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Review on Reactive Power Compensation in Short Transmission Line

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ABSTRACT
Flexible AC Transmission Systems (FACTS) devices is the most advanced devices for power flow control in short transmission line, medium transmission line and long transmission line. Awareness of power quality and power flow is big deal in power system because voltage sags, swells, harmonics etc. are the various power quality problem as well as power flow problem. Short transmission line are considered as uncompensated short transmission line and then compensated short transmission line with different FACTs devices are Reviews. Review of reactive power compensation through different research review and author. These papers are focused on problem related to reactive power compensation.

Keywords: FACTS, TCSC, STATCOM, UPFC, SSSC, real and reactive power

I Introduction

Reactive power is the power that supplies the stored energy in reactive elements. Power, as we know consists of two components, active and reactive power. The total sum of active and reactive power is called as apparent power. In AC circuits, energy is stored temporarily in inductive and capacitive elements, which results in the periodic reversal of the direction of flow of energy between the source and the load [1].

In AC circuits, energy is stored temporarily in inductive and capacitive elements, which results in the periodic reversal of the direction of flow of energy between the source and the load. The average power after the completion of one whole cycle of the AC waveform is the real power, and this is the usable energy of the system and is used to do work, whereas the portion of power flow which is temporarily stored in the form of magnetic or electric fields and flows back and forth in the transmission line due to inductive and capacitive network elements is known as reactive power. This is the unused power which the system has to incur in order to transmit power [2].

Inductors (reactors) are said to store or absorb reactive power, because they store energy in the form of a magnetic field. Therefore, when a voltage is initially applied across a coil, a magnetic field builds up, and the current reaches the full value after a certain period of time. This in turn causes the current to lag the voltage in phase [3].

Capacitors are said to generate reactive power, because they store energy in the form of an electric field. Therefore when current passes through the capacitor, a charge is built up to produce the full voltage difference over a certain period of time. Thus in an AC network the voltage across the capacitor is always charging. Since, the capacitor tends to oppose this change; it causes the voltage to lag behind current in phase [4].

II Need for Reactive power compensation

Electrical energy is generated, transmitted, distributed, and utilized as alternating current (AC). But the alternating current has several disadvantages. One of these is the need of reactive power that is required to be supplied along with active power. Reactive power can be leading or lagging. The total power comprises of active and reactive power and there is no other need of the reactive power in the transmission and distribution.

Reactive power is generated or consumed in almost every component of the system, generation, transmission, and distribution and eventually by the loads. The Reactance contributes to reactive power in the circuit and it can be either inductive or capacitive. Majority of the loads are inductive, and must be supplied with lagging reactive power.

The main reason for reactive power compensation in a system is:

1) The voltage regulation.
2) Increased system stability.
3) Better utilization of machines connected to the system.
4) Reducing losses associated with the system.
5) To prevent voltage collapse as well as voltage sag.

III Research Summary

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Table 1-: Literature survey and methods

1	**Belkacem Mahdad et. al.**	UPFC	IEEE 30-bus system and proposed Newton power flow algorithm	Voltage, Active and Reactive power.
2	**F Gopinath Balakrishna et. al.**	UPFC	Adaptive Neuro Fuzzy Inference System (ANFIS)	Real and Reactive power.
3	**D. Murali, M. Rajaram,**	UPFC, SSSC	UPFC at sending end of SMIB system and comparison with SSSC	Real power, Reactive power and power angle oscillation.
4	**Salim Haddad et. al.**	UPFC	Distribution system	Active and Reactive power
5	**Prashant Dhoble, Arti Bhandakkar**	SSSC, STATCOM	two-area four-machine 11-bus test system model	Active, reactive power flow and voltage control and power oscillation damping (POD)
6	**Raju Pandey, A. K. Kori**	TCSC, UPFC	Comparison of UPFC with TCSC and damping	Real and reactive power
7	**Parvathy S, K C Sindhu Thampatty**	UPFC	Decoupled control scheme for shunt and series converter	Active, Reactive power, Voltage
8	**Vatsal J. Patel, C.B.Bhatt**	TCSC	Power compensation by changing firing angle of TCSC in Transmission line	Reactive power, voltage stability
9	**R.M. Malkar, V.B.Magdum**	FC-TCR, STATCOM	Compensation by changing capacitor rating FACTs device in Transmission line	Real power, Reactive Power and voltage stability
10	**Shyam B. Ghodke, Kompelli Santosh**	SSSC	Two machine power system and power Oscillation damping	Active and Reactive power
11	**Bindeshwar Singh et. al.**	SVC, TCSC, TCPAR, SSSC, STATCOM,UPFC, IPFC, GUPFC, HPFC	Review of FACTs controller.	Reactive power support, Real power losses, Voltage profile, Damping ratio of power systems.
12	**This Paper**	TCSC, STATCOM, UPFC, SSSC	FACTs devices in sending end of transmission line and comparative analysis of FACTs Devices with MATLAB	Real and Reactive power flow control

