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Stability Analysis of AC Transmission Line Using UPFC at Different Lengths of Transmission Line

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ABSTRACT: This paper compares in a load flow calculation, line losses, reactive power and active power and power factor comparison Unified Power Flow Controller (UPFC).This research deals with simulation of transmission line using UPFC to improve the real and reactive power flow control through a transmission line. In this research paper a Simulink Model is considered with UPFC model to evaluate the performance of a single and double transmission line systems (500/230) kV. In the simulation study, the UPFC models ease the real time control and dynamic compensation of AC transmission system**.** Role of ttransient stability control plays a significant role in ensuring the stable operation of power systems in the event of large disturbances and faults. In effect, from the point of view of both dynamic and steady-state operation, the system is really uncontrolled. Because all FACTS Controllers represent applications of the same basic technology, their production can eventually take advantage of technologies of scale. Just as the transistor is the basic element for a whole variety of microelectronic chips and circuits, the thyristor or high-power transistor is the basic element for a variety of high-power electronic Controllers. FACTS devices are capable of controlling the active and reactive power flows in a transmission line by controlling its series and shunt parameters [1, 2, 3].

KEYWORDS:FACTS, UPFC,VAR, STATCOM, SSSC.

I.INTRODUCTION

Power flow analysis is also used to determine the steady state operating condition of a power system. For the planning and operation of power distribution system. With the rapid development of power electronics technology and computer control technology, a variety of new type of automatic, fast reactive power compensation device have appeared. Early in time, mechanical switching capacitor device is used in power grid, it was switched on group though circuit breaker or contactor. When the circuit breaker is used in the power grid to put into capacitor or filter, a great change and development have taken place. On the one hand, it may produce the stretching discharge phenomena and so on, this phenomenon will reduce action times of circuit breakers, therefore it should not to be switched frequently; On the other hand, and due to the action time of mechanical circuit breaker contact is dispersion. So it is lack of synchronicity, and willinevitably produce transition process. This result may cause system shock, especially frequent switching the circuit breaker will make the system unstable [1, 2]. Static Var Compensator is the shunt compensation equipment of thyristor switched for reactive compensation in power system as a reactive source.

Recent development of power electronics introduces the use of FACTS controllers in power systems. FACTS controllers are capable of controlling the network condition in a very fast manner and this feature of FACTS can be exploited to improve the voltage stability, and steady state and transient stabilities of a complex power system. This allows increased utilization of existing network closer to its thermal loading capacity, and thus avoiding the need to construct new transmission lines. The well known FACTS devices are namely SVC,SSSC, STATCOM and UPFC.

II. UNIFIED POWER FLOW CONTROLLER (UPFC)

Among the available FACTS devices, the Unified Power Flow Controller (UPFC) is the most versatile device that can be used to enhance steady state stability, dynamic stability and transient stability.

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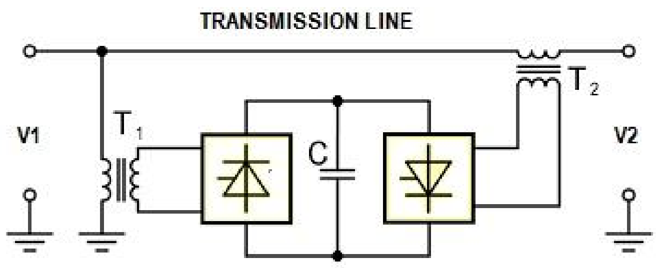

Figure 1 Basic structure of upfc

The UPFC is an advanced power system device capable of
Providing simultaneous control of voltage magnitude, active and reactive power flows in an adaptive fashion. It has

- Extended functionality
- Capability to control voltage, line impedance and phase angle in the power system network
- Enhanced power transfer capability
- Ability to decrease generation cost
- Ability to improve security and stability
- Applicability for power flow control, loop flow control

