INTELLIGENT OF VOLTAGE STABILITY CONTROL IN OLTC OPERATION

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***ABSTRACT*--In modern power system the voltage/reactive power control becomes more and more important because of the growth in system demands and for many utilities, the difficulty of building new power plants. In this paper we proposed to maintain the voltage profile in power system using OLTC by fuzzy expert system method. Simulation results are found in MATLAB using real data's.**

Keywords: voltage profile, fuzzy expert, OLTC.

1. INTRODUCTION

The voltage stability problem has become a major concern in operating and planning today's power system as a result of heavier and heavier loading conditions. It is well known that the operation of on-load tap changers (OLTC's) has a significant influence on voltage instability. In fact, most of the current literature has concentrated on the contribution of OLTCS to voltage collapse Faced with the evolution of the power system and operating condition, a better management of the voltage profiles and reactive power is essential in order to improve the power system security and reactive power resources utilization. It is Consists of three levels, which are tertiary voltage control, secondary voltage control and primary voltage control. The primary voltage control involves keeping generator stator voltages at their set-point values, by means of control actions of automatic voltage regulators (AVR) installed on generators. At this level, the control devices attempt to compensate rapid and random voltage variation by keeping generator terminal voltages equal to the set-point values updated by the secondary control. The response time is in the range of seconds. The main objective of secondary control is to adjust and to maintain the voltage profiles inside a network area. The controller of this level responds slow and large voltage variations. The time constant is in the range of minutes. Control actions in this level are carried out by var compensation devices like synchronous generators, capacitors, reactors, static compensators and OLTC transformers.

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2. SECONDARY SIDE VOLTAGE CONTROL IN OLTC

Voltage control is carried out by var compensation devices include synchronous generators, shunt capacitors/reactors and OLTC transformers. Every kind of compensation device has its unique control capability and characteristics. Generator can be adjusted continuously without the limit of adjustment number. Its response to the reactive power and voltage disturbance is fast. Shunt capacitors/reactors are used for flatting load conditions along the daily load curve, and OLTC transformers are used for improving reactive power distribution. The numbers of switching control of capacitors/reactors and adjusting of OLTC transformers are limited and their responses to the disturbance are slow. OLTC is single winding transformer, IF you changing the tap position in OLTC at the time of violation of voltage profile in secondary of the OLTC .Simultaneously voltage variations occur in primary side of the OLTC but recently that variation has care taken by National Grid. We can't able to interrupt in primary side. In this paper, a secondary voltage intelligent control method and implement based on fuzzy expert system is presented. In order to augment voltage security and stability.

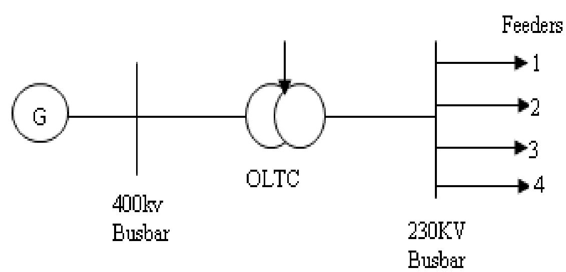

Fig.1single line diagram

3. METHODOLOGY

Here we are using MATLAB as a platform for using the fuzzy logic tool to attain the voltage stability in power system. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. In recent trends it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development and analysis. MATLAB features a family of add-on application-specific solutions called toolboxes.

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Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others. In this context, FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster.

4. FUZZY INFERENCE SYSTEMS

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. The process of fuzzy inference involves all of the pieces that are described in the previous sections: Membership Functions, Logical Operations, and If-Then Rules.

There are two types of fuzzy inference systems that can be implemented in Fuzzy Logic Toolbox: Mamdani-type and Sugeno-type. These two types of inference systems vary somewhat in the way outputs are determined. Mamdani's fuzzy inference method is the most commonly seen fuzzy methodology. Mamdani's method was among the first control systems built using fuzzy set theory..Mamdani's effort was based on for complex systems and decision processes.