IV Problem in Transmission Line

Electricity flow through the path of least impedance freely and this flow of electricity may cause certain transmission line to be over loaded or under loaded.

Transmission line with lightly loaded, reactive power generated by the line capacitance become much more as compare to reactive power absorbed by the line inductance, thus resulting voltage increases in the line may exceed the allowable limits.

Transmission line with heavily loaded, reactive power generated by the line capacitance become much less as compare to reactive power needed by the line inductance thus resulting voltage along the line may decrease the accepted limit [5}.

V Flow Chart for Problem & Solution Domain

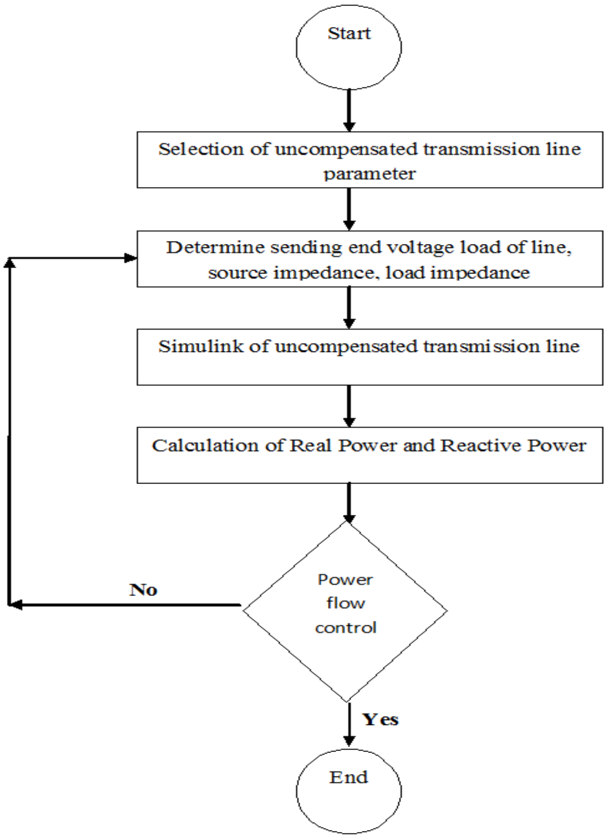

Fig. 1 flow chart for Problem domain

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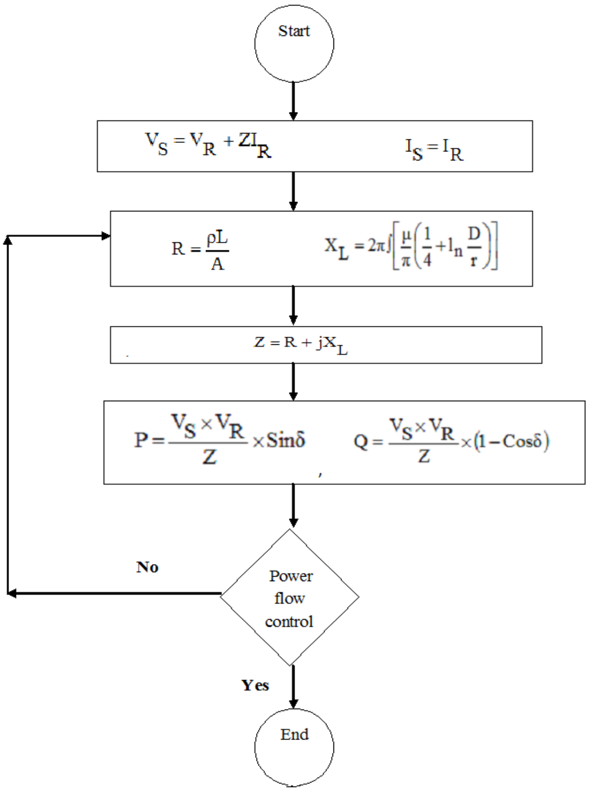

Fig. 2 flow chart for Solution domain

VI Reactive Power Compensation

There are two types of compensation techniques one is the series compensation the other is the shunt compensation:

1. Shunt compensation

The principles and theoretical effects of shunt reactive power compensation in a basic ac system, which comprises a source V_1, a power line and a typical inductive load. Figure 3 shows the system without compensation, and its associated phasor diagram. In the phasor diagram, the phase angle of the current has been related to the load side, which means