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Simulation of TCSC controller for power factor improvement using MATLAB Simulink

Kapadia Mohmedhusein[1], Hardik Mistry[2], Vivek Nai[3],Doodhwala Mubashshir[4],Adil Kazi[5]

[12345]Department of Electrical Engineering, Shroff S. R. Rotary Institute of Chemical Technology, Ankleshwar, India

Abstract:

The industrial power demands increases day by day. As we know that 80 % load of industry is motor which required reactive power. Hence reactive power compensation and power factor improvement is required. This research paper presents power factor improvement by TCSC controller. Here for different value of firing angle resultant power factor is tabulated and simulated using MATLAB Simulink.

Keywords **—FACTS, MATLAB, TCSC, Venier.**

I. Introduction

After the restructuring of the power system to improve the performance of the power system power electronics controller facts devices are used for alternative current transmission line. To stabilize the complex power system in terms of transient stability improved voltage profile in large complex system facts devices installed in network. Transmission line congestion is one of most major difficulties in the operation of restructured power systems. Now a day demand of power system is increased as well as generation of power also increase but it is not possible to develop new transmission line to feed the power from generation to load due to cost constrain and environmental condition. In order to avoid huge investment on generating and transmission system together, improving the operating performance facts are used [1] [2]. Flexible alternating current transmission systems are capability of various electrical parameters in transmission circuits. Facts devices used in thyristor controlled series compensator, static VAR compensator (SVC), Thyristor controlled phase angle regulator (TCPAR), static compensator (STATCOM), unified power flow controller etc. FACTS devices have been mainly used voltagestability, power flow control and transfer capability enhancement for power system. TCSC is the important member of facts. It is applied to utility long transmission lines in the modern power system. It is use the operation and control of power flow decreasing unsymmetrical components, reducing net loss, providing voltage support, limiting short circuit currents, Mitigating sub synchronous resonance, damping the power oscillation and enhancing transient stability.[5][12][13]

FACTS help us to less difficulty by enblinding to get the most transmission facility and enhance grid reliability. In advance technology is paramount for the reliable and secure operation of power system. To achieve the secured and reliable operation advance control technology i.e. facts are used. Facts technology provides advance solutions as cost effective alternative to new transmission line construction. Facts technology allows for improved transmission system operation with minimum infrastructure investment, environment impact and implementation time compare to the construction of new transmission line.[15]

II. Series compensation

FACTS controllers can be broadly divided into four categories, which include series controllers, shunt controllers, combined series-series controllers, and combined series-shunt controllers.. to control the series impedance A series controller is mainly used in line by including the capacitive effect which is contract to the inductive effect of the transmission line[10].

The reduction of the series impedance of the transmission line effects on the voltage drop across the line i.e the voltage at the receiving buses may improve because of the reduction of the series impedance. The overall losses of the system may also reduce with the control of the series impedance of the transmission line.[11]
The reactive losses of the system are majorly effect with the change of impedance of the transmission line. With the increase of the voltage profile also it may conclude that the reactive power losses of the system reduce. The basic series compensating device without controlling parameter is series capacitance. The scope of control ability of the series Capacitance can be increased by including power semiconductor devices which is called Thyristor Controlled Series Capacitor (TCSC).[18][21].

III. TCSC- Thyristor Controlled Series Capacitor:-

TCSC - Thyristor Controlled Series Capacitor compensator consisting of the series compensating capacitor, whereto is parallel connected thyristors controlled reactor (TCR), and it is one of FACTS devices which are mainly used to control active power flow in power system and increase the transmission power lines capacity. TCSC is the combination of Thyristor control reactor and capacitor. It is controlled capacitance reactance.[17][20]
Capacitor bank C, bypass inductor L and bidirectional thyristors are main three components of TCSC. TCSC is costly device. It is find to optimal size and location in power system so this device maximum benefit be achieved.[3][5]TCSC is involved in a series to line and allows changing impedance of the transmission line and effect on flows of power. Control is fast, efficient and increased between the transmitted powers. Basic scheme of TCSC device is shown in the follows figure

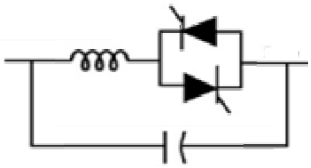

Figure A:- TCSC controller

So the basic idea behind the TCSC system is provide continuously variable impedance by means of partially cancelling the effective compensating capacitance by the means of TCR. So the transmission line compensating by means of TCSC can used to increase the power transfer capability improve transient stability, reduce transmission losses. The design criteria to find the value for inductor and capacitor for TCSC depends on the net reactance of the transmission line and on the power flow through the line [6][7][8][9].