In this paper, a comprehensive method is developed for power flow analysis of a transmission system with UPFC Simulink Model to evaluate the performance of a single and double transmission line system has been focused. The aim of this technique is to control the real andreactive power flow in the transmission lines, by effectively changing the firing angle of shunt converter and modulation index of the series converter the two leg three phase converters based on UPFC. They suggests that theUPFC with their controller successfully increase the real as well as reactive power flow and improves voltage profile The basic configuration of a UPFC is shown in Fig. 4. The UPFC is capable of both supplying and absorbing real and reactive power and it consists of two ac/dc converters. One of the two converters is connected in series with the transmission line through a series transformer and the other in parallel with the line through a shunt transformer. The dc side of the two converters is connected through a common capacitor, which provides dc voltage for the converter operation. The power balance between the series and shunt converters is a prerequisite to maintain a constant voltage across the dc capacitor. As the series branch of the UPFC injects a voltage of variable magnitude and phase angle, it can exchange real power with the transmission line and thus improves the power flow capability of the line as well as its transient stability limit. The shunt converter exchanges a current of controllable magnitude and power factor angle with the power system. It is normally controlled to balance the real Power absorbed from or injected into the power system by the series converter plus the losses by regulating the dc bus voltage at a desired value.The UPFC has many possible operating modes.VAR control mode and the reference input is asimple var request that is maintained by thecontrol system regardless of bus voltage.

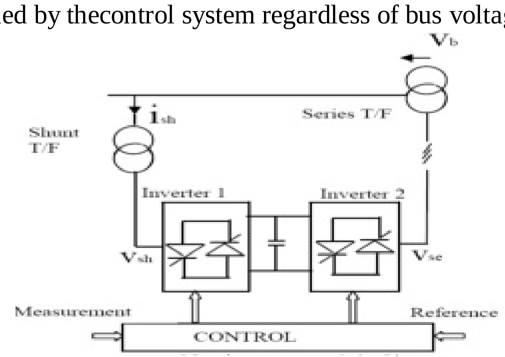

Figure 2 UPFC in a transmission line

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III. INVESTIGATION OF TRANSMISSION LINE WITH UPFC

Simulink Model of 500/230KvkV Transmission Lines [3]**:**The Simulink Model is shown in Fig.5 represents the doubleLine transmission model which consists of normal circuit and compensation circuit with an UPFC device.. The real power needed by the compensation circuit to mitigate the compensation is exactly equal to the real power delivered by the normal circuit which includes both line and converterswitching losses.
Fig 3 Now we have the MATLAB Simulink model of Figure6singlelinediagram with UPFC of 500/230Kv transmission system for length When L1=60KM, L2=L3=45KM

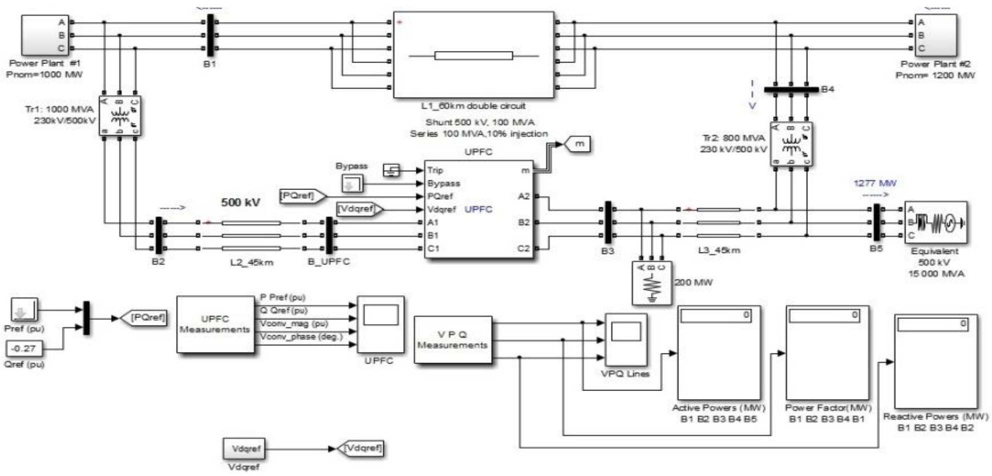

Figure 3: MATLAB Simulink model of single line diagram of above transmission line without using UPFC.

IV. COMPARISON BETWEEN UPFC ACTIVE, REACTIVE AND POWER FACTOR VALUES FOR POWER SYSTEM STABILITY

Description of a single line diagram [3]–

1.Thesinglelinediagramofa 500kv/230kvtransmissionsystem.Thesystem isconnectedinaloopconfigurationconsistsof5 buses(b1tob5),interconnectedto3transmission line (L1, L2, L3) and two 500kv/230kv transformerbank tr1, tr2.

2.Twopowerplantslocatedon230kvsystem, generateatotalof1500MWpower,whichis transmitted to a 500kv, 15000 MVAand to a200 MWRLCloadconnectedatbusB3.