that the active current IP is in phase with the load voltage V_2. Since the load is assumed inductive, it requires reactive power for proper operation and hence, the source must supply it, increasing the current from the generator and through power lines. If reactive power is supplied near the load, the line current can be reduced or minimized, reducing power losses and improving voltage regulation at the load terminals. This can be done in three ways

a) with a capacitor,
b) with a voltage source,
c) with a current source.

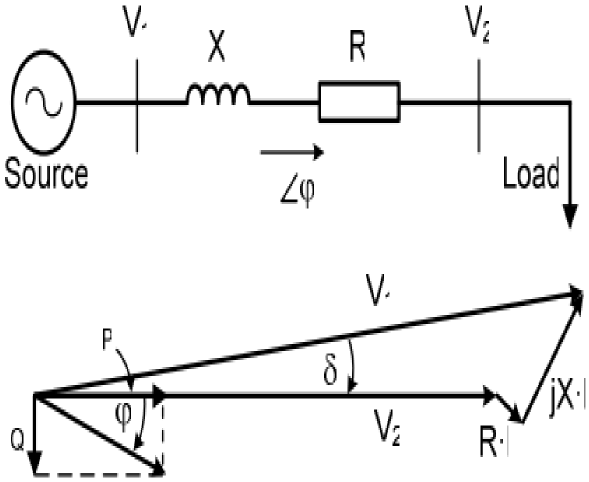

Fig. 3 system without compensation in shunt

In Fig. 4, a current source device is being used to compensate the reactive component of the load current (IQ). As a result, the system voltage regulation is improved and the reactive current component from the source is reduced or almost eliminated. If the load needs leading compensation, then an inductor would be required. Also a current source or a voltage source can be used for inductive shunt compensation. The main advantages of using voltage or current source VAR generators (instead of inductors or capacitors) is that the reactive power generated is independent of the voltage at the point of connection [8].

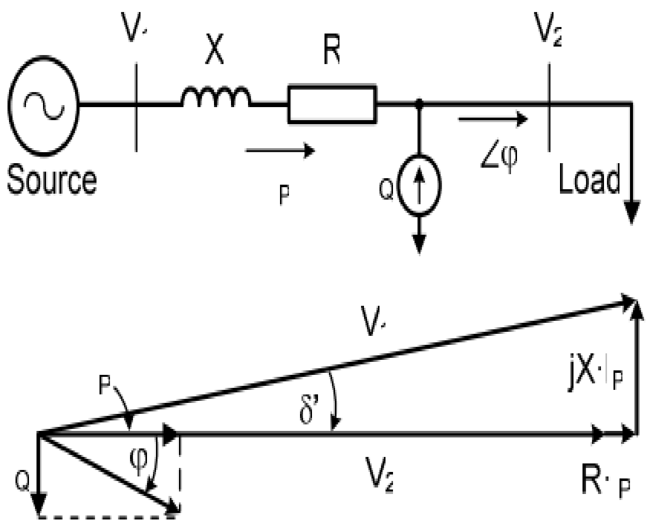

Fig. 4 system with compensation in shunt

2. Series compensation

The principles and theoretical effects of series reactive power compensation systems use capacitors to decrease the

