International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 07, July 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Improvement of Real Power Flow Control inTransmission System Using TCSC

Pooja P.Raut[1], M. Venkateswara Reddy[2]

[1,2]*Electrical Engineering, R H Sapat College, Pune university, (India)*

ABSTRACT

Interconnected transmission system provides a widescope for power sharing thereby avoiding chances of overloading in transmission lines. But this can be achieved only with proper control on the transmission network.[1] To improve the real power flow in the transmission lines by varying the reactance of transmission line. Real power flow can be control with the SSC but the capacitor is of fixed value so the smooth variation in reactance cannot be achieved. TCSC can be used to have a smooth and controllable reactance of transmission line. Control of TCSC by varying the firing angle is simulated using MATLAB. A hardware implementation of TCSC to analyses the power flow control is developed in a 2-bus system.

Keywords: FACTS, Power Flow Control, Reactance Control,TCSC.

I. INTRODUCTION

Modern electric power utilities are facing many challenges due to ever-increasing complexity in their operation and structure. In the recent past, one of the problems that got wide attention is the power system instabilities. With the lack of new generation and transmission facilities and over exploitation of the existing facilities geared by increase in load demand make these types of problems more imminent in modern power systems. Demand of electrical power is continuously rising at a very high rate due to rapid industrial development. To meet this demand, it is essential to raise the transmitted power along with the existing transmission facilities. The need for the power flow control in electrical power systems is thus evident with the increased loading of transmission lines. The power system should adapt to momentary system conditions, in other words, power system should be flexible [11].

The widespread use of electronic equipment, such as information technology equipment, power electronics such as variable speed drives, programmable logic controllers, and energy efficient lighting LED, static rectifier, converters to a complete change of electric loads nature .So to improve the voltage profile, stability of system, enhancement of power quality and reliability of power etc. the various flexible alternating current transmission system are come in electrical network. The FACTS based application of power electronic devices effective for the power distribution systems to enhance the quality of power fed to the consumers. The cores of FACTS technology consist of high power electronics, a variety of thyristor devices, micro-electronics, communications and advanced control actions. By FACTS, operator governs the phase angle, the voltage profile at certain buses and line impedance. Power flow is controlled and it flows by the control actions by the use of FACTS devices, which contain (i) Static VAR Compensators, (ii) Thyristor Controlled Series Capacitors, (iii) Static Compensators, (iv) Static Series Synchronous Compensators, etc.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

II. FACT S

Flexible AC Transmission Systems (FACTS) are the name given to the application of power electronics devices to control the power flows and other quantities in power systems.

Basic Types of FACT'S Controllers

In general, FACTS Controllers can be divided into four categories:

1. Series Controllers
2. Shunt Controllers
3. Combined series-series Controllers
4. Combined series-shunt Controller

III. CLASSIFICATION OF FACTs DEVICES

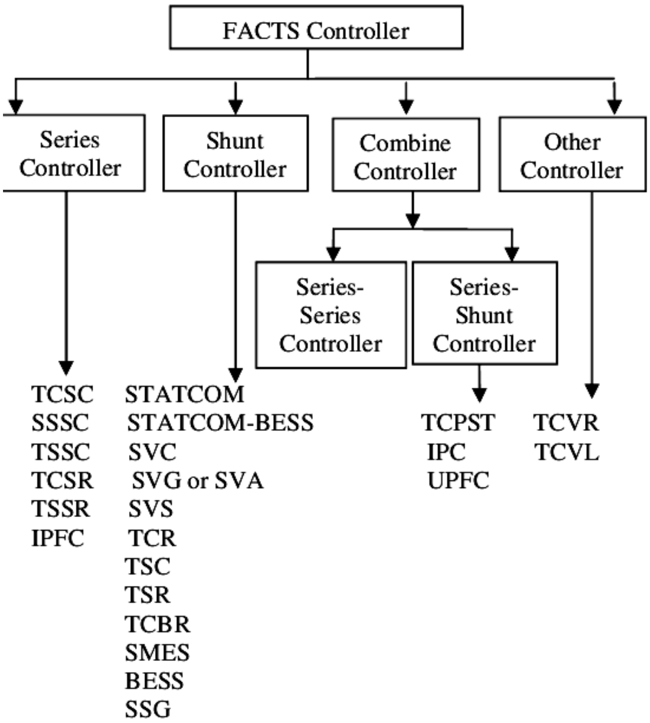


Fig 1.Classification of FACTs Devices

IV. TCSC

A capacitive reactance compensator which consists of series capacitor bank shunted by a thyristor controlled reactor in order to provide a smoothly variable series capacitive reactance. [9]

