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Performance Comparison between SVC and STATCOM for Reactive Power Compensation by Using Fuzzy Logic Controller

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Abstract: The performances comparison between SVC and STATCOM controller for compensating the reactive power by using the control technique i.e. with fuzzy controller and without fuzzy controller to improve the voltage stability. Improving the system reactive power handling capacity via Flexible AC transmission System (FACTS) devices is a remedy for prevention of voltage instability. This paper compares the SVC and STATCOM in static voltage stability improvement and the performance of the STATCOM is better compare with that of the conventional SVC.A Simulations using MATLAB / SIMULINK are carried out to verify the performance of the proposed controllers and paper deals only with power-factor correction mode and show the Total Harmonic Distortion.

Key Words: **SVC, STATCOM, FUZZY LOGIC CONTOLLER.**

I. INTRODUCTION

In Modern electric power utilities are facing many challenges problems due to ever increasing demand and voltage is attending instability by increases in loss and various power quality problems. After studying several researches works in the field of compensation of Reactive Power and demand for controllable reactive power source has gone up mainly for efficient and dependable operation of ac electric power system. The rapid development of the high-power electronics industry has made Flexible AC Transmission System (FACTS) devices attractive for utility applications. Static Var Compensator (SVC) has been widely used for compensating of reactive power. These types of compensation have some disadvantages big size, more losses and slower response. Today, inverter based power quality conditioner devices have been proposed for improving the power quality problems in distribution systems because of their fast response, small size and low losses. , the static synchronous compensator (STATCOM) is one of the facts devices. The STATCOM is an inverter for improving the power quality performances by connected in shunt type with ac system. It playing important roles in reactive power provision, voltage regulation and improving performances of the transient stability of power systems; because of its attractive steady state performance. It is used for load balancing, voltage regulation and harmonic filtering in distribution system. In this paper Comparison performances between SVC and STATCOM controller by using the control technique i.e. with fuzzy controller and without fuzzy controller. Moreover, STATCOM does not significantly alter the existing system impedance which gives it an advantage over the SVC. Also, the performance of the STATCOM is compared with that of the conventional SVC.A Fuzzy logic new control method for SVC and STATCOM is proposed and applied for damping oscillations. Simulations using MATLAB / SIMULINK are carried out to verify the performance of the proposed controller. This paper deals only with power-factor correction mode and show the Total Harmonic Distortion.

II. STATIC VAR COMPENSATOR

The SVC is a shunt type of FACTS devices family using power electronics to regulate voltage, control power flow and improve transient stability in power system. The main construction of SVC, is thyristor switched capacitor(s), TSC, and thyristor-controlled reactor(s), TCR, together with filters. The filters are used to remove low-frequency harmonics produced by the TCR. With proper coordination of the capacitor switching and reactor control, the reactive power output can be varied continuously between the capacitive and inductive ratings of the equipment to regulate the ac voltage.

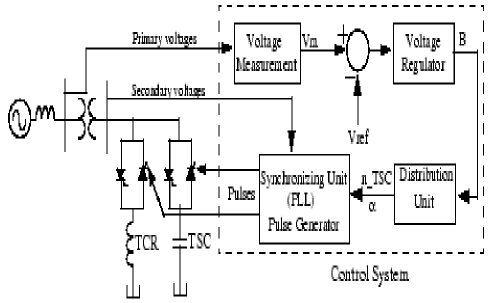

Fig 1: Schematic circuit Diagram of SVC

III. STATCOM CONTROLLER

The STATCOM consists of a coupling transformer, a voltage-sourced inverter, a control system and a dc capacitor. The STATCOM is a shunt device of the FACTS family and it improves transient stability on power grids. The STATCOM regulates voltage at its terminals by controlling the amount of reactive power injected into or absorbed from the power system. For purely reactive power flow the three phase voltages of the STATCOM must be maintained in phase with the system voltages. The variation of reactive power is performed by means of a VSC connected through a coupling transformer. The VSC uses forced commutated power electronics devices (GTO's or IGBT's) to synthesize the voltage from a dc voltage source. A capacitor connected on the DC side of the VSC acts as a dc voltage source.