equivalent reactance of a power line at rated frequency. The connection of a series capacitor generates reactive power that, in a self-regulated manner, balances a fraction of the line's transfer reactance. The result is improved functionality of the power transmission system through:
i) increased angular stability of the power corridor,
ii) improved voltage stability of the corridor,
iii) optimized power sharing between parallel circuits.
Series compensation can be implemented like shunt compensation, i.e. with a current or a voltage source as shown in figure 5. The results which are obtained by series compensation through a voltage source and it is adjusted to have unity power factor at V_2.

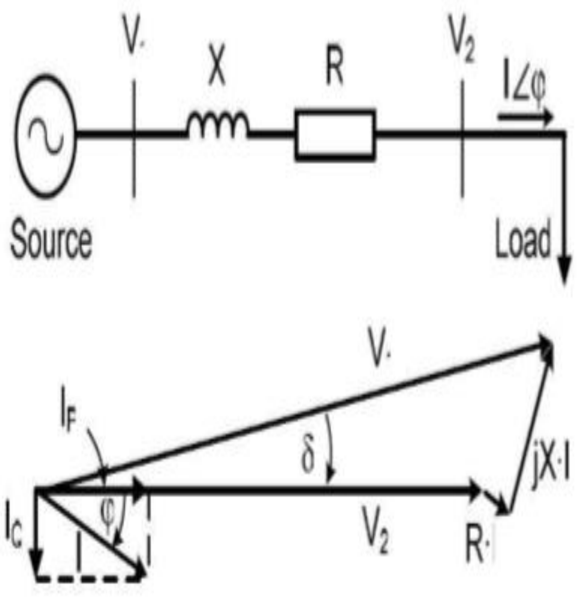

Fig. 5 system without compensation in series

However series compensation techniques are different from shunt compensation techniques, as capacitors are used mostly for series compensation techniques. In this case, the voltage V_{COMP} has been added between the line and the load to change the angle V_2. Now, this is the voltage at the load side. With proper adjustment of the magnitude of V_{COMP}, unity power factor can be reached at V_2.

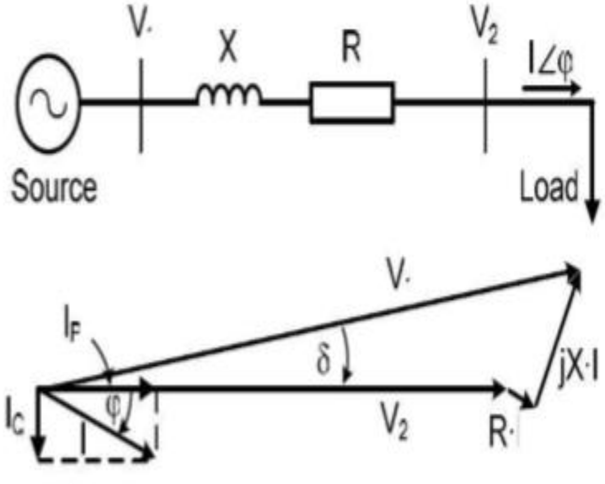

Fig. 6 system with compensation in series

As can be seen from the phasor diagram of Fig. 4, V_{COMP} generates a voltage with opposite direction to the voltage drop in the line inductance because it lags the current [8].

VII Conclusion

The variation of Real and Reactive power with change in capacitance so that Maximum value of Real and Reactive power for better compensation is obtained at different capacitance and different FACTs devices. Reactive power compensation is obtained as per change the value of capacitance for better compensation.

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