



Optimum Distribution of Power by Intelligent Fuzzy Sets Analyzer and Controller

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Abstract

Meeting increasing demand for the electrical power without changing the existing infrastructure is a challenging issue. The transmission and the distribution are always struggling with losses in our ac power system networks. In this research an intelligent fuzzy logic approach is to be used for power system operation and control in distribution management. The VAR compensating devices like OLTC, SVC are to be controlled by the fuzzy expert system for modifying reactive power. The fuzzy membership functions, fuzzy rules are to be displayed. A co-ordination control between these VAR compensating devices using fuzzy logic control is to be discussed. An optimum location and the proper design of a capacitor banks for reducing the harmonic injection in the power system is to be suggested. The validity of this approach is to be given by the comparison graphs. All the simulations are to be carried out by MATLAB software. This research will investigate the effects of arising problems in an ac power system distribution without changing the existing infra structure. The various types of problems arising in a power system are to be listed. Among these the voltage stability in the buses has got the top priority. The solutions for reducing the power congestion created by these arising problems can be carried out.

Keywords: Reactive power compensation, Distribution generation, voltage control, FACTS, OLTC, SVC, STATCOM and fuzzy logic system.

1. Importance of Proposed Topic

The electricity supply in India is highly challenging issue to provide better service.

To reduce the fluctuation one way is to increase the generation capacity, it require a huge investment including the investment in transmission and distribution. The poor economical status of the utilities cannot implement to do this process immediately, because they have been struggle with a lack of revenue collected by the consumers. In India agricultural subsidy is high and policy adapted by government is not up to mark to reduce the theft. Due to theft, transmission and distribution losses increase. Most of states in India is not charged for agricultural purposes.

Considering the above facts made the topic become very vital, at least for reducing the technical problems without changing any infrastructure of our country power system distribution network.

1.1 Objectives of the Proposed Topic

The objective of this research is to supplement the firmness of voltage using the co-ordination of VAR compensating devices controlled by fuzzy expert system. Fuzzy rules will be developed for the operation of OLTC, SVC and the Switching capacitor banks. Here fuzzy is used for its fast and accuracy only. This will reduce the distribution losses, and maintaining the desired voltage level in our power distribution.

2. Present situation of an ac power system distribution network in India

Rural electricity supply in India has been suffered with voltage stability and power quality problems. In Tamilnadu, the power is

free for agricultural subscribers. For industrial and commercial consumers our government tariffs Policy, will made them, to go for capacitive power generation for their inductive loads. This is achieved by using diesel generators. In Tamilnadu, our Electricity board will not found any solution for agricultural loads in rural areas. If our utility trying to billing for agriculture, suddenly they would like to face the consequence of all formers and politicians opposition.

One more major problem is conventional incandescent lamps which are largely used in rural areas in our country. These lamps commonly cause an increasing energy demand around rural areas. Discussions have been done for replacing these lamps with compact fluorescent lamps (CFL). This will commonly reduce the electricity bills of consumers and also will reduce the energy demand considerably. In the country Iran there is a subsidy for using CFL. But CFL will cause some crucial problems in network. They have been suffered with poor power harmonic injection to the network. Some buses are more sensitive to nonlinear loads like CFL.

2.1 Some identified problems in an ac power system

The common problems arising in an ac power system are:

- Poor power quality.
- Voltage unbalance.
- Transmission line losses.
- Harmonics generated by non linear loads, power electronic control devices.
- Centralized generation.
- Long transmission lines.
- No integration of renewable energy sources.
- Long grids (No micro or smart grids).
- Poor grid capacity.
- High power rapid impact loads.

- Asymmetrical impact loads.
- Inevitable power system faults.
- Old equipments in agricultural fields, Industrial fields.
- Switching transients.
- Poor power factor maintained by customers.
- Negative sequence currents.
- Power swings.
- Natural causes like storms, lightning etc.,
- Theft (nearly 20% in India).
- Manual mal operation of devices.