TCSC as one of the most attractive FACTS technology which offers fast, smooth, and flexible control of the line impedance in transmission line. TCSC is used to provide various benefits to the power systems including transient stability improvement, Sub-Synchronous Resonance (SSR) mitigation, power swings damping and fault reduction etc. The objective of TCSC is to control the real power flow in the transmission line. It can be achieved by varying and controlling the reactance of the transmission line. FACTS devices like TCSC can be used to provide a smooth variation in reactance. TCSC is connected in series with transmission line and the firing angle of the TCSC module is varied or controlled to achieve a smooth variation in power flow.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 07, July 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

V.OPERATION OF TCSC

TCSC falls under category of series controller. TCSC is composed of a fixed capacitor (FC) in parallel with a Thyristor Controlled Reactor (TCR). The switching element of the TCR consists of two anti-parallel thyristors, which alternate their switching at the supply frequency. The system is controlled by varying the firing angle of the thyristor firing pulses relative to the crest of the capacitor voltage. Fig. 2 shows the circuit diagram of TCSC.

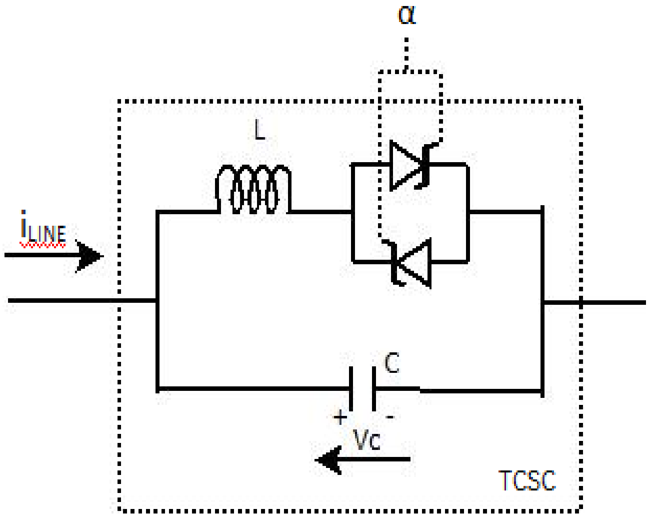


Fig 2. TCSC Circuit diagram [1]

5.1 Modes of Operation:

1. Blocking Mode –In this mode, they are not triggered thus opening inductive branch. In such actually operate as fixed series capacitor.
2. Bypass Mode-In this mode they are actually ON. In such mode thyristor & capacitor are parallel help in reducing current through TCSC.
3. Boost Mode-In this mode, thyristor are triggered slightly before capacitor voltage reaches or crosses zero. Thus, allowing current to flow through inductive branch addition to capacitive current

VI. RESULT AND DISCUSSION

Fig 3 shows the simulation diagram of 2 bus system. It consists of TCSC, control circuit, firing circuit.

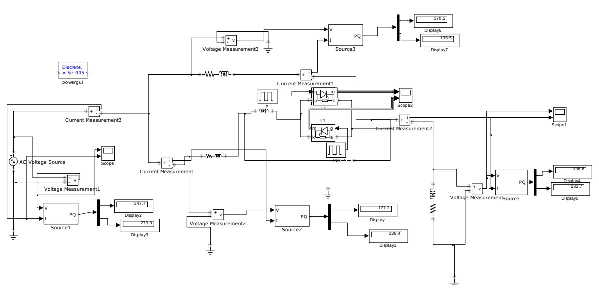


Fig 3 Simulation of 2 bus system

Fig 3 Shows the Single Phase with TCSC Simulink model. It consist of single phase 230V connected to the two transmission lines with the TCSC model. The single phase 230V supply has taken at load end. RL type of load is connected to the system. We are generating the pulses by comparing reference voltage and load voltage. The

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

simulation is done with the 10 % compensation in system. It is clear that power at receiving end is compensated and the source side power is almost same as at receiving end