IV. Operation of TCSC:-

TCSC is one of the popular series FACTS controllers. It has been in use for many years to increase line power transfer as well as to enhance system stability.[16] The firing angles of the thyristors are controlled to adjust the TCSC reactance in accordance with a system control algorithm, normally in response to some system parameter variations. There are mainly three modes of operation of TCSC:-

A. Mode I. Thyristor switched reactor mode:

The thyristor is gated for 180°. The susceptance of the reactor is greater than capacitor. Most of the line current passes through reactor and thyristor valves. For protection of capacitor against overvoltage, this mode is used. [4]

B. Mode 2 Waiting Mode:

No current pass through valves and gate pulses are blocked. The reactance 0f TCSC and fixed capacitor is similar. That's why this mode is awaited mostly. [4]

C. Mode 3 Vernier mode:

Here the thyristor valves are operated by two gate pulses in the two region i.e. capacitive Vernier region ($\alpha_{min} < \alpha < 90$) and inductive Vernier region is reduce to 180°. Vernier operation the natural characteristic of the series capacitor of compensated line cannot change by bypassing the series capacitor and high degree of compensation can cause sub synchronous Oscillations. [4]

V. Simulation and Result:-

We made simulation of open loop control of TCSC controller for a case study:-

Data(Case Study):-

The problem is as follow:-

Vs=230 V

Rload=100 ohm

Xload=102 ohm

PF of load=0.7

C of TCSC = 40 microF

L of TCSC = 0.1274 H

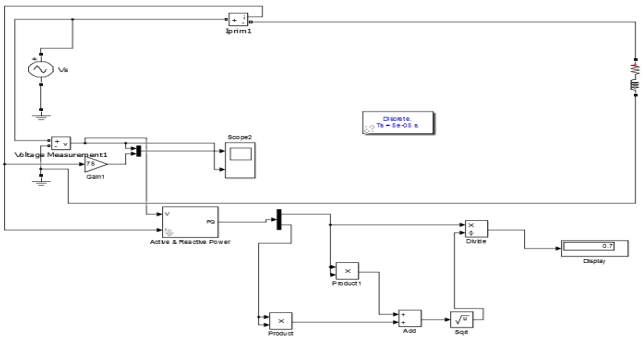

Figure B:-Simulation Model of problem

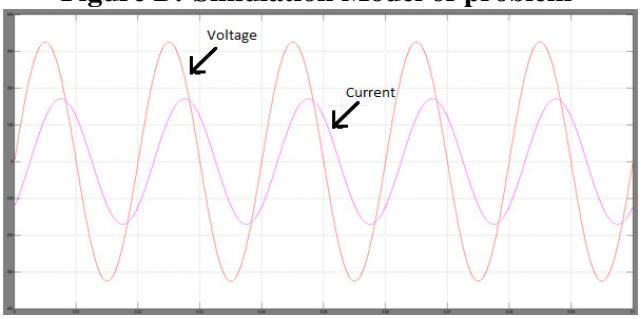

Figure C:-Waveforms of V& I of load

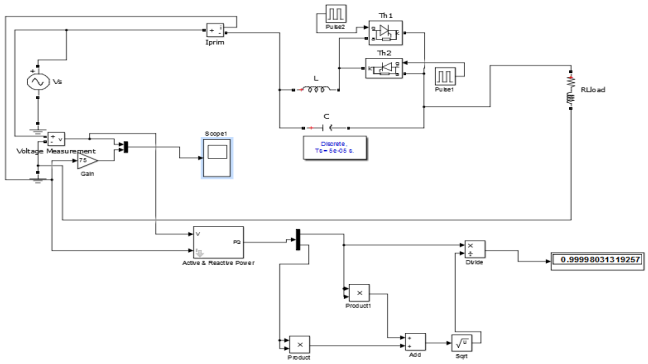

Figure D:-Simulation Model using TCSC

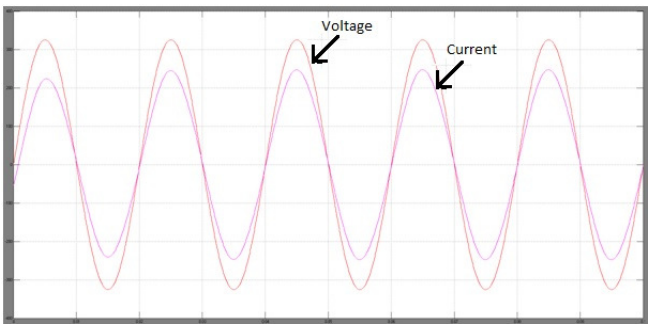

Figure E:-Waveforms of V& I after application of TCSC

Results:-

Firing angle of TCSC	Power factor	Remarks
0°	0.7879	Lag
10°	0.8703	Lag
20°	0.9279	Lag
30°	0.968	Lag
40°	0.9913	Lag
50°	0.9998	Lag
53°	0.9999	Lag
60°	0.9973	Lead
70°	0.9889	Lead
80°	0.9801	Lead
90°	0.9749	Lead

VI. Conclusion:-

The power factor is 0.7 lagging which is improves up to 0.9999 leading by using TCSC controller.

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