International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 2 Issue 4, April-2013, pp: (52-57), Available online at: www.erpublications.com

POWER FACTOR CORRECTION USING SVC WITH FUZZY LOGIC CONTROLLER

Puranik Sahu[1], Arun Pachori[2]
[1]puranik1987@gmail.com

Abstract: To transmit or distribute fixed amount of power at fixed voltage, the conductor have to carry more current at low power factor. This necessities a large conductor size. The large current at low power factor cause more copper loss in power system as well as increase KVA rating of equipments. This low power factor also cause poor voltage regulation and reduce power handling capacity of power system. All these problems can be removed by Static VAR Compensator (SVC). Fixed capacitor thyristor controlled reactor can be used for power factor correction, flicker reduction, and steady-state voltage control, and also have the benefit of being able to filter out undesirable frequencies from the system. In this paper FC-TCR with fuzzy logic controller is simulated using Matlab Simulink

Keywords: Voltage stability, fuzzy logic controller, FC-TCR, power factor, MATLAB simulink.

I. INTRODUCTION

SVC is power electronics based FACTS devices used to enhance the transmission capability near thermal limit without affecting the stability. The purpose of svc with fuzzy controller to change the natural electrical characteristics of transmission line to make it more compatible with prevailing load demand Static var compensators (SVCs) are very flexible and have many roles in power systems.SVC typically consist of a TCR in parallel with fixed capacitors. The fixed capacitors are usually connected in ungrounded wye with a series inductor to implement a filter. The reactive power that the inductor delivers in the filter is small relative to the rating of the filter (approximately 1 to 2 percent). There are often multiple filter stages tuned to different harmonics. The controls in the TCR allow continuous variations in the amount of reactive power delivered to the system, thus increasing the reactive power during heavy loading periods and reducing the reactive power during light loading. [1]

SVCs can be very effective in controlling voltage fluctuations at rapidly varying loads. Unfortunately, the price for such flexibility is high. Nevertheless, they are often the only cost-effective solution for many loads located in remote areas where the power system is weak. Much of the cost is in the power electronics on the TCR. Sometimes this can be reduced by using a number of capacitor steps. The TCR then need only be large enough to cover the reactive power gap between the capacitor stages. Most of a.c. appliance have induction motor as their main drive which works at lagging power factor and the mostly contribute for lagging power factor of system. Fixed capacitor of FC-TCR provides capacitive VAR which helps to improve the power factor and compensate reactive power demand.

The main objective of using static var compensator with supplementary controller is to improve the power factor in distribution system during normal as well as abnormal condition and also to improve the voltage stability of system during fault condition so that to meet continuity of supply. The ultimate objective of compensation is to increase transmittable power. This may required to improve the KW capacity of transformer and alternators, to improve the regulation of line and to decrease overall cost per units. [2]

II. RESEARCH METHODOLOGY

A. *Control Concept Of SVC*

The control concept of svc is based on controlling of shunt susceptance (B) which can be controlled by changing the firing angle of thyristor Fig. 1 illustrates a TCR SVC, including the operational concept. The control objective of the SVC is to maintain a desired voltage at the high-voltage bus. In the steady-state, the SVC will provide some steady-state control of the voltage to maintain it the high-voltage bus at a pre-defined level. If sudden load is increased the high-voltage bus begins to fall below its set point, in such a condition the SVC will inject reactive power (Qnet) into thereby increasing the bus voltage back to its net desired voltage level. If load is falls suddenly, then bus voltage increases, the SVC will (thyristor controlled reactor) will absorb reactive power, and the result will be to achieve the desired bus voltage. From Fig. 1, +Qcap is a fixed capacitance value, therefore the magnitude of reactive power injected into the system, Qnet, is controlled by the magnitude of –Qind reactive power absorbed by the TCR [4].