Considering the above power network area problems, maintaining the desired voltage level in buses is a challenging issue. Normally voltage and reactive power are inter-related. Modifying reactive power will maintain the desired voltage buses as well as in transmission lines.

2.2 Sorting the Problems

These problems can affect the power system performances. The control of reactive power is needed for power quality issues. The stability of AC systems is increased by reactive power compensation. Series and shunt compensation is required to compensate reactive power.

2.3 Traditional Methods

Traditionally, Reimbursement of reactive power can be by:

- Generator excitation directive.
- Reconfiguration of EB composition.
- Synchronous Reimbursement.
- Voltage alterations by tapping of transformer to adjust the flow of power in the grid.
- Series capacitors used for reimbursement.
- Shunt reactor or shunt capacitor for switching.
- Magnetic supervised reactor

3. Importance of Remunerations in reactive power

VAR remuneration is defined as the organizing of reactive power to boost the accomplishment of an alternating current power system. The concept of VAR remuneration receive enthusiastically a wide diverse field of customer problems and also power system crisis related with power caliber issues, since most of power quality problems can be virulence or solved with organizing of reactive power. The problems occurs in remunerations of reactive power are load reimbursement and voltage support. In load reimbursement the ambition is to boost the value of the system power factor, to equilibrium the real power drawn from the alternating current supply, compensate regulation of voltage and to limit current harmonic components are produced by large and variation non linear inductive loads. Reactive power remunerations are much needed for better distribution in the EB side. Optimal voltage is needed to eliminate losses that occur in distribution side.

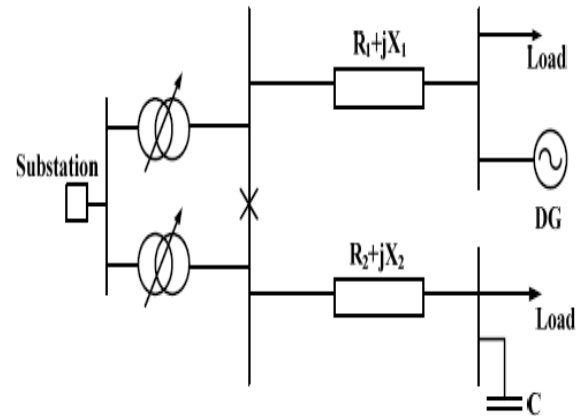


Fig. 1: Simple System for Voltage control

3.1 Basic compensations to modify reactive power

Shunt and series remunerations are used to vary the reactive power. Series reimbursement alters the parameters of transmission or distribution system, while shunt remunerations modifies the effective resistance of the load. Generally loads are inductive in nature, needs a capacitive VAR compensation. In normal practice, Shunt capacitors with suitable reactive power limits are the excellent choice connected with buses to be maintained with suitable voltage profile.

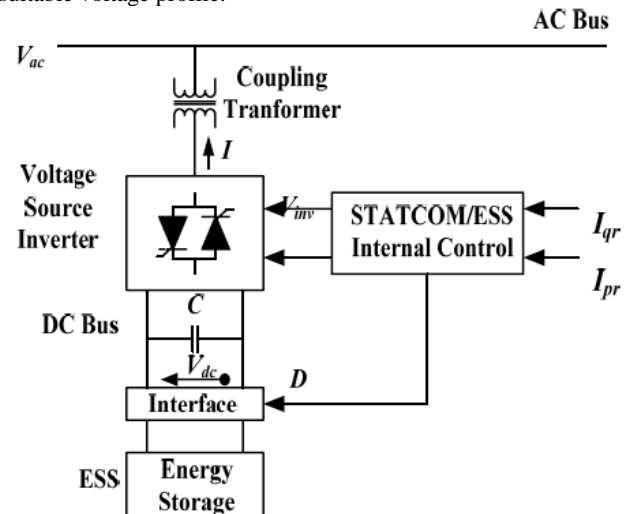


Fig. 2: Statcom for reactive power compensation

Commercially they are known as capacitor banks placed at a substation in a distribution network system. They are economical with suitable life period for some years. In rural areas in India, shunt capacitor bank is a best choice for modifying reactive power. Also they have been eliminated the harmonics generated in an ac power system.

