International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 02 | Feb 2021 www.irjet.net p-ISSN: 2395-0072

POWER SYSTEM PERFORMANCE ENHANCEMENT BY STATCOM USING FUZZY –PI CONTROLLER

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Abstract - *In the era of development electric power demand is increasing tremendously. The increased demand of electric power must be met by increased transfer of power through available transmission lines and for that restructuring in some countries add to the power system complexity. The FACTS is an application of a power electronics device to control the power flow and to improve the system stability of a power system. The FACTS device STATCOM(static synchronous compensator) and its performance have been studied in this paper. The detail modeling of VSC is done for six pulse and twelve pulse inverter. The modeling of STATCOM in three phase system has been done using 6-pulse converter. The two machine system is considered for analysis and implementation of STATCOM using FUZZY-PI Controller is done. The results obtained with simulations shows the effectiveness of the STATCOM for improving the power system stability.*

Key Words: **STATCOM, FACTS Device, Fuzzy PI controller**

1.INTRODUCTION

The power system is a highly nonlinear system that operates in a constantly changing environment; loads, generator outputs, topology, and key operating parameters change continually. 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 problem of transient stability after a major fault can become a transmission power limiting factor. The power system should adapt to momentary system conditions, in other words, power system should be flexible [1].

1.1 INTRODUCTION TO FACTS

The IEEE Power Engineering Society (PES) Task Force of the FACTS Working Group has defined FACTS and FACTS Controller as given below [1].

1.2 Flexible AC Transmission System (FACTS)

Alternating current transmission systems incorporating power electronic-based and other static controllers to enhance controllability and increase power transfer capability.

1.3 FACTS Controller

A power electronic-based system and other static equipment that Provide control of one or more AC transmission system parameter. FACTS Controllers are divided into four categories [1].

i) Series FACTS Controllers
ii)Shunt FACTS Controllers
iii)Combined Series-Series FACTS Controllers
iv)Combined Series-Shunt FACTS Controllers

2. STATCOM- working principle

STATCOM constitute of components like VSC, energy storage device (dc), and coupling-transformer. STATCOM has energy storage device so that it can exchange reactive power with the transmission line, if battery is replaced by energy storage device. The controller exchanges real and reactive power in transmission line, and its operation region extends in four quadrants. The construction of STATCOM is as shown in Fig.2.1Converter ac output voltage and voltage across dc capacitor will relates each other as follows, Where k=coefficient, Depending upon the relative change between output of converter voltage and AC system Bus voltage, reactive power will flowing in the system either from coupling transformer to system or from system to coupling transformer. Losses occurred due to switching are provided by the true power flowing into VSC and charges a dc capacitor to a sufficient dc voltage level. In steady state operation capacitor voltage remains fixed and capacitor will charge and discharge through switching wave. In stable level, power from ac system will balance losses because of switching. The STATCOM's capability to take and deliver true power relies

on the size of dc capacitor along with the true power losses because of switching. Every time the dc capacitor and also the losses are comparatively small, the quantity of true power transfer is also comparatively small. This means that the STATCOM's outline ac current Iac, needs to be around + 90º with regards to ac system voltage at its line terminals. Varying the amplitude of the converter three-phase output voltage Vout controls the reactive power production as well as delivered to the STATCOM. AC current will flow from transformer reactance to the ac system if the amplitude of output voltage is raised above ac system bus voltage. so ac system extracts capacitive current that leads by an angle of 90º by ac system voltage, assume the losses occurs in the converter are equal to zero. If the amplitude of converter output voltage is less than ac system voltage then converter absorbs reactive power. For an inductive operation the current lags the ac voltage by an angle of 90°.Assuming that the converter losses are ignored. If the amplitudes of the ac system and converter output voltages are equal, it seems to be in floating state [1].

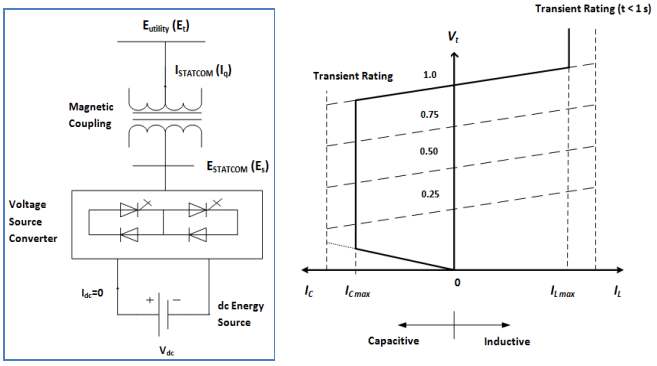

Fig -1: Functional model and characteristic of STATCOM [1]