5. DESIGN OF FUZZY INFERENCE SYSTEM

Now, we'll be building it using the graphical user interface (GUI) tools provided by Fuzzy Logic Toolbox. Although it is possible to use Fuzzy Logic Toolbox by working strictly from the command line, in general it is much easier to build a system graphically. There are five primary GUI tools for building, editing, and observing fuzzy inference systems in Fuzzy Logic Toolbox:

- Fuzzy Inference System (FIS) Editor
- Membership Function Editor
- Rule Editor
- Rule Viewer
- Surface Viewer

Fuzzy Inference System (FIS) Editor

Fig.2 shows the FIS Editor structure. It shows the input and output parameters. Where the input parameter is voltage and output parameter is OLTC TAP and Reactive power VAR (Q). The center block shows mamdani file name OLTC.

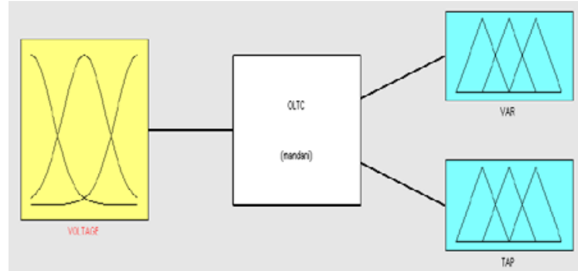


Fig.2 FIS Editor

Membership Function Editor

The Membership Function Editor is used to define the shapes of all the membership functions associated with each variable. Here we are using voltage as input variable. We are choosing 200-260 as a voltage range in OLTC secondary side. The fig.3 shows the following ranges

a. Normal voltage (220-240)kv
b. Low voltage (210-220)kv
c. Very low voltage (200-210)kv
d. High voltage (240-250)kv
e. Very high voltage (250-260)kv

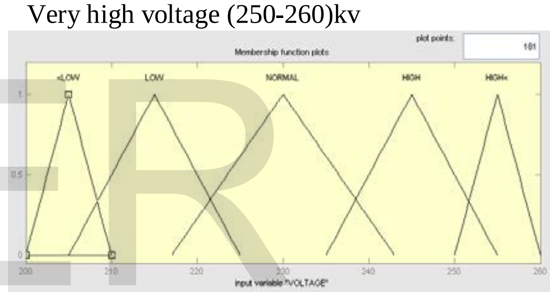


Fig.3 membership function of input (Voltage)

On Load Tap Changing Transformer (OLTC) have the 17 tapping positions. The fig.4 shows the tap position with respect to corresponding voltage on the secondary side of the OLTC ranges are following

a. If voltage is normal then tap position is(7-11)
b. If voltage is low then tap position is increased as a range of (10-14)
c. If voltage is very low then tap position is more increased as a range of (13-17)
d. If voltage is high then tap position is decreased as a range of (4-8)
e. If voltage is very high then tap position is more decreased as a range of (1-5)

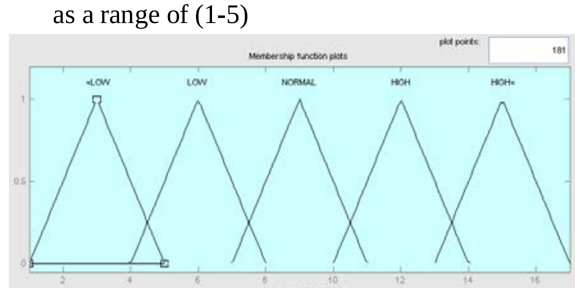


Fig.4 membership function of output (TAP)

The fig.5 shows the Reactive power compensation membership functions with respect to voltage changes occur in power system. If the voltage is exceed from its normal level then the reactive power absorption has been done by using compensating devices. In case the voltage is reduced from its normal level then the reactive power injection has been done by using compensating devices like OLTC, SVC, FACTS, etc.