4. FACTS devices

Nowadays FACTS (Flexible AC Transmission System) devices are also been used in some places. They are very fast devices controlled by thyristors with suitable reliability. In our India, especially in rural areas, these devices will be an excellent choice. But there is a difficulty of using these devices in our existing infrastructure of our power system in rural areas. It will need some initial investment to change our infrastructure.

Our Tamilnadu Electricity Board doesn't have the ability to change all our distribution networks in rural areas due to the lack

of revenues. Statistics have been shown a number of rupees 40,000 crores (1\$=57 rupees) is found as a loss per year. These above facts made a traditional compensation device like a shunt capacitor is our only economical as well as a best choice for rural networks for modifying reactive power. The upcoming generation requires high quality of power and balance in power distribution.

The reactive power balance methods before the arrival of SVC are:

- Arrangements of EB setup in different forms.
- Excitements of Generator
- Compensation by synchronous method.
- Modification of voltage by Tap modifying transformer
- Capacitor compensation by series setup.
- Shunt reactor or shunt capacitor ON/OFF switch
- Controlling reactor magnetically

Compared to above remunerations methods, the Static VarCompensator plays vital role in compensation. The SVC has different application, such as TCR, TSC, TSR and BSC. The SVC mentioned is composed of TCR and BSC and also it deals with the need of SVC for Voltage balance and modifications in alternating load.

4.1 OLTC

The other devices for modifying reactive power are the OLTC (On Load Tap Changer) and the distribution transformers with taps are commonly used in our ac transmission system. The three levels of voltage are controlled by tap changing transformer. The reactive power response is fast by generator adjustment.

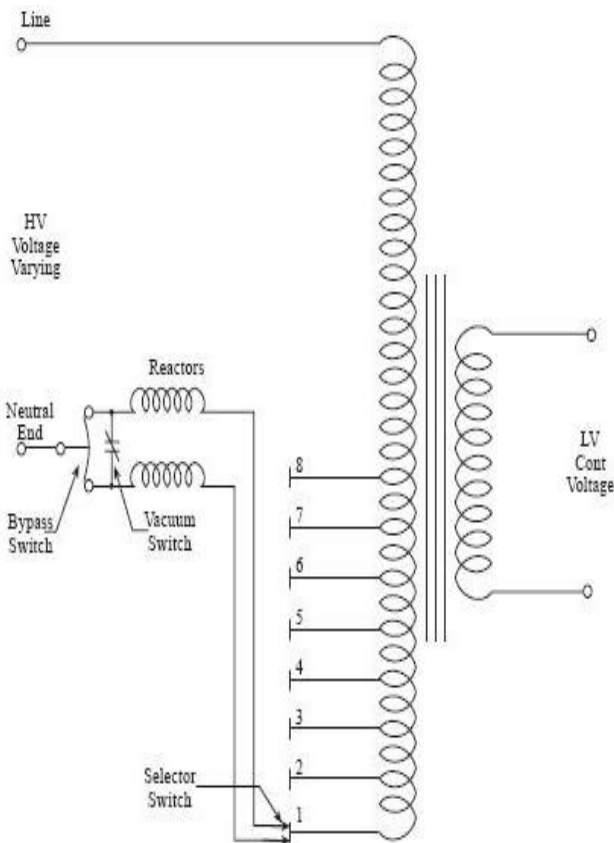


Fig. 3: On load tap changer for reactive power compensation

OLTC is a 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 interrupt in primary side. On this research, a voltage expert control method and implementation are

done based on fuzzy analyser and controller system presented for voltage security and stability.

4.2 Why SVC?

For varying reactive power at high response time, Static VarCompensator can be used to generate a constant Voltage. In long distance transmission line, due to Ferranti effect, the increase power at receiving side are limited by SVC. For solving this problem, the SVC is installed at power distribution system.