2.1 OPERATING MODES OF STATCOM

Table-1: STATCOM OPERATING MODES

Mode	Waveform
No load mode	Vs, Vc, (a)Vs = Vc
Capacitive operation mode	Vs, Vc, Ics=Leading current, (b)Vc > Vs
Inductive operation mode	Vs, Vc, Ics=Lagging current, (c)Vc < Vs

3. SIMULATION AND RESULTS

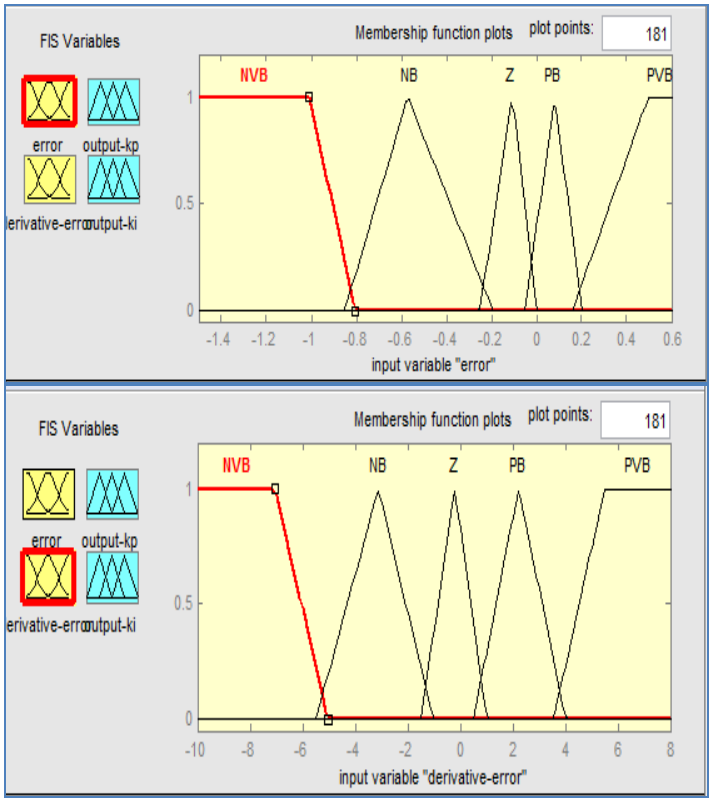

Fig -2: Membership function plots for error and derivative error

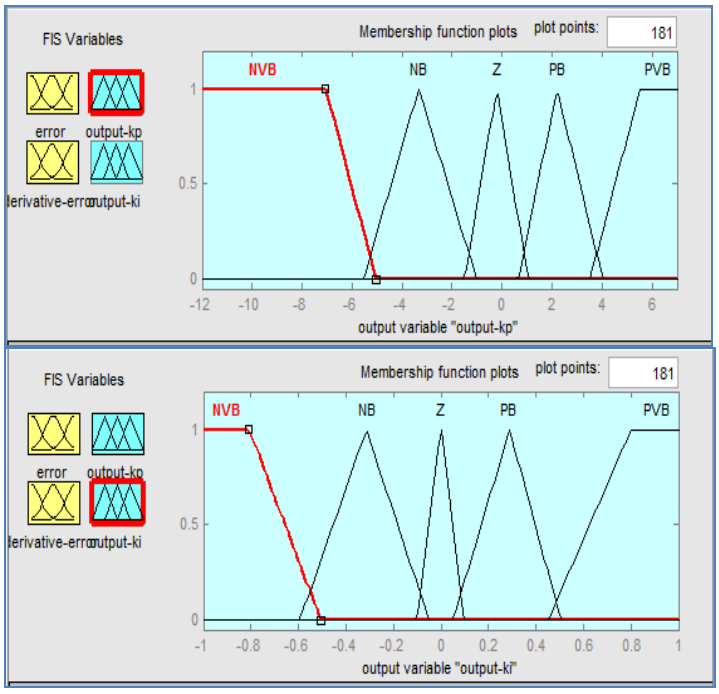

Fig -3 : Membership function plots for output variable Kp and Ki

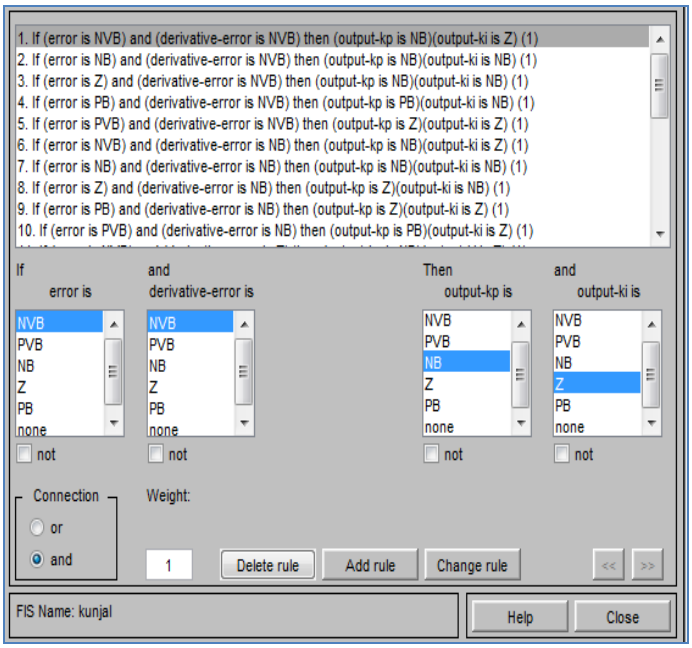