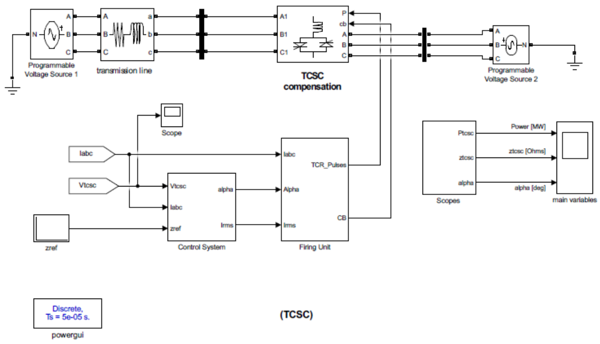
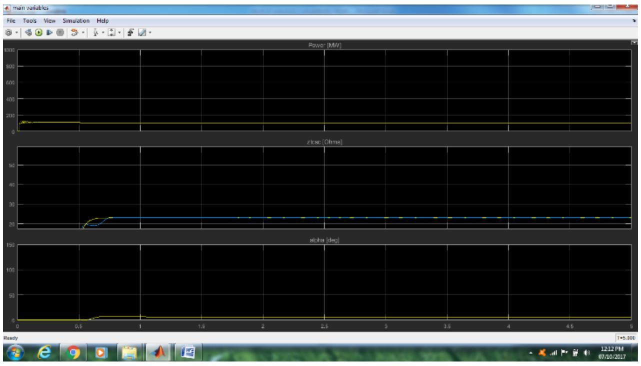


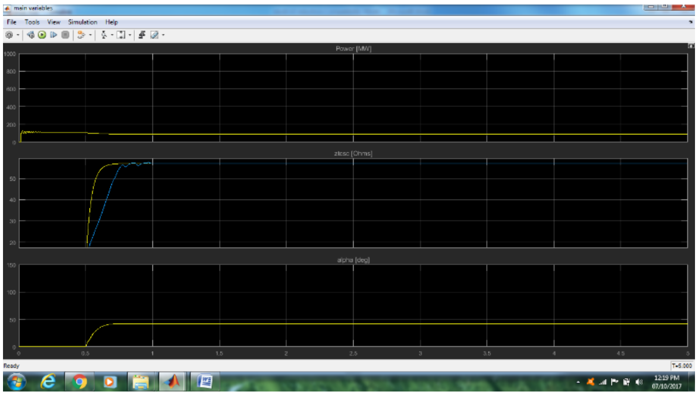
Fig 4 Simulation three phase model

Fig 4 shows the simulation model of three phase model. It consists of a firing unit, control system programmable voltage sources and TCSC. TCSC is connected after a transmission line and the power transfer is seen at the scopes. The model can be operated in inductive either capacitive mode.

Results of Inductive mode：



Impedance=23 ohm



Impedance=57 ohm

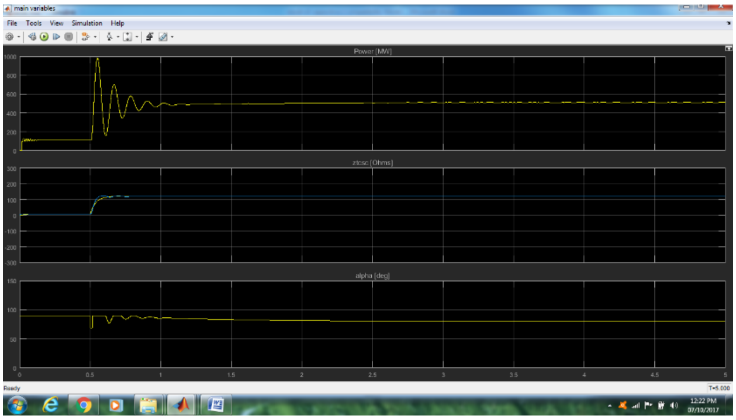
Fig 5 Results of inductive mode

Fig 5 shows the results of inductive mode. It shows result at various impedance values. It shows graphs of power in MW, impedance of TCSC and alpha i.e the firing angle. The firing angle is set at 0.5 sec. From 0-0.5

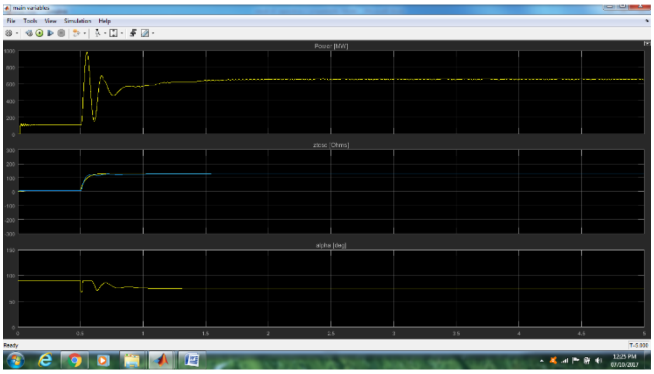
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

sec power is not constant it varies at 0.5 sec the impedance of TCSC is increased and the power transfer is constant. As the impedance is increased the power transfer is low and constant in inductive mode.