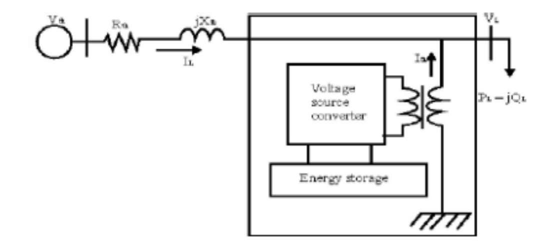

Fig 2: Schematic Diagram of a STATCOM controller

A STATCOM can improve power-system Performance like: dynamic voltage control in transmission and distribution systems, power-oscillation damping in power- transmission systems, transient stability; voltage flicker control and control of not only reactive power.

IV. FUZZY LOGIC CONTROLLER

Fuzzy logic control essentially involves the derivation of a control law from heuristic and imprecise (fuzzy) rules. The configuration of the Fuzzy logic control system that is employed for designing the Fuzzy supplementary controller. The FLC contains four main components, the fuzzification interface (FUZZIFICATION), the knowledge base (FUZZY RULE BASE), the decision making logic (FUZZY INFERENCE ENGINE) and defuzzification interface DEFUZZIFICATION).A Mamdani type double input single output (DISO) FLC has been designed.

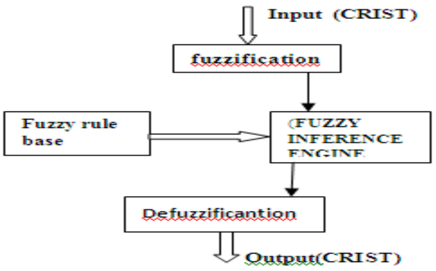

Fig 3 : Fuzzy logic controller

The following steps are involved in the designing fuzzy logic controller.

Choose the inputs to FLC (INPUT-CRISP): The inputs to FLC used in this study are generator terminal voltage deviation and generator speed deviation which are given

ΔVc(pu)=Vref -Vf
Δw(pu)=w-wo
Where
Vt= generator terminal voltage;
Vref=Reference voltage;
ω_o =synchronous speed of generator;
ω = speed of generator;

i. Choose membership functions to represent the inputs and outputs in fuzzy set notation (FUZZIFICATION): Triangular member ship functions were selected for this study as shown with five linguistic variables chosen as large positive (LP), Small positive (SP), Very small (VS), Small negative (SN), Large Negative (LN) for both inputs and outputs. The values of the axes are given in Appendix.

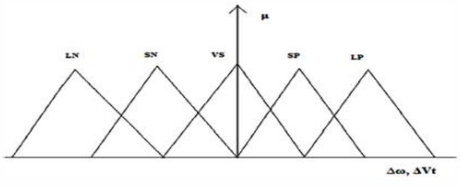

Fig 4 : Triangular member ship function

ii. Develop fuzzy rules set of decision rules relating the inputs to the controller with the output are compiled and stored in the memory in the form of decision table. Twenty five rules for the present study are developed as follows. Twenty four rules are formed in the same way as shown in the Table I.

Δw (x) ΔVt(y)	LN	SN	VS	SP	LP
LN	SN	SN	LN	LN	LN
SN	SN	SN	SN	LN	SN
VS	SP	SP	VS	SN	SN
SP	LP	SP	SP	SP	SP
LP	LP	SP	LP	SP	SP

iii. Since there are N (five) membership functions for each input, there are N2 (twenty five) possible combinations resulting in M (five) values for the decision variable u. All the possible combinations of inputs, called states, and the resulting control are arranged in a (N2xM) fuzzy relationship matrix. The membership values for the output characterized by the M linguistic variables are then obtained from the intersection of N2 values of membership function /l(x) with the corresponding values of each decision variables in the fuzzy relationship matrix.

iv. Defuzzy to obtain crisp output (DEFUZZIFICATION):

The output FLC is converted to crisp value by Centre or Gravity (COG) method in this study. The crisp value of FLC in COG is expressed.

