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Application Study of FACTS Devices in Indian Power System

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Abstract - Flexible AC Transmission System (FACTS) is an emerging technology which improve power transfer scenario around the world. It improves the power transfer capability of existing transmission system with enhances reliability and security of the system. Also achieve better controllability with stability in power transmission networks. In place of building new transmission line, installing FACTS devices in existing networks is more economical. Due to these advantages, FACTS technology is now adopted by many countries like Brazil, China, India etc.. Installing of FACTS devices in developing nation like India where power demand rate is very high and increasing constantly, is very helpful to improve transmission system with great economy. In this paper, a comprehensive survey of FACTS installations and study of proposed installation of FACTS devices in different part of India by PGCIL or various state electricity boards is done. The paper gives detail of installed FACTS project, project performance and proposed studies within India.

Keywords **- FACTS, STATCOM, TCSC, FCTCSC, FSC.**

1. Introduction

In today's world, the demand of electricity is growing rapidly. So need to strengthen power transmission capability by improving power transfer capacity of existing network or by installing new transmission networks. Building of new transmission networks is time consuming process and requires bulky investment. In developing nation like India where funds are limited generally avoid this practice. Under Indian circumstances, it is important to better utilization of existing transmission systems as efficiently as possible, to increase both the capacity and the quality of transmission networks through various methods with minimum investment. Problems arising from delays or difficulty to add new transmission system could be partially or completely overcome by increasing the flexibility of the existing network [4,5,6]. Installation of FACTS device in existing transmission network is an alternative way to strengthen power transmission capability. FACTS are power electronic based technology which help to increase the power transfer capacity and enhances controllability in ac transmission system. FACTS devices can be connected to a transmission networks in many ways, such as in series, shunt, or a combination of series and shunt. Like, thyristor controlled series capacitor (TCSC) and static synchronous series compensator (SSSC) are connected in series; the static VAR compensator (SVC) and static synchronous compensator (STATCOM) are connected in shunt are connected in series and unified power flow controller (UPFC) are connected in a series and shunt combination [4]. Series FACTS devices increase stability and Shunt FACTS devices provide reactive power compensation.

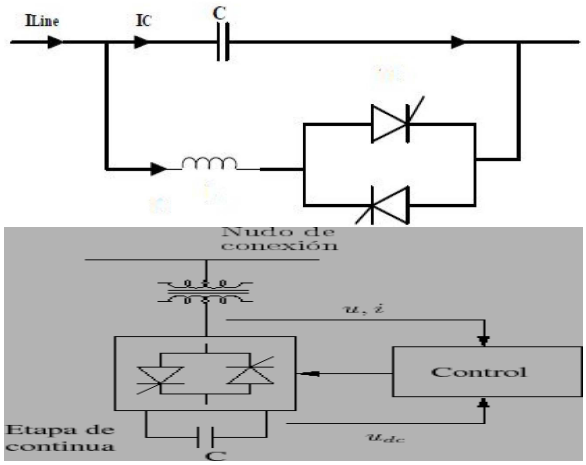

Figure 1

2. World Scenario

The world's first SVC for utility application was installed by General Electric (GE) at Nebraska, North America in 1974.Further some installation of FACTS devices in America are, TCSC rating of 202 MVAR at Slatt 500 KV Substation of Bonneville Power Administration in Oregon [5], STATCOM rating of +/- 100 MVAR at 161 kV Sullivan Substation of Tennessee Valley Authority installed in 1995, UPFC rating of +/- 320 MVAR by American Electric Power Company at 138 kV Inez

Substation (Kentucky) for controlling voltage, line impedance and phase angle [5]. IPFC at 345 kV Marcy Sub-station of New York Power Authority [5].

3. Indian Scenario

In India FACTS has received much attention in the last 2 decades. The first FACTS device installed in India is Thyristor Controlled Series Capacitor (TCSC) with Fixed Series Compensation (FSC) at 400 kV transmission line between Kanpur (U.P) and Ballabgarh (Haryana) in the Northern Grid [5]. Some more existing FACTS project which work successfully in India are, Ranchi-Sipat 400 kV D/C , 376 Km transmission line with 40% FSC at Ranchi end, Raipur-Rourkela 400 kV, D/C ,412 Km transmission line with FSC-TCSC installed at Raipur end [6]. FSC-TCSC installed at Kalpakam-Khammam 400 kV, D/C, 364 Km transmission line in Andra Pradesh [7].

4. Detail Survey of Existing FACTS Devices in India

A.Case-1

A 3 phase 400 kV, 364 km long transmission system between Kalpakam and Khammam in Andhra Pradesh. This transmission line takes 50% Series Compensation [7]. Out of which 30% is provided for fixed compensation and remaining 20 % is for TCSC device. Data are collected from APTRANSCO [7].

This system show more improved and controlled operation after the installation of FC –TCSC under various loading conditions.

The system is design for (i) line without compensation (ii) line with Fixed series compensation and (iii) line with Fixed Capacitance and TCSC [7]. The cost of implementing FC-TCSC are not negligible but after installing FC-TCSC we get much improved result and controlled output which justify the implementation of this device.