3.UPFC or any other device is connected at the right end line L2is used to control the active or reactive power at bus UPFC is connected at the right end of line L2 is used to control the active and reactive power at the 500 kv bus b3 .Each plant model includes a speed regulator, an excitation system as well as power system stabilizer. The 1200 MW generating capacity power plant p1 is exported to the 500 KV equivalents through two 400MVA transformer connected between (B4, B5) BUS.

4. The UPFC is joined at the right end of line L2 is used to control the active and reactive power at the 500kv bus B3 the UPFC used here include two 100 MVA, IGBT based converters (one series converter and one shunt converter) both the converter are interconnected through a DC bus two voltage source inverter connected by a capacitor charged to a DC voltage realize the UPFC the converter number one which is a shunt converter draws real power from the source and exchange it (minus the losses) to the series converter the power balance between the shunt and series converter is maintained to keep the voltage across the DC link constant capacitor.

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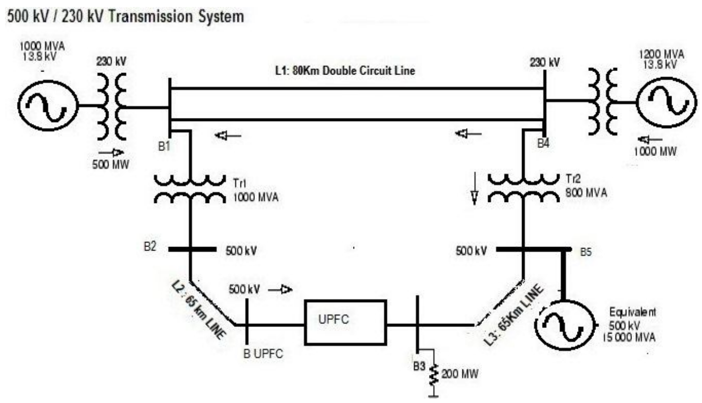

Figure4singlelinediagram with UPFC of 500/230Kv transmission system for length When L1=80KM, L2=L3=65KM

Now as we in the fig.4 we have taken the length of double transmission line L1 of 80km and the other transmission line as L2 of 65km and L3 also of 65km in the MATLAB SIMULINK of this circuit.Thesystem isconnectedinaloopconfigurationconsistsof5 buses(b1tob5),interconnectedto3transmission line(L1,L2,L3) and two 500kv/230kv transformerbank tr1, tr2.Two power plants located on the 230 kV system generate a total of 1500 MW (illustrated in figure 2) which is transmitted to a 500 kV, 15000 MVA equivalent and to a 200 MW load connected at bus B3. Each plant model includes a speed regulator, an excitation system as well as a power system stabilizer (PSS). In normal operation, most of the 1200 MW generating capacity power plant P1 is exported to the 500 kV equivalents through two 400 MVA transformer connected between buses B4 and B5 .The UPFC is connected at the right end of line L2 is used to control the active and reactive power at the 500kv bus B3 the UPFC.As we run the model we get the result values of active power, reactive power loss and power factor.

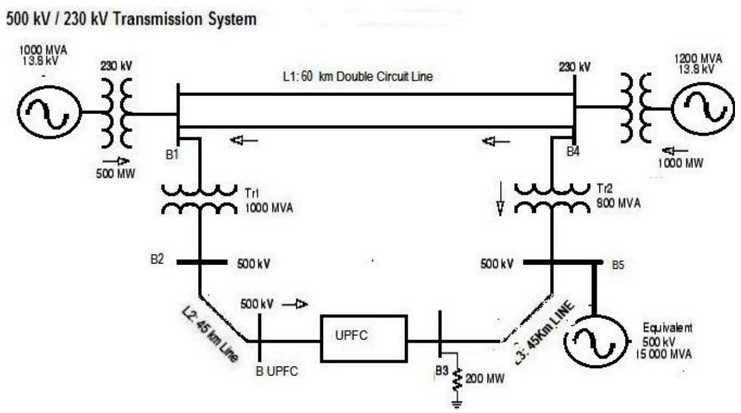

Figure5singlelinediagram with UPFC of 500/230Kv transmission system for length When L1=60KM, L2=L3=45KM

Now as we in the fig.5 we taken the length of double transmission line L1 of 60km and the other transmission line as L2 of 45km and L3 also of 45km in the MATLAB SIMULINK of this circuitas we run the model we get the result values of active power, reactive power loss and power factor.