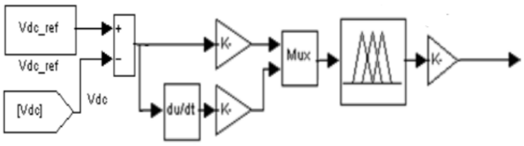

Fig 5: SIMULINK model of the fuzzy logic controller (FLC)

V. SIMULATION RESULTS

The performance of the STATCOM along with the proposed control strategy is demonstrated and discussed in this section. Moreover, the performance of the STATCOM is compared with that of the conventional SVC during different faulty operating conditions and for different system strength SCR. Simulations using MATLAB / SIMULINK are carried out to verify the performance of the proposed controllers. The performances between SVC and STATCOM controller by using the control technique i.e. with fuzzy controller and without fuzzy controller. Also, the performance of the STATCOM is compared with that of the conventional SVC.A Fuzzy logic new control method for SVC and STATCOM is proposed and applied for damping oscillations. Simulations using MATLAB / SIMULINK are carried out to verify the performance of the proposed controller.

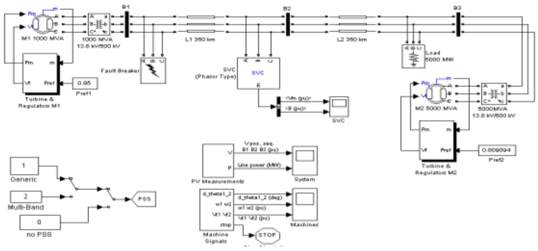

Fig 6 : Simulation circuit diagram SVC without fuzzy

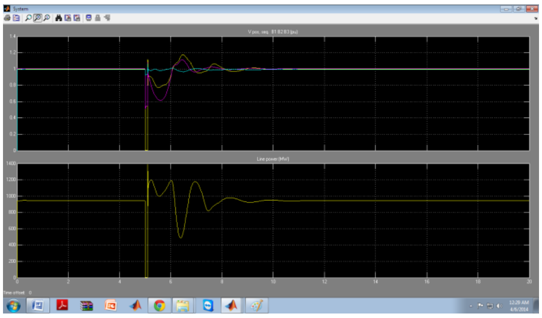

Fig 7: voltage and power of b1,b2,b3 buses

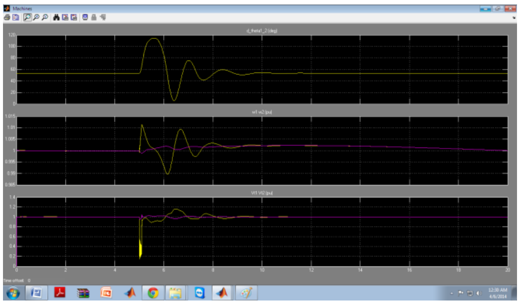

Fig 8: Machine signals

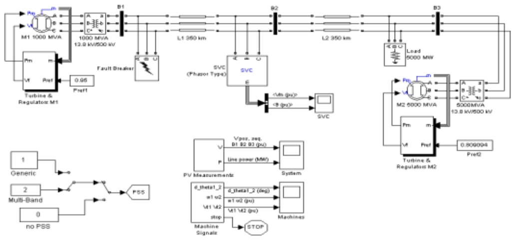

Fig 9 : Simulation circuit diagram SVC with fuzzy