B. Case-II

Another FC-TCSC are installed at 3 phase 400 kV, 412 km double circuit transmission system between Raipur and Raurkela to transfer surplus power from eastern grid to western grid and also provide back up support for eastern region to southern region in case of contingency of one pole outage of Talcher- Kolar HVDC Bipole[6]. So this is very strategic location for implementing FACTS devices.

Raipur –Rourkela is the important link connecting eastern region to southern region through HVDC Back to Back Bhadravati station.

After the implementation of FC-TCSC some faults are occurred result in sudden inrush of power causes power oscillation which is damped out by TCSC [6] and the system become more stable and gives more controlled output.

5. Proposed FACTS Project in India

A. Proposed STATCOM project in India are as follow [1]:-

State	Location S/s	v/g level	MVAR Rating	Estimated Cost (Cr.)
Maharashtra	Vita/Pandharpur S/s	220kV	(+)50 /(-) 100	57.75
J&K	Budgam S/s	220kV	(+)125 /(-)25	57.75*2
	Udhampur			
Tamil Nadu	Theni S/s	220kV	(+)100 /(-)50	57.75*3
	Kodikuruchi			
	Udaythu			
Andhra Pradesh	Urvakonda	220kV	(+)100 /(-)100	57.75
Karnataka	Chitradurga	220kV	(+)50 /(-)100	57.75
Rajasthan	Tinwari S/s	220kV	(+)50 /(-)100	57.75
Gujarat	Radhanpur	220kV	(+)50 /(-)100	57.75

Total Estimated Cost- Rs. 704 Cr.

The total estimated cost of Statcom project is Rs 704 Crore and it will plan located in different parts of India from north to south. Its cost as well as its rating in comparison with SVC is less. Although both are Shunt devices used for reactive power compensation and increase power transfer capacity.

B. Proposed Bus reactors (Switchable/ Controlled reactor) project in India are as follow:-

State	Location S/s	v/g level	MVAR Rating	Total No.
Tamil Nadu	Tappagndu & Rasipalayam	420kV	1x150	2
	Salem & Hosur	420kV	1x125	2
Andhra Pradesh	Kondapur	420kV	1x150	1
	Hindupur	420kV	1x125	1
Maharashtra	Dondaicha/Dhule - STU	220kV	l1x50/25	1
	Alkud (MSETCL)	420kV	l1x150	1
	Kolhapur S/s	765kV	l1x240	1
Gujrat	Motipaneli,Bhatia, Bachau, Deodhar & Nakhtarna	220kV	1x25/1x50	5
	Solar Park-II	420kV	l1x150	1
Karnataka	Davangiri & Hiriyur	420kV	l1x150	2
	Narendra S/s	765kV	1x240	1
Rajasthan	Jaipur, Merta, Ramgarh	420kV	1x125	3
	Bhadla, Akal, Bikaner, Jaisalmer	420kV	1x150	4

6. Proposed FACTS Project in India

C.Proposed SVC project in India are as follow [1]:-

In comparison with other FACTS devices SVC is the costliest device and it will only installed only in a two location in India . Also its MVAR Rating is too high in comparison with other FACTS devices.

State	Location S/s	v/g level	MVAR Rating	Estimated Cost (Cr.)
Maharshtra	Kolhpur(PG) S/s	400kV	(+)400 /(-)300	211.75
Tamilnadu	Udumalpet S/s:	400kV	(+)400 /(-)300	211.75

7. Conclusion

In developing nation like India, power demand in near future is very high and to meet this increased power demand; not only installed capacity has to be increased but also transmission network to be strengthened. With the installation of Fixed Series Capacitor with TCSC improve dynamic performance under various contingencies of operation and may avoid disintegration of grid as faced a number of times in the past. Under Indian circumstances, it is important to utilize existing systems as efficiently as possible, to increase both the capacity and the quality of present transmission networks, even if for limited period, through various innovative methods with minimum investment.

References

[1] Transmission Plan for Envisaged Renewable Capacity. a Report, Vol-I, Power Grid Corporation of India Ltd., July, 2012.

[2] Transmission Plan for Envisaged Renewable Capacity. a Report, Vol-II, Power Grid Corporation of India Ltd., July, 2012.

[3] *Role of HVDC and FACTS in future Power Systems*. W. Breuer, D. Povh, D. Retzmann, E. Teltsch. X. Lei. Siemens AG, Germany. XJ Group, China.

[4] Understanding FACTS. Concepts and Technology of Flexible AC Transmission Systems, Narain G.Hingorani & Laszlo Gyugyi.

[5] Application of FACTS in Indian Power System. Subrata Mukhopadhyay, Senior Member, IEEE, Ashok K. Tripathy, Senior Member, IEEE, V.K.Prasher, and Krishan K.Arya.

[6] Improvement of Transmission Performance Using Some FACTS Device. Rashmi Singh, Manish Kumar, Sheetal Deshmukh, Sourbh Mahakalkar, K.D Joshi, Senior Professor, Department of Electrical Engineering, GHRCE Nagpur.

[7] Implementing TCSC Device in Kalpakam-Khammam Line for Power Flow Enhancement. G. V. T. Prudhvira, Raghu, S. Meikandasivam and D. Vijayakumar, 2013 International Conference on Circuits, Power and Computing Technolog ies [ICCPCT-2013]

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