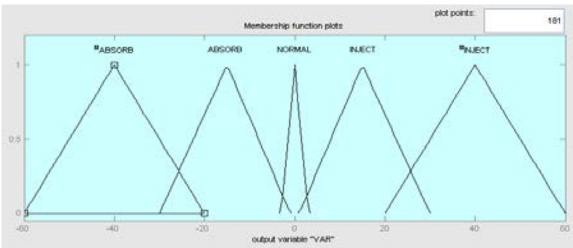


Fig.5 membership function of output (VAR (Q))

Rules

1. If (VOLTAGE is <LOW) then (VAR is 'MOREINJECT) (TAP is HIGH<)
2. If (VOLTAGE is LOW) then (VAR is INJECT) (TAP is HIGH)
3. If (VOLTAGE is NORMAL) then (VAR is NORMAL) (TAP is NORMAL)
4. If (VOLTAGE is HIGH) then (VAR is ABSORB) (TAP is LOW)
5. If (VOLTAGE is HIGH<) then (VAR is 'MOREABSORB) (TAP is <LOW)

Rule Viewer

Rule viewer is a tool used to see the graphical view of the rules with respect to the output. It shows the road of the FIS. . Each rule is a row of plots, and each column is a variable. The rule numbers are displayed on the left of each row. You can click on a rule number to view the rule in the status line. The first two columns of plots show the membership functions referenced by the antecedent, or the if-part of each rule. The third column of plot shows the membership functions referenced by the consequent, or the then-part of each rule. The fig.6 shows the low voltage level. The second column shows the VAR injection to the power system. The third column shows the corresponding tap changing in OLTC.

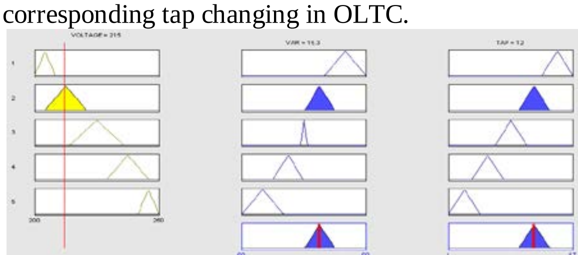


Fig.6 Low voltage level

The fig.7 shows the high voltage level with respect to corresponding VAR absorption and tap position changes in OLTC.

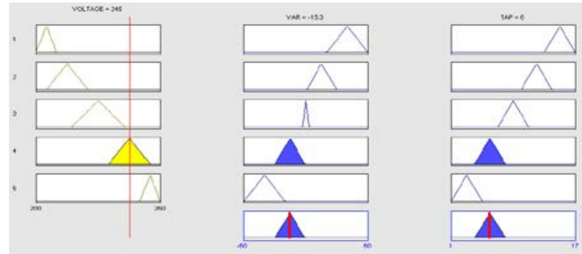


Fig.7 High voltage level

The fig.8 shows the normal voltage level. So there is no VAR injection or absorption in power system.

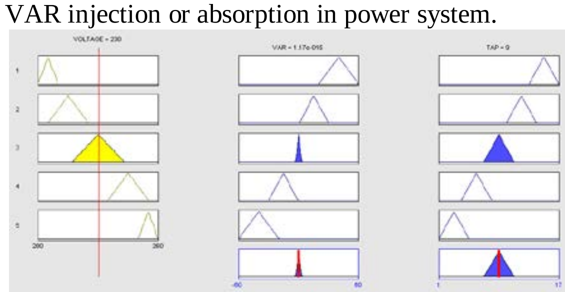


Fig.8 Normal voltage level

6. KNOWLEDGE BASED

In this paper we are using real data's collected from 400/230kv Sri Perumbudur substation in Tamil Nadu.

Date	Time	Tap	BUS VOLTAGE 400kv	BUS VOLTAGE 215kv	Auto-I	Auto-II	Sakoli	Kadaperi-II	Kadaperi-II	Kovembedu	NCTPS	Gummidipoondi	Arni	Taramani	Hyundai	kundrathur
29.01.14	07.00	3	401	215	-30	-30	+8	-12	-12	-16	+8	+20	+10	10	+8	-16
29.01.14	08.00	4	401	218	+20	+20	16	-12	-12	-16	+4	+12	+16	F	-8	-16
30.01.14	09.00	5	406	220	-60	-60	-24	-16	-16	-16	F	+4	F	F	-15	-16
30.01.14	10.00	6	397	220	-30	-30	-16	-24	LC	-16	+4	+4	+4	-5	-5	-16
05.02.14	07.00	12	395	219	+25	+25	-32	-12	-12	-24	+4	+8	-4	-10	-5	-24
05.02.14	08.00	9	404	220	+5	+5	-16	-12	-12	-24	+4	+8	+6	F	-8	-24

7. SIMULATION RESULTS

A new secondary voltage intelligent control system has developed based on the real data's collected from substation. All the simulation results got from MATLAB only. In power system, at the time of voltage violation occur we are using compensating devices to inject or absorb the reactive power to normalize the voltage stability. In earlier methods the reactive power control has done by using digital systems. It gives the approximate VAR injection or absorption but in fuzzy expert system gives the accurate values. In fuzzy expert system gets the actual voltage level from the feeder lines and FIS compares with reference voltage. If any change in voltage profile based on that the FIS automatically changes the tap position of OLTC to compensate or normalize the voltage profile.

