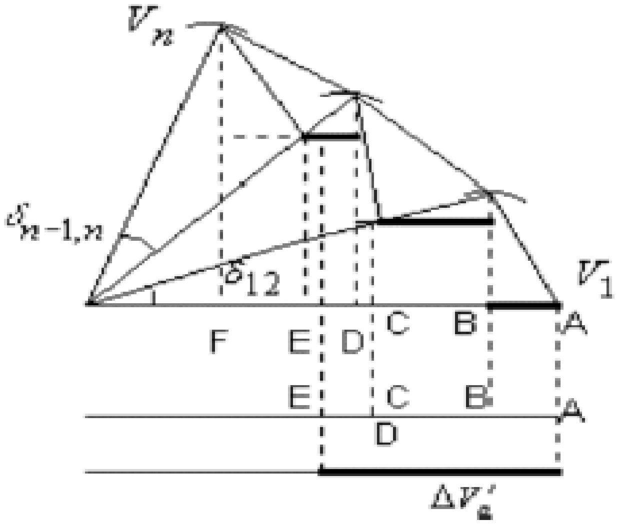

Figure 1: Voltage drop projections and sum of corrected voltage drop segments along the transmission path.

The voltage collapse proximity index is defined as minimum TPSI value of APTPs and RPTPs. A minimum TPSI value for APTP or RPTP indicates a voltage instability problem that is due to active power or reactive power loading, respectively. The VPA does not utilize Jacobean elements for the calculation of indices as in LFI method.

V. PROPOSED PLACEMENT STRATEGY

The LFI method [1] identifies the critical lines instead of critical buses whereas VPA identifies the critical transmission paths but not the critical segments. Hence, there is a need for modification in the VPA approach for identification of the critical segments. A close examination of VPA reveals that critical path identification is dependent on corrected voltage drop along a line segment. Hence, intuitively, the segment experiencing the maximum corrected voltage drop in the critical path may be construed as the best location for placing a FACTS controller. Thishypothesis is examined for various systems of different sizes at base case and maximum loading conditions (up to no convergence of load flow). Studies performed reveal that this hypothesis works accurately in all systems at different loading conditions. This hypothesis is now termed as extended voltage phasors approach (EVPA).

VI. CONCLUSION

The proper location of FACTS devices is imperative in the power system as these devices involve huge costs and optimal location of these devices will give the optimal use of the devices as well the optimal operation of the power system. As the most of the methods are sensitivity based like in security enhancement power flow sensitivity indices and in reactive power dispatch loss coefficients are used, the new method of voltage phasor approach gives the easy way to locate the optimal location of the FACTS devices and it involves less computational time as we generally have the voltage measurements of almost all the buses in the power system. This new method is quite easy to implement and to get the results. The new techniques for the power transfer capability is also helpful in the way that it also takes care of the change in the generation policies along with the implementation of FACTS devices. For controlling more than one variable the multi-objective optimization or the decomposition methods can be used which is still the area of interest for power system engineers.

REFERENCES

[1] Nikhleshkumar Sharma, Arindamghosh, Rajiv varma, “A novel placement strategy for Facts controllers” IEEE transaction on power delivery, vol. 18. No.3, July 2003.

[2] B.T. Ooi, M. Kazerani, R. Marceau, Z. Wolanski, F.D. Galiana, D. McGills, D. Joos, “Mid-point siting of FACTS devices in transmission lines”, IEEE transaction on power delivery,Vol .12, No. 4, October 1997.

[3] Rajiv K. Varma, “Introduction to FACTS Controllers”,IEEE 200

[4] M.H. Haque , “Optimal location of shunt FACTS devices in long transmission lines”, IEE Proc-Gener. Transm. Distrib., Vol. 147, No. 4, July 2000.

[5] BelkacemMahdad, TarekBouktir, KamelSrairi, “Strategy of location and control of FACTS devices for enhancing power quality”, IEEE MELECON, pp 1068-1072, May 2006.

[6] S.N. Singh, “Location of FACTS devices for enhancing power system’s security”, pp: 162-166, IEEE 2001.

[7] K.S. Verma, S.N. Singh and H.O. Gupta, “FACTS devices location for enhancement of total transfer capability”, pp: 522-527, IEEE 2001.

[8] D. Thukaran, Abraham Lomi, “Selection of static VAR compensator location and size for system voltage stability improvement”, Electric Power System Research 54, pp: 139-150, 2000.

[9] Narain G. Hingorani, Laszlo Gyugyi, “Understating FACTS Concepts and Technology of Flexible AC Transmission systems”, IEEE Press, 2000.