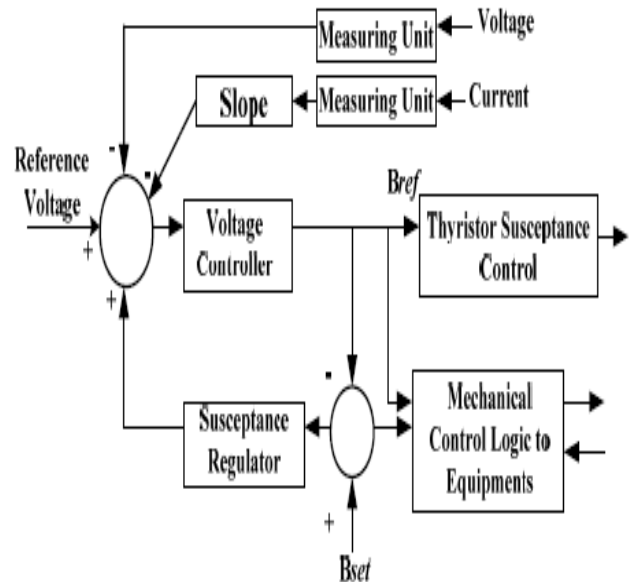


Fig. 4: SVC for reactive power compensation

Benefits

- Regulates the Voltage.
- Increase the constant stabilization of power system.
- Capacity of Transmission line.
- Modify transient over voltage.
- Modifies the voltage at three phases.
- Organize the voltage in DC system and provide remunerations in reactive power.
- Improves stability of the power system.
- Remuneration of the reactive power, leads to gradual improvement in the power factor and quality.
- Reduction in the various losses of system.

4.3 Expert systems (Fuzzy logic control)

The main contribution of the research is maintaining the system voltage, using fuzzy control logic. This thesis will give some idea for controlling voltage in buses, reducing distribution losses, improving load side power factor. It provides a solution for technical problems always arising in a power system. Distribution side power systems are improved by Fuzzy logic analyzer and controller. It deals with unpredictability and problem solving applications. The distribution management are encrypted with fuzzy sets analyzer and controller. KBS used to locate the status present in polling of meters. The real time data are analyzed by knowledge based systems.

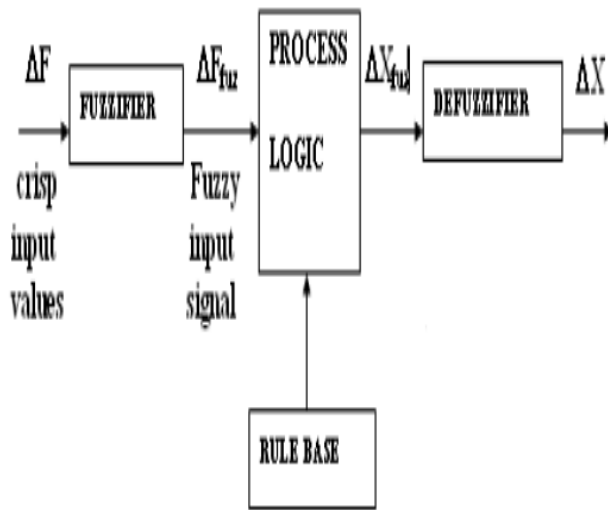


Fig. 5: Structure of fuzzy load flow controller

SIMULINK and vehicle simulation software ADVISOR are innovated in this research to model the modern power system in India. The stability of voltage, load flow solutions is analyzed by fuzzy sets by comparison for critical base voltage also. The expert fuzzy sets modify the reactive voltage and reimburse the reactive power for constant distribution management systems.

5. Conclusion

Collecting some substations data for a period of time duration and a proper analyzing the data is to be carried out. Fuzzy membership functions are to be developed. The fuzzy rules are then to be written for the individual and the co ordination of VAR compensating devices like OLTC, SVC and the switching capacitors etc. All these things are carried out by using MATLAB software only. The comparison between the fuzzy expert system and the conventional methods is to be displayed for the validity of this approach.

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