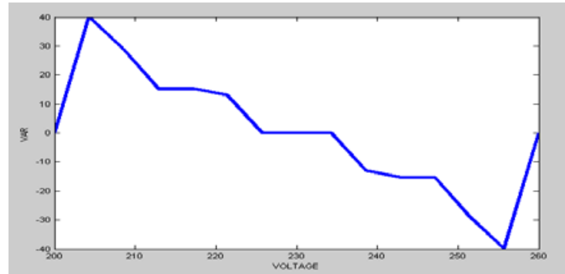


Fig.9 simulation result for voltage Vs VAR

The fig.9 shows the simulation result of fuzzy expert system in OLTC. At the time of the normal condition there is no reactive power injection or absorption so the reactive power level is zero. If the voltage is rise from its normal position then the reactive power absorption has shown in negative values of VAR. same like that voltage is decrease from its normal position then the reactive power injection has shown in positive value of VAR.

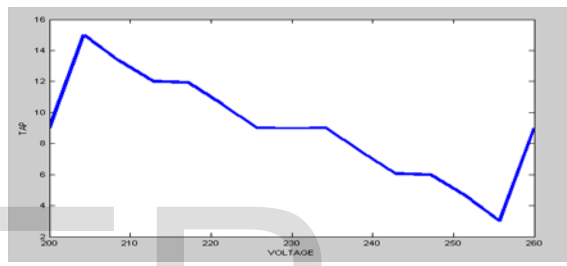
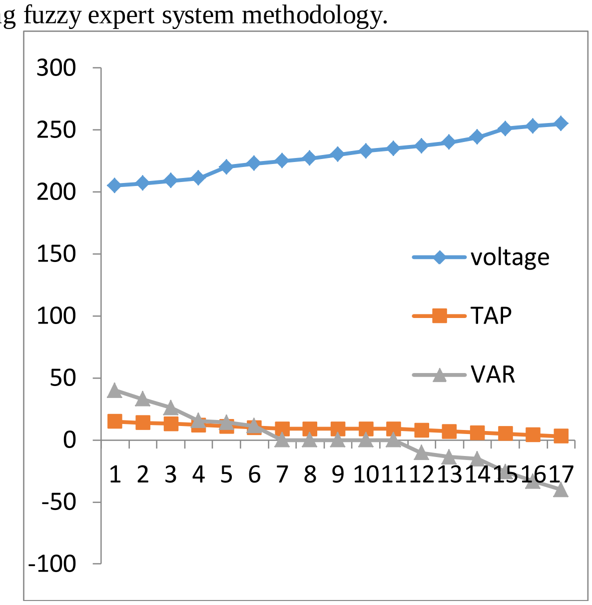


Fig.10 simulation result for voltage Vs tap

The above graph explains the relationship between the voltages Vs tap. The tap position of OLTC 9 gives the normal voltage level. Suppose if the voltage profile value increased from its normal position then we must absorb the reactive power by decreasing the tap position and similarly voltage profile value decreased from its normal position then the reactive power injection has done by increasing the tap position of OLTC by using fuzzy expert system methodology.



The above Excel graph shows the normal graphical relationship between the tap, voltage and var of the real data's.

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In fuzzy expert system method the FIS automatically processed and take the intelligent decision to maintain the voltage stability in power system.

8. CONCLUSION

Secondary voltage intelligent method has developed based on fuzzy expert system is proposed in this paper. In order to augmenting voltage stability and security, the compensating device OLTC has controlled in power system in intelligent way. As an example some simulation results of real data based graphs are given. In future its modified and developed using Neuro-Fuzzy technique to control the secondary voltage in expert decision making way.

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