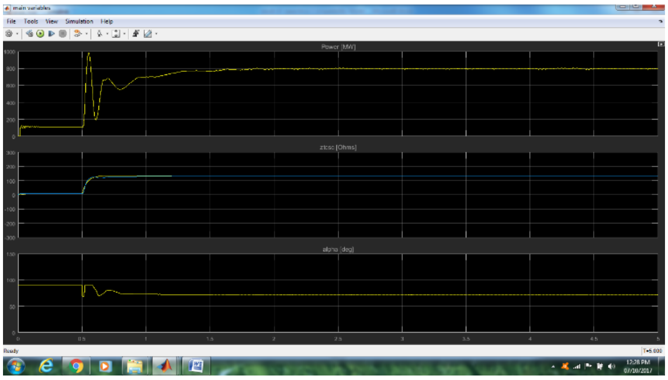
Results of Capacitive mode：



Impedance=122 ohm



Impedance=130 ohm



Impedance=135 ohm

Fig 6 Results of capacitive mode

Fig 6 shows the results of Capacitve mode. It shows result oat various impedance values. It shows waveforms of power in MW, impedance of TCSC and alpha i.e the firing angle. The firing angle is set at 0.5 sec. From 0-0.5 sec power is constant it varies at 0.5 sec the impedance of TCSC is increased and the power transfer is constant. As the impedance is increased the power transfer is increased and constant in capacitive mode.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

VII. HARDWARE

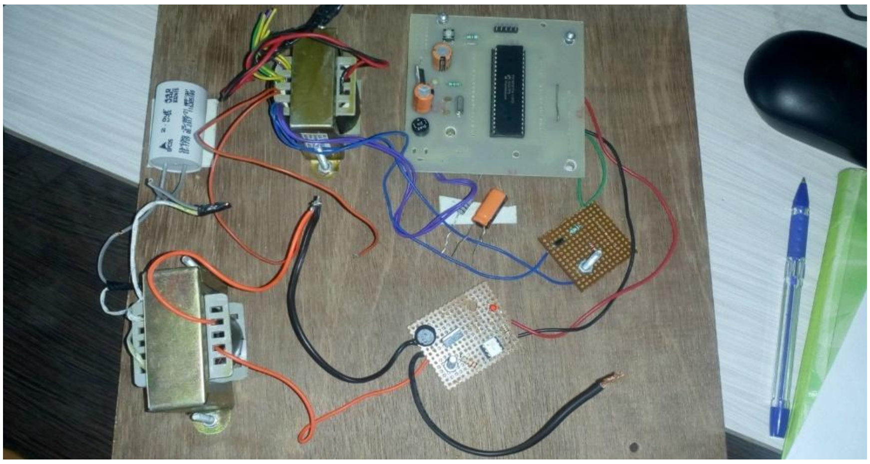


Fig 7 Hardware Diagram

The figure 7 shows the overall diagram of hardware. It consists of injection transformer, ZCD circuit, TCSC circuit having a inductor and capacitor and TRIAC is used for triggering.

Fig. 8 Capacitor voltage in inductive region

The figure 8 shows the output of Capacitor voltage in inductive region waveforms.

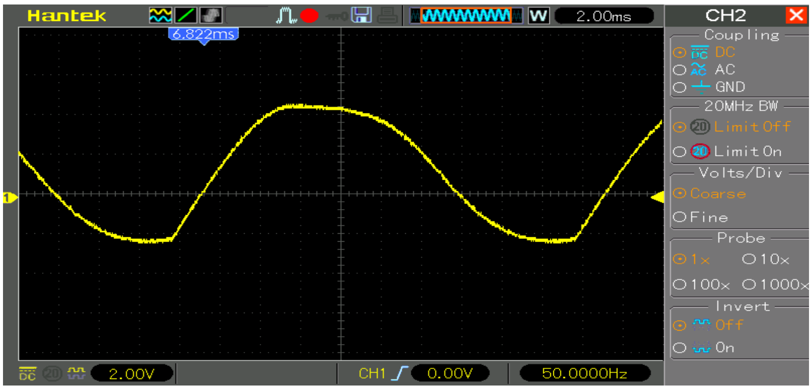


Fig 9 Capacitor voltage in capacitive region

The figure 9 shows the output of Capacitor voltage in capacitive region waveforms