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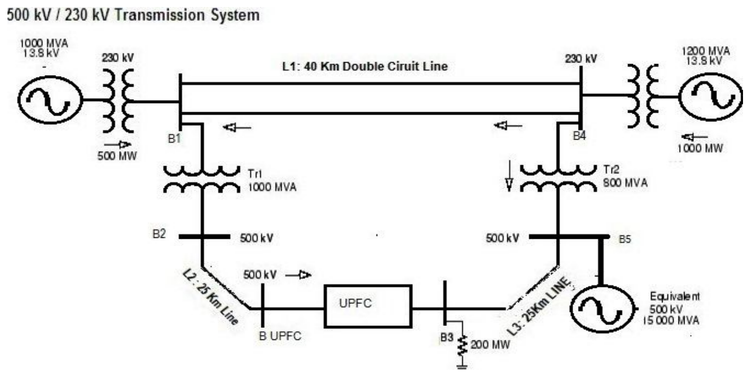

Figure6singlelinediagram with UPFC of 500/230Kv transmission system for length When L1=40KM, L2=L3=25KM

Now as we in the fig.6 we taken the length of double transmission line L1 of 40km and the other transmission line as L2 of 25km and L3 also of 25km in the MATLAB SIMULINK of this circuitAs we run the model we get the result values of active power, reactive power loss and power factor.

V. RESULTS

Table 1 shows the comparison of UPFC (fact device) of a circuit. In table 1 we have included the results of the active power, reactive power and power factor values of the several of a particular length. And we investigated that the various values of length of transmission line we have drawn the various graph.We have observed that at various lengths of the transmission line the medium length have more active power, less reactive power loss and also very good power factor as compared to other lengths of the transmission line.

As we see in the table that we see that the comparison of reactive power for various length. We analysis that the medium length have observe more reactive power as compared to others. The medium lengths have more of the reactive power absorption as compared to other lengths.

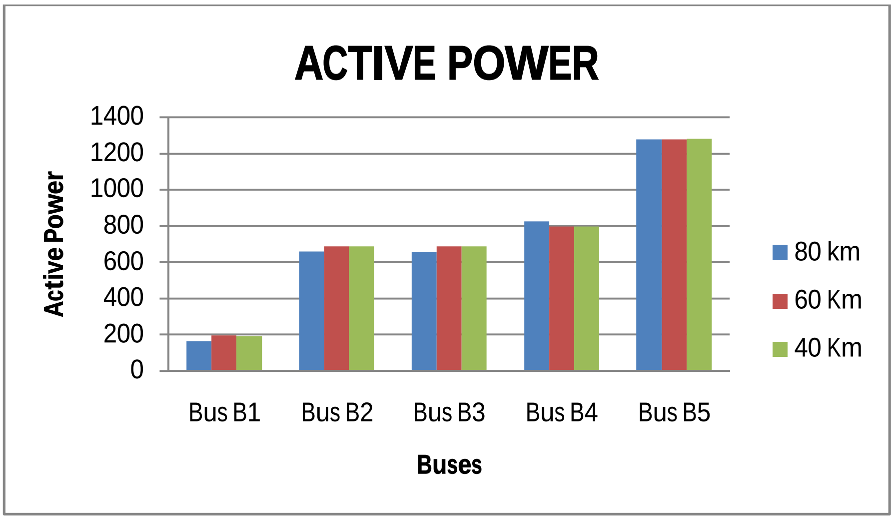

Figure 7 Active powers Comparison Plot for various buses and for different lengths

As we see in the above fig.7 we see that the comparison of active power for various length. We analysefrom the bar graph that the medium length have more active power as compared to others.

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If we draw again the comparison in the form of line graph as seen in the the fig. we obserbe that both graph show the result that the medium length have more active as compared in the graph.