Fig -4 : Rules list

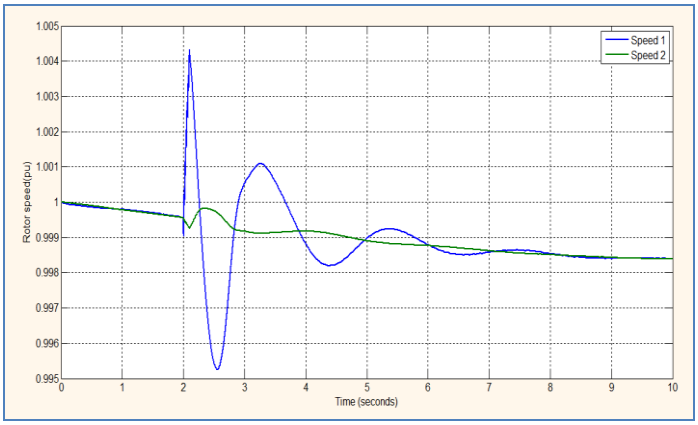

Fig -5 : Rotor speed waveform using six pulse converter

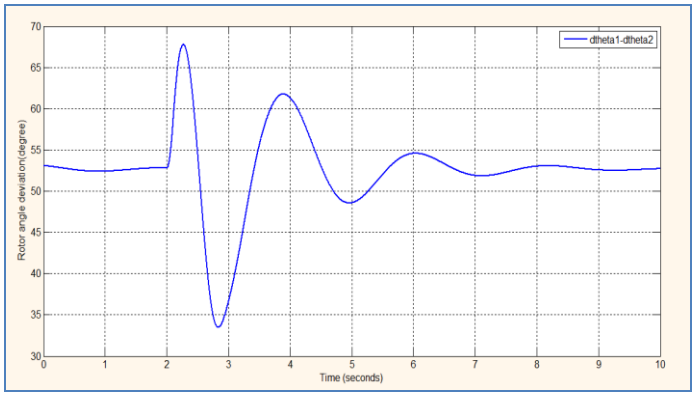

Fig -6 : Rotor angle deviation waveform using six pulse converter

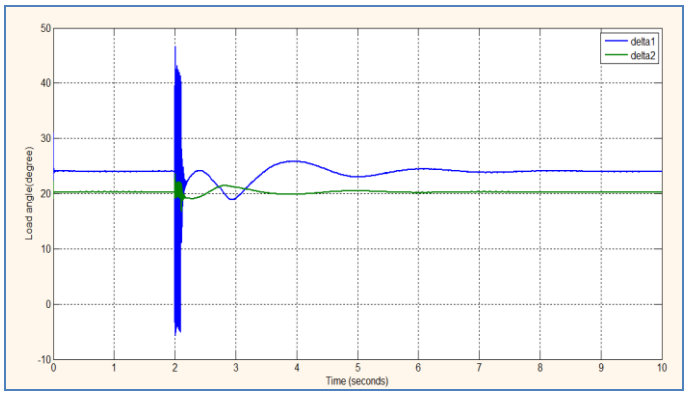

Fig -7 :Load angle waveform using six pulse converter

4. CONCLUSIONS

power system performance is enhanced by STATCOM using FUZZY-PI controller here we get rotor speed 7sec, Rotor angle deviation 8 sec , Load angle 6 sec.

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