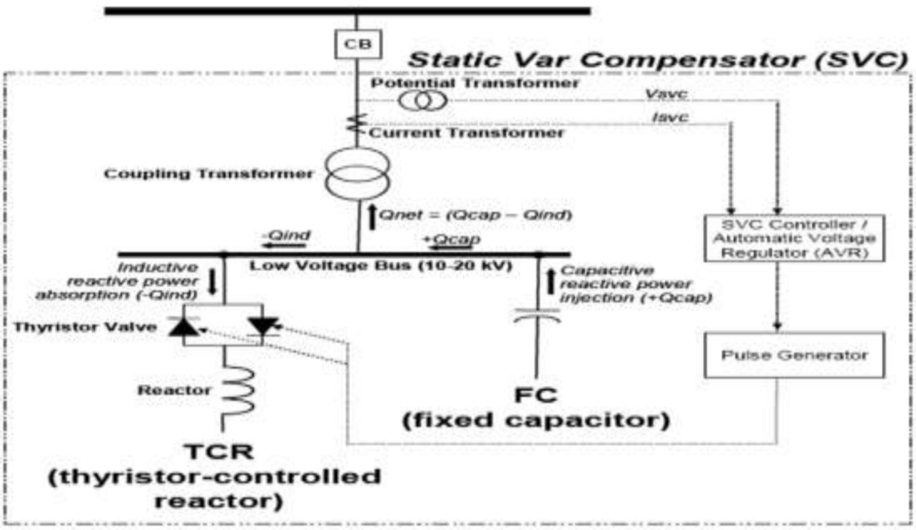

Fig.1: SVC with control concept

SVC is simulated by means of fixed capacitor thyristor controlled reactor (FC-TCR). Thyristor controlled reactor can be varied by means of varying of variable susceptance, B_{SVC}.The equivalent susceptance B_{equ} can be determined by the firing angle α of thyristor.

$$B_{EQU} = B_L(\alpha) + B_C \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where

$B_L(\alpha) = \frac{1}{wL}\left(1 - \frac{2\propto}{\pi} - \frac{1}{\pi}\sin(2\alpha)\right)$,

$B_C = wc$ and α varies from zero to 90^0

If real power consumed by svc is zero then $P_{SVC} = 0$

$$Q_{SVC} = V^2 B_{SVC} \ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Where, V is bus voltage magnitude. Since reactive power is function of square of voltage hence a reactive power generated decreases as the voltage decreases.

Subsystem of power measuring block is shown in figure2 which is used to measure power factor as well as power factor angle (Ө).