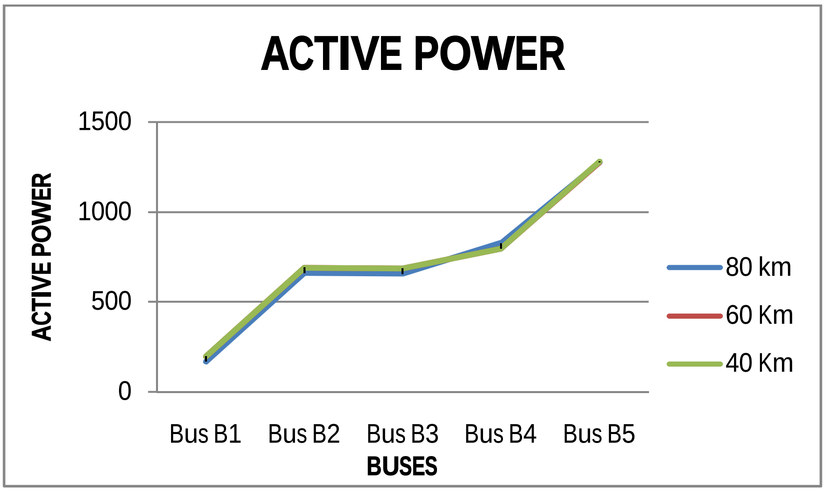

Figure 8 Active powers Comparison Plot for various buses and for different lengths

As we see in the above fig.8 we see that the comparison of active power for various length. We analyse that the medium length have more active power as compared to others. The graph shows the result in fig7.

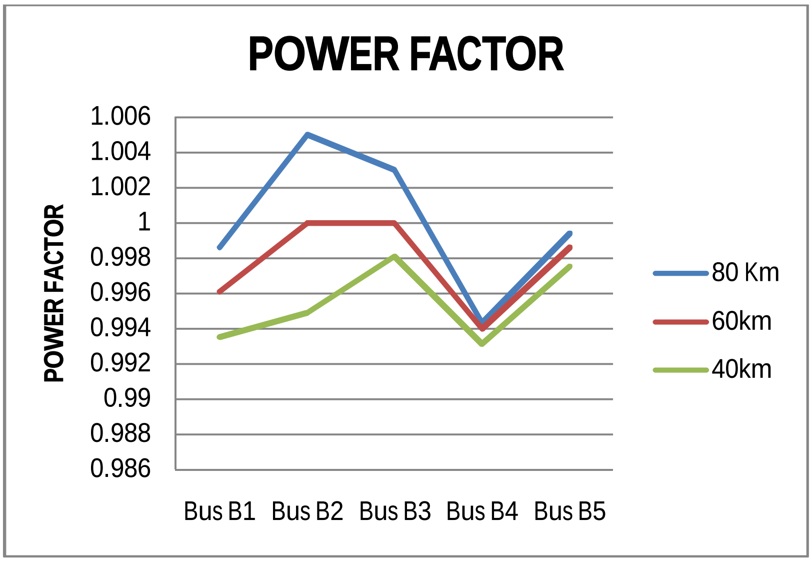

Figure 9 Active powers Comparison Plot for various buses and for different lengths

As we see in the above fig.9 we see that the comparison of active power for various length. We analyse that the medium length have more active power as compared to others. The graph shows the result in fig. 9.

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Table 1: Comparison between the values of UPFC at different lengths

	When L1=80KM,L2=L3=65KM			When L1=60KM, L2=L3=45KM			When L1=40KM, L2=L3=25KM		
BUSES	REAL POWER	REACTIVE POWER LOSS	POWER FACTOR	REAL POWER	REACTIV E POWER LOSS	POWER FACTO R	REAL POWER	REACTIV E POWER LOSS	POWER FACTOR
B1	166.6	-25.77	0.9986	196.3	-29.47	0.9961	195.4	-25.55	0.9935
B2	659.9	-99.58	1.005	689.4	-88.3	1	688.5	-64.11	0.9949
B3	656.7	-27	1.003	687	-27	1	687	-27	0.9981
B4	826.1	17	0.9943	796.4	16.07	0.994	797.8	17.56	0.9931
B5	1275	-81.19	0.9994	1277	-93.42	0.9986	1280	-110.1	0.9975

VI. CONCLUSION

In this paper the response of the various facts devices has studied on the bases of load flow comparison and cost par var. UPFC has the attributes of Superior dynamic response & fast fault recovery as compared to that of conventional facts devices. FACTS are powerful devices to improve the voltage profile and power system enhancement. In this paper, comparison of different FACTS devices with respect System Stability Enhancement is carried out and gives an idea about the FACT devices. It is found that the performance of the UPFC is higher for power system stability improvement in the range of UPFC of 500/230Kv transmission system for length When L1=60KM, L2=L3=45KM. The UPFC system has the advantages like reducemaintenance and ability to control real and reactive power.

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