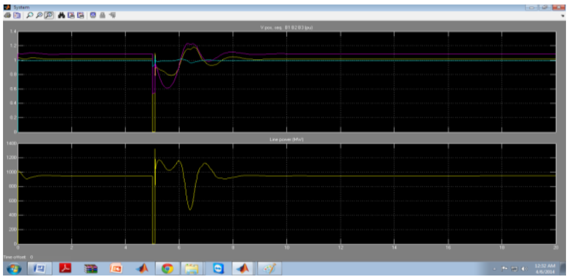

Fig 10: voltage and power of b1,b2,b3 buses with fuzzy

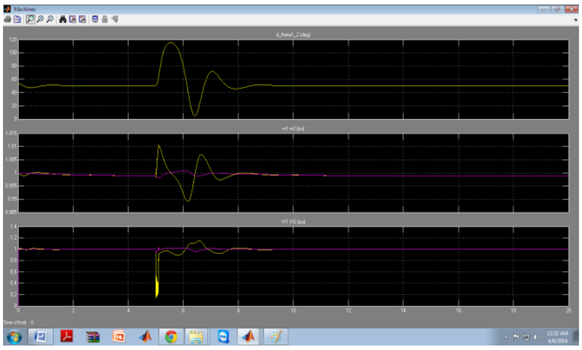

Fig 11: Machine signals with fuzzy

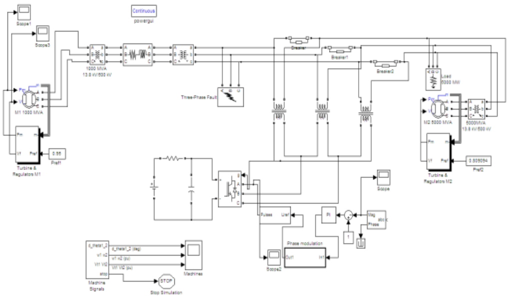

Fig12 : Simulation circuit diagram STATCOM with PI

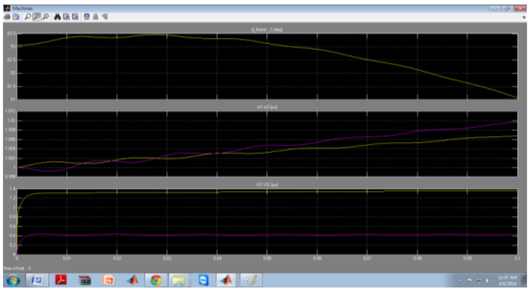

Fig 13: Machine signals with PI for STATCOM

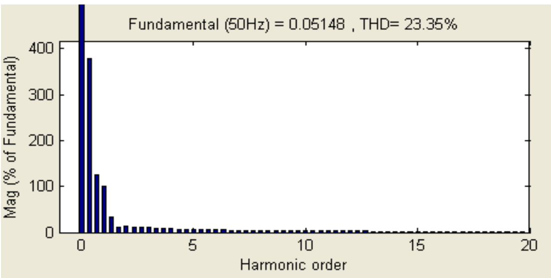

Fig 14: total harmonic distortion for statcom with PI

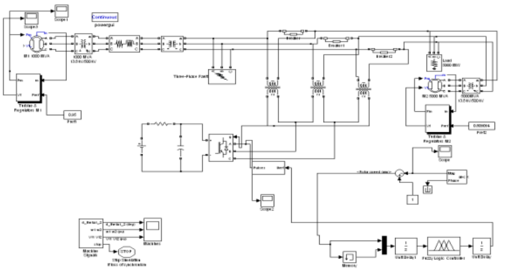

Fig15: Simulation circuit diagram STATCOM with fuzzy logic controller

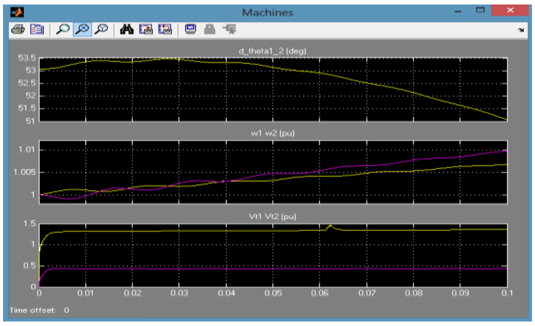

Fig 16: Machine signals with fuzzy for STATCOM

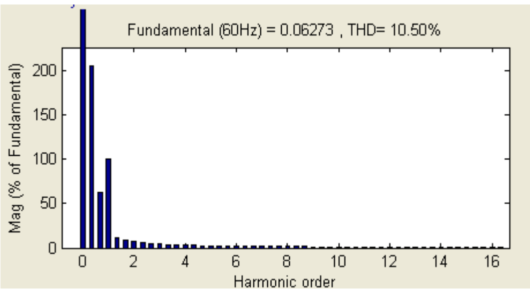

Fig 17: Total harmonic distortion for statcom with fuzzy

VI. CONCLUSION

A comparison study of SVC and STATCOM in static voltage stability improvement is presented. Performances comparison between the SVC and STATCOM in static voltage stability improvement and the performance of the STATCOM is better compared with that of the conventional SVC.A Fuzzy logic new control method for SVC and STATCOM is proposed and applied for damping oscillations. Simulations using MATLAB / SIMULINK are carried out to verify the performance of the proposed controllers and

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