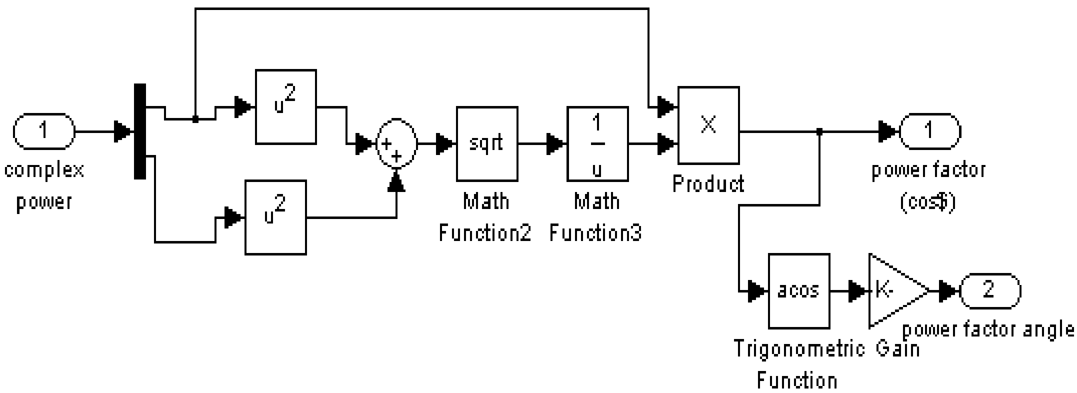

Fig. 2 subsystem power measurement block

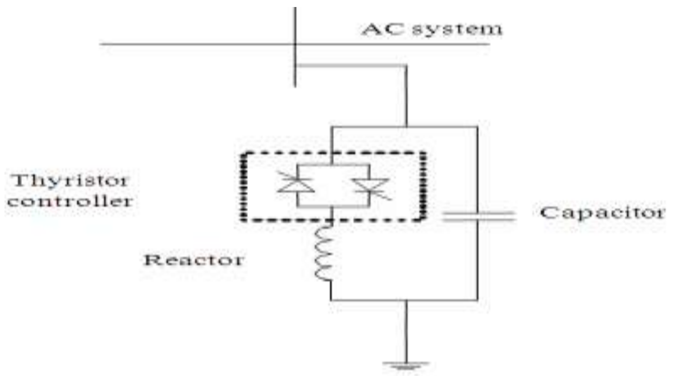

Fig. 3 Schematic diagram of SVC

B. *Fuzzy Logic Interfacing*

Mamdani based fuzzy logic interfacing rule is adopted for correction of power factor. Complex power is taken from power measuring block, in which power angle is taken as input of fuzzy controller. According to power angle control output (firing angle) is provided by fuzzy controller. When power angle is large firing angle is also large. Controlled output is supplied to variable delay circuit and it is supplied to thyristor. According to the output of variable time delay circuit firing angle of thyristor is changed. When power angle is very small then firing angle is also very small. When power angle is medium then firing angle is also medium. When power angle is large then firing angle is also large [9].

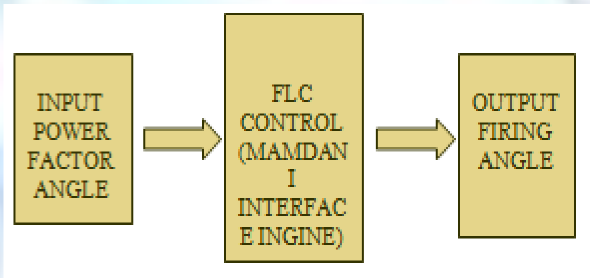

Fig. 4 Structure of fuzzy logic controller

Variable time delay circuit is shown in figure5 in which the output of fuzzy controller works as input for it. And output of variable time delay is used for firing angle control of thyristor.

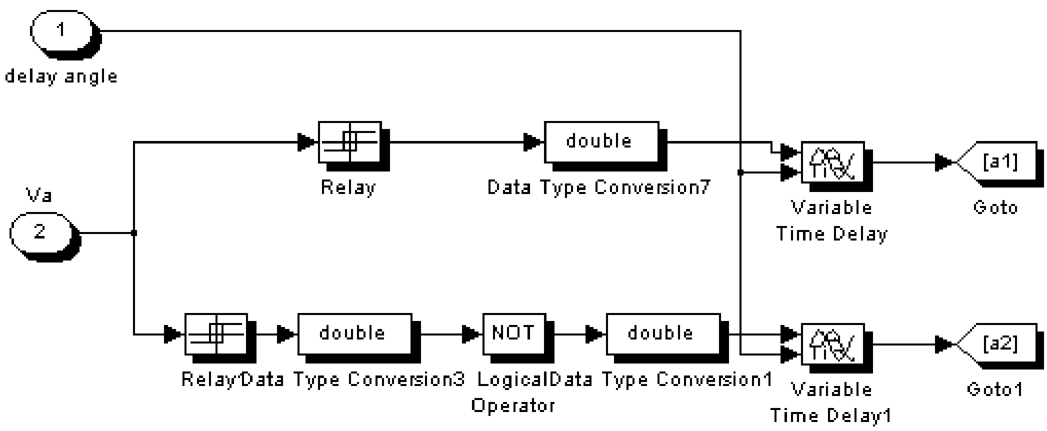

Fig. 5 Variable time delay circuits

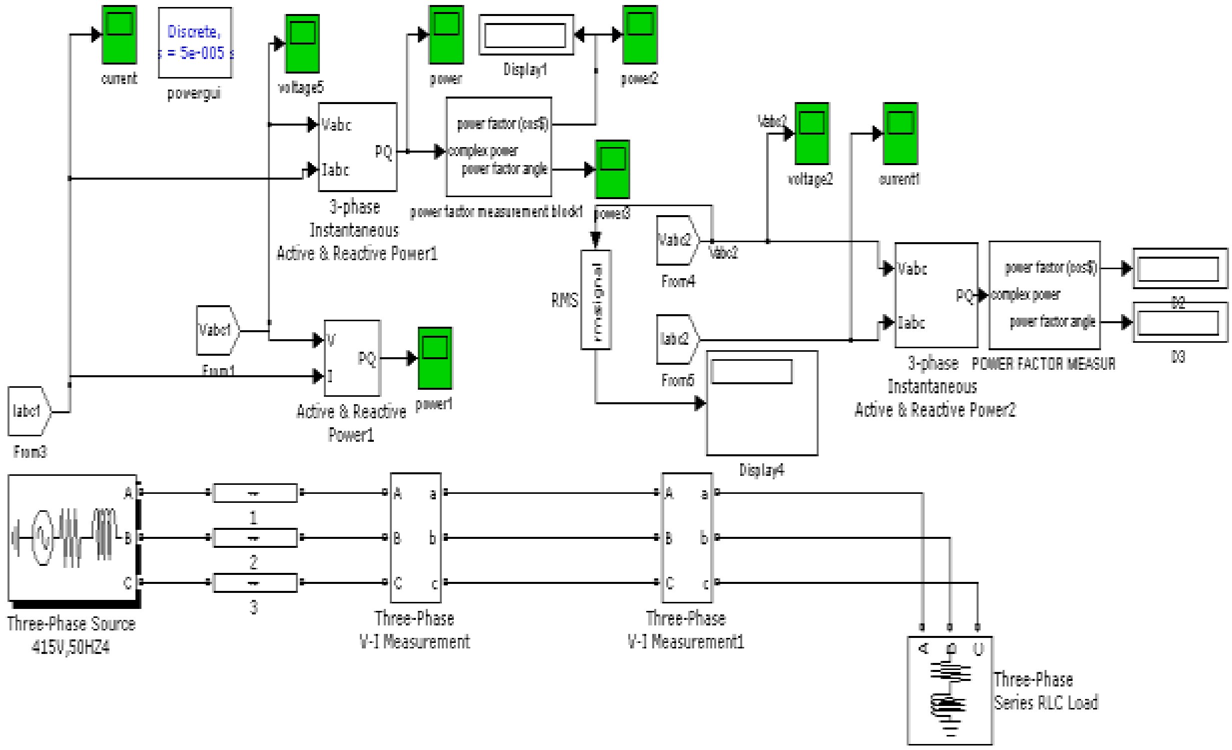

Fig. 6 simulation of distribution line without controller

III. DATA ANALYSIS

Matlab simulation is done for various inductive loads at sending end voltage 415 volt three phase distribution system. Variation of power factor and output voltage for various loads with and without controller is shown in table.

TABLE: Effect of power factor with and without controller

	WITH OUT CONTROLLER			WITH CONTROLLER		
LOADS (K.W)	VOLT.	ϴ	P.F.	VOL T.	ϴ	PF
P=2.50 Q=1.615	225.6	32.88	0.84	239.6	0.0177	1
P=3.50 Q=2.615	213.6	36.78	0.8011	239.6	0.0133	1
P=4.50 Q=3.615	205.3	38.80	0.7796	239.6	0.0105	1
P=10.0 Q=9.615	165.3	42.5	165.3	239.6	0.0046	1

IV. EXPERIMENTAL RESULTS

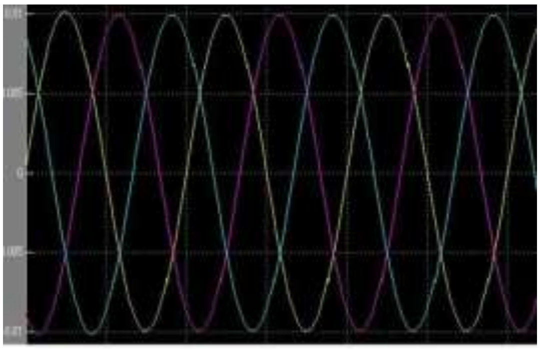

Fig. 7 Receiving end current

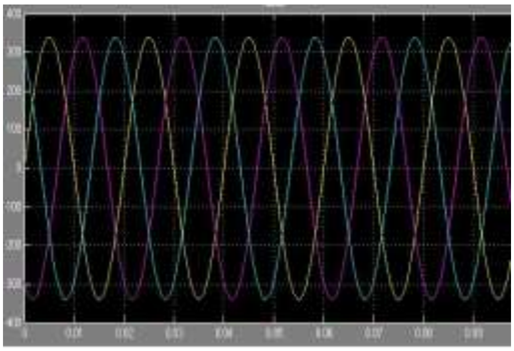

Fig. 8 Receiving end voltage

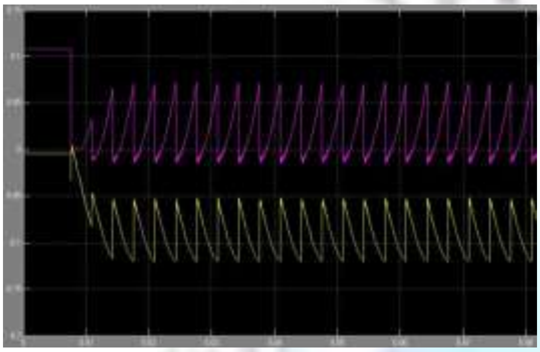

Fig. 9 Power across TCR

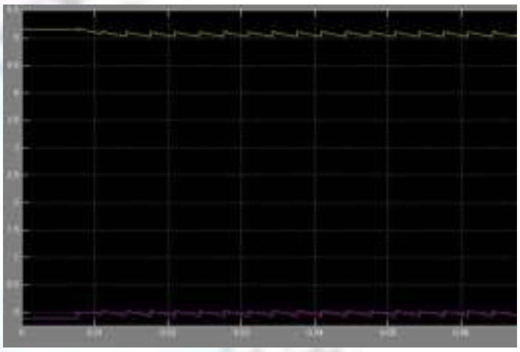

Fig. 10 Instantaneous power

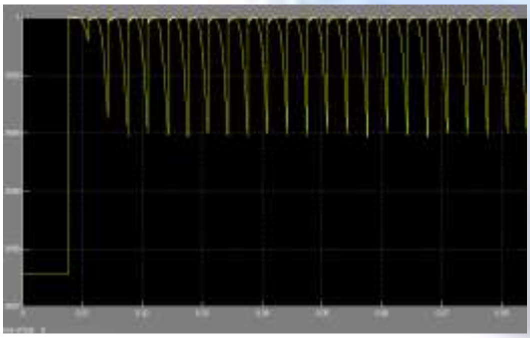

Fig. 11 Power factor

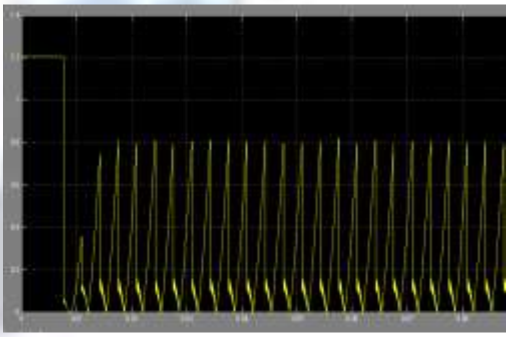

Fig. 12 Power angle

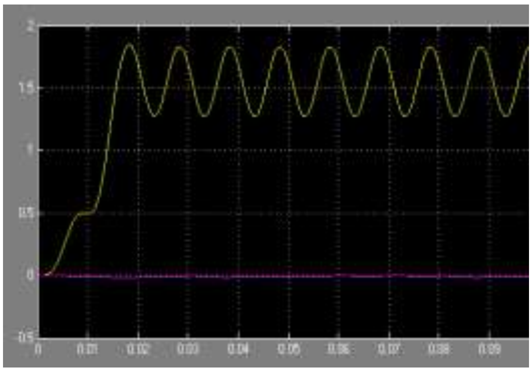

Fig. 13 Active and reactive power at load end

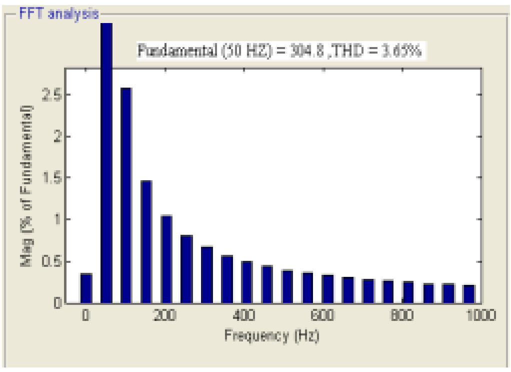

Fig.14 FFT analysis of voltage of nonlinear load with FC-TCR

CONCLUSION

From above result it conclude that svc with fuzzy controller play an important role to maintain power factor constant at receiving end under normal as well as overloading condition. It is cost effective solution to maintain constant voltage and constant power for highly inductive load. . The use of fuzzy logic has facilitated the closed loop control of system, by designing a set of rules, which decides the firing angle given to SVC to attain the required voltage and power factor. With MATLAB simulations it is observed that SVC (FC-TCR) provides an effective reactive power control irrespective of load variation and also provide voltage stability.

REFERENCES

[1]. "Electrical Power Systems Quality" by R.C Dugan, McGraw-Hill Companies, 2008.
[2]. Narain G. Hingorani, Understanding FACTS, Concepts and Technology Of flexible AC Transmission Systems, by IEEE Press USA, 2000.
