Optimal Location of Thyristor Controlled Series Compensator (TCSC) to Maximize the Loss Reduction in Power System

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Abstract—Flexible Alternating Current Transmission Systems (FACTS) devices represent a recent technological development in electrical power systems. FACTS devices offer so many advantages like transient stability improvement, sub-synchronous resonance (SSR) mitigation, damping of power swings, avoiding voltage collapse, enhancing power system reliability, minimize the loss in power system. Though FACTS controllers offer many advantages, their installation cost is very high. Hence the optimal placement and the optimal parameter settings of these devices in the power system are of important issues. In this paper analytical method is proposed to find optimal location and optimal parameter setting considering power loss minimization in power system. The proposed method is carried out on IEEE-14bus power system.

Keywords: Flexible Alternating Current Transmission Systems (FACTS) Thyristor controlled series capacitor (TCSC)

I. INTRODUCTION

In modern era due to industrial and commercial development and up gradation of standard of leaving, the load demand is increasing day by day and generation level is not increasing up to the level of load. Due to deregulated market environment in power system, there is a competition. There are numbers of operating problems related to power system. Examples of operating problems to which unregulated power flows may give rise are: loss of system stability, power flow loops, high transmission losses, voltage limit violations, an inability to utilize transmission line capability up to the thermal limit, and cascade tripping. [1] Power system problems have been traditionally solved by building new power plants and transmission lines, install a new transformer and /or upgrade system component, a Solution that is costly to implement and that involves long construction times. To solve these Problems, FACTS technology was proposed. FACTS device is a fast acting and self-commutated power electronics convertor introduced in 1988 by Hingorani [2]

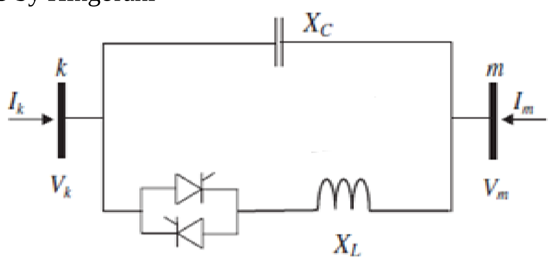

Fig. 1: TCSC diagram

Thyristor controlled series capacitor (TCSC) is one of the most important FACTS devices that provide smooth and flexible control of line impedance, which offers to minimize loss in power system. Fig 1 is a schematic representation of TCSC. In TCSC branch of capacitor is connected in parallel with series connection of anti-parallel thyristor with inductor. [3]

II. MODELING OF TCSC

A. *Variable Series Impedance Power Flow Model:*

The TCSC power flow model has been described in this paper is based on the simple concept of a variable series reactance, the value of which is adjusted automatically to constrain the power-flow across the branch to a specified value. The changed reactance would give the resultant effect as either inductive or capacitive zone. [4]

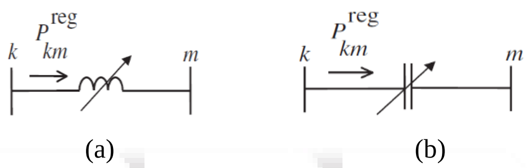

Fig. 2: TCSC Model as variable impedance (a) Reactor (b) Capacitor

TCSC are connected in series with the lines. The effect of TCSC on network can be seen as controllable reactance inserted in related transmission line, that compensate reactance of line .It may have one of two characteristics; capacitive, inductive

III. SIMULATION RESULTS

The power-flow analysis has been done by Newton-Raphson method using MATLAB code. It has been executed by programming using MATLAB code for IEEE 14-bus system.

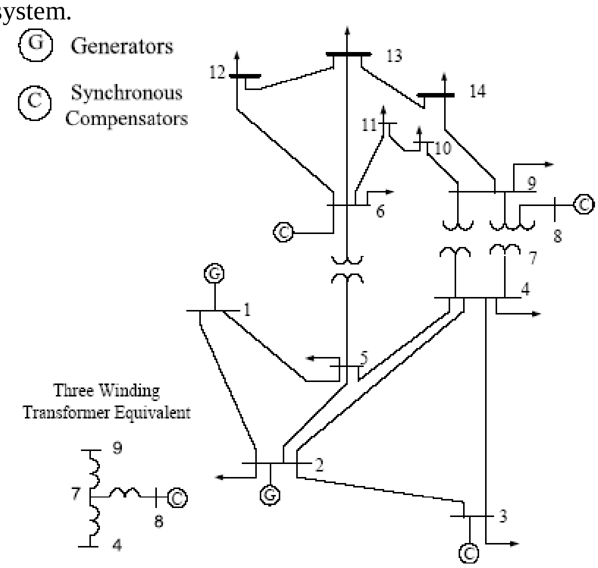

Fig. 3: IEEE-14 bus system

The location and the reactance of the TCSC were considered as variables to reduce the system losses. Therefore, the TCSC is modelled for the load flow computation like a controllable reactance inserted in the system branch, which can increase or decrease the line reactance. The working reactance range of the TCSC is considered to be [$-0.5X_L$ to $0.5 X_L$]. [5]

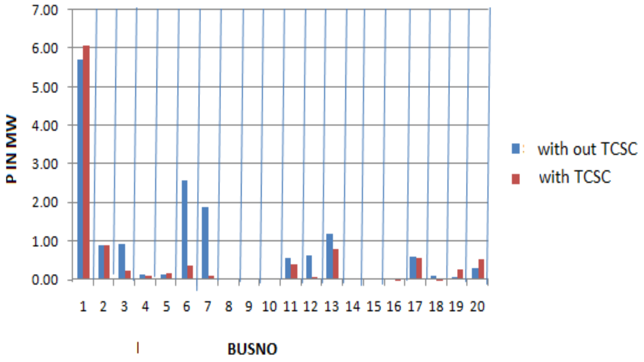

Fig. 4 : Active power loss without and with TCSC

Branch	Form bus	To bus	P loss without TCSC(MW)	P loss with TCSC(MW)
1	1	2	5.71	6.09
2	1	5	0.87	0.87
3	2	3	0.93	0.24
4	2	4	0.12	0.09
5	2	5	0.12	0.16
6	3	4	2.56	0.34
7	4	5	1.86	0.09
8	4	7	0.00	0.00
9	4	9	0.00	0.00
10	5	6	0.00	0.00
11	6	11	0.56	0.38
12	6	12	0.62	0.05
13	6	13	1.19	0.77
14	7	8	0.00	0.00
15	7	9	0.00	0.00
16	9	10	0.01	0.00
17	9	14	0.58	0.54
18	10	11	0.08	0.00
19	12	13	0.06	0.27
20	13	14	0.30	0.51
Total Losses			**15.57**	**10.42**

Table. 1: Comparison of Active Power Loss without and With TCSC

Simulation result shows that the optimal location of TCSC in the system is in branch no 3(from bus 2 to bus 3) and TCSC reactance X_{tcsc} = 0.039594

Fig 4 shows active power loss without and with TCSC. Table 1 shows simulation results.

IV. CONCLUSION

This paper has presented analytical method to optimally locate TCSC using Newton –Raphson algorithm for loss minimization in power system .TCSC'S reactance is taken to be the state variable .By varying TCSC reactance loss minimization is achieved. By incorporating TCSC in branch 3 total active power losses reduced from 15.57 MW to 10.42 MW in power system

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