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Reactive Power Control in Power System using Modified UPFC

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Abstract**—*****The power system is a exceptionally nonlinear system that works in an always showing signs of change condition, loads, generator yields, topology and key working parameters changes consistently. The stability of the system depends on the nature of the disturbance as well as the initial operating condition. The power congestion known as the limitations to how much power can be transferred across a transmission interfaces and further that there is an incentive to actually desire to transfer more power. The old approach was to correct congestion lies in reinforcing the system with additional transmission capacity. Although easy to perform, this approach is complex, time consuming and costly. It is ending up noticeably progressively hard to get the licenses to building new transmission passages, or even grow existing ones. This issue can be solved by introducing Facts devices in the transmission system. Facts Devices play an imperative part in controlling the reactive and active power flow to the power network and thus both the system voltage variances and transient stability. Among Facts device Unified Power Flow Controller (UPFC) is the most versatile and complex power electronic equipment which can increase reliability and can serve as an alternative to new investments in overhead lines, which are difficult due to a lack of public support. The proposed work is based on control of reactive power in power system utilizing modified Unified Power Flow Controller (UPFC). The impact of customary UPFC and modified UPFC on the power flow of transmission lines were analyzed.*

Keywords—***Flexible AC Transmission System (FACTS), Modified DC Link Capacitor, Matlab Simulink. Power System, Reactive Power, Unified Power Flow Controller (UPFC).***

I. INTRODUCTION

In this world of ever expanding consumers the design of a particular device is to be done with utmost care. It is well known that with the help of present overhead (OH) transmission line it will become impossible to laying a new transmission line for increase in consumers to supply them their electric needs. So to supply the electric need of every consumer after 10-20 years we have done to lay a new transmission line as these so called FACTS devices are available in the market.

Unified power flow Controller (UPFC) is the most versatile converters among the Flexible AC Transmission System (FACTS) devices [1-5]. It comprises of two voltage source converters (VSC), one is connected with parallel with transmission line to insert a reactive power in the transmission line and other is connected with series with the transmission line to insert active power in the transmission line, by this way this converter will compensate the reactive power and active power all together or independently [6].The UPFC is a combination of static synchronous compensator and static synchronous series compensator which are connected via a common DC link, as shown in fig.1 to allow bi-directional flow of real power between series output terminals of SSSC and the shunt terminals of the STATCOM, and is allowed to provide concurrent real and reactive power compensation. These two devices are two voltage source inverters (VSI), operated from a common DC link provided by a DC storage capacitor.

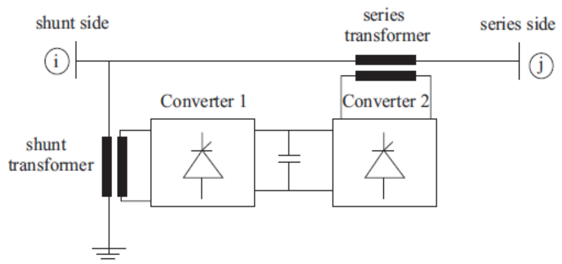

Fig. 1: Schematic Diagram of Conventional UPFC

Ratings of this DC link capacitor bank may have a significant impact on the cost and physical size of the UPFC. The capacitor is sized for a specified ripple voltage, typically 10% of the nominal voltage. The main drawback with this DC link capacitor is its design for maintaining the desired ripple [7]. Also this capacitor has shorter life when compared to AC capacitor of same rating. This limits the life and reliability of the voltage source inverter [8].

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II. THE PROPOSED SCHEME OF UPFC

An effort has been taken to remove the DC link capacitor in the UPFC without affecting its performances. The DC link of conventional UPFC has been modified with lengthened the DC link as in field and one extra transmission line need to be lay. Finally the combined responses are compared for simplicity. Various observations are made only on a single phase Unified Power Flow Controller (UPFC). As the exchange of active and reactive power is taking place in between the shunt and series part, the location of series and shunt part is of most important. The power system stability, efficiency and disturbance problems in power system are undefined in the grid. To enhance the power system strength efficiency, the shunt portion of Unified Power Flow Controller UPFC ought to be situated in the place from where it can diminish the impact of voltage changes and the series part ought to be situated in where its parameter changes impact the variation of active and reactive power the most [9,10,11]. Ignoring the cost involved in laying one extra line, this approach can be used to improve the system stability condition using UPFC with lengthening DC link, and where we can install the UPFC in our required location as shown in fig.2 and fig.3.

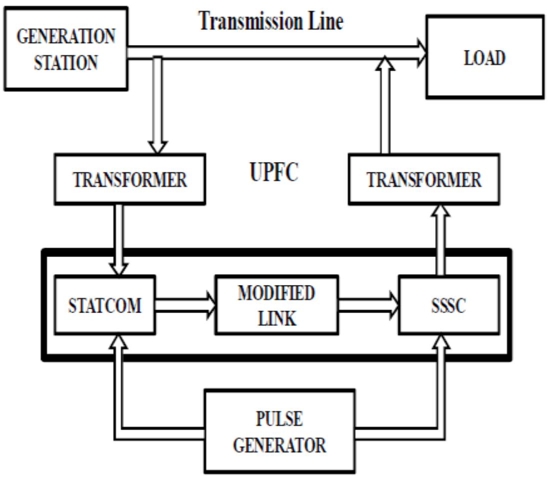

Fig. 2: Block Diagram of Modified UPFC

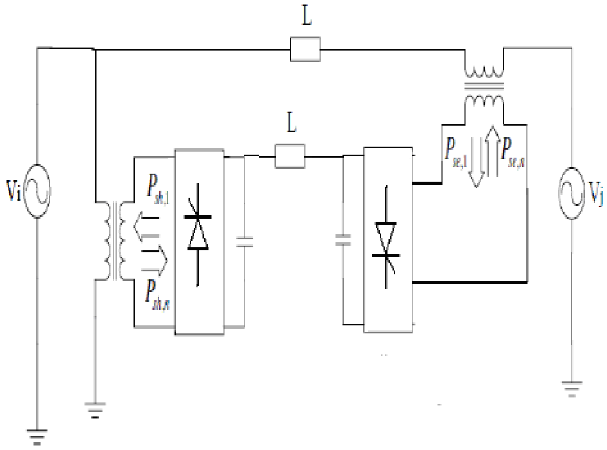

Fig. 3: Schematic Diagram of proposed UPFC

III. SIMULINK MODEL OF 22KV TRANSMISSION LINE

Experiments carried out for 22kv transmission line system for three different cases.

a. Without UPFC
b. Conventional UPFC
c. Modified UPFC.

3.1 Without