[3]. "Voltage Stability Improvement using Static Var Compensator in Power Systems" Leonardo Journal of Sciences Issue 14, p. 167-172, January-June 2009.
[4]. "Voltage Level Improving by Using Static VAR Compensator (SVC) Global Journal of researches in engineering Volume 11 Issue 5 Version 1.0 July 2011.
[5]. Takashi Hiyama, WalidHubbi,Thomas H. Ortmayer, "Fuzzy logic Control Scheme with Variable gain for Static Var Compensator to enhance Power System Stability", IEEE Transactions on Power Systems, vol.14, No.1, Feb,1999.
[6]. A. E. Hammad, "Comparing the voltage control Capabilities of present and future VAR compensating techniques in transmission systems," IEEE Trans. Power Delivery, vol.11, no.1, pp. 475484, Jan.1996.
[7]. "Voltage stability improvement using svc with PID controllers," vol.2, issue7, ijeat exploring research and innovations July 2012.
[8]. K. L. Lo and Khan Laiq, "Fuzzy logic based SVC for power system transient stability enhancement, International Conference on Electric Utility Deregulation and Restructuring and Power Technologies (DRPT 2000), pp.453- 458, April 2000.
[9]. Vladimiro Miranda, "An improved Fuzzy Voltage Inference System for VAR control," IEEE Transactions on Power Systems, vol.22, No.4, November 2000.
[10]. V. K. Chandrakar and A. G. Kothari, "Fuzzy-Based Static Synchronous Compensator for Improving transient Stability performance" International Journal of Energy Technology And Policy, Vol. 5, No. 6, pp.692707, 2007.