VIII.CONCLUSION

TCSC can be used to improve the power flow intransmission network. In an interconnected system this devicealso helps in power sharing between transmission lines. Operation of TCSC in both inductive and

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

capacitivemode is explain. The results shows that the over flow reduces in inductive mode and increases in capacitive mode as the impedance is varied.. Thususing TCSC ensures a smooth control ofpower flow in transmission line over a wide range.Also an improvement in the efficiency and voltage regulation of transmission line.TCSC is more effective than other compensating techniques such as mechanical switching capacitors and synchronous condensers.

REFERENCES

[1.] K. Manjusha, S. Balamurugan, N. Kirthika, “Real Power Flow Control in Transmission System using TCSC”, Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE), 2016 IEEE.

[2.] Priyanka Kathal, ArtiBhandakkar, “Power Flow Control in PowerSystem using FACT Device Thyristor Controlled Series Capacitor (TCSC): A Review”, International Journal of Science and Research (IJSR),Vol.2, Issue 3, March 2013.

[3.] N.G. Hingorani and L. Gyugyi, Understanding FACTS, IEEE Press, New York, USA, 1999.

[4.] Zellagui Mohamed, ChaghiAbdelaziz, “Impact of Series Compensation Insertion in Double HV Transmission Line on the Settings of DistanceProtection”, International Journal of Scientific & Engineering Research, ISSN 2229-5518, Vol.2, Issue 8, August-2011.

[5.] D. Chatterjee, A. Mitra, S. Sarkar, “A Conceptual Study for Control Strategy of TCSC in Inductive and Capacitive Region”, International Conference on Circuit, Power and Computing Technologies [ICCPCT], pp.1-6, March 2014.

[6.] D. G. Gotham and G. T. Heydt, “Power Flow Control and Power Flow Studies for Systems with FACTS Devices,” IEEE Trans. Power Systems, Vol.13, pp. 60– 65, 1998.

[7.] www.electricalenggineringportal.com

[8.] SijaGopinathan,Dr.BosMathewJos,SmithaPaulose, ”Load Flow Solutions of Power Systems with FACTS Devices” International Journal of Advanced Research in Electrical, Electronics and instrumentation Engineering Vol. 2, Issue 3March2013.

[9.] VenuYarlagadda, Dr.B.V.Sankar Ram and Dr. K. R. M. Rao, “Automatic Control of Thyristor Controlled Series Capacitor (TCSC)”, International Journal of Engineering Research and Applications(IJERA), Vol.2, pp. 444-449, Issue 3, May-Jun 2012.

[10.] Martin German-Sobek, lubomírBena, Roman Cimbala,” Using of the Thyristor Controlled Series Capacitor in Electric Power System”, ELEKTROENERGETIKA, Vol.4, No.4, 2011 .

[11.] Shrawan Ram &G.K.Joshi,“Power Flow Control using TCSC Facts Controller”, International Journal of Computer Applications (0975 – 8887)National Conference on Intelligent Systems (NCIS 2014).

[12.] Zhao Xueqiang, Chen Chen,“Circuit Analysis of a Thyristor Controlled Series Compensation”, 1998 IEEE.

[13.] Dragan Jovcic, G. N. Pillai, “Analytical Modeling of TCSC Dynamics”, IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 20, NO. 2, APRIL 2005.

[14.] S. R. Joshi and A. M. Kulkarni, “Analysis of SSR Performance of TCSC Control

[15.] A. Schemes Using a Modular High Bandwidth Discrete-Time Dynamic Model”, IEEE TRANSACTIONS ON POWER SYSTEMS, VOL. 24, NO. 2, MAY 2009.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[16.] M. TarafdarHaque, "A. Roshan Milani, Coordinated design of PSS and TCSC dynamics model forpower system network oscillations" PEDS 2007.

[17.] Mohammed Osman Hassan, S. J. Cheng, Steady-State Modeling of SVC and TCSC for Power Flow Analysis", Proceedings of the International Multi Conference of Engineers and Computer Scientists 2009 Vol II IMECS 2009, March 18 - 20, 2009, Hong Kong.

[18.] Dongxia Zhang ,Luyuan Tong, An Analytical Mathematical Model for Describing the Dynamic Behavior of the Thyristor Controlled Series Compensator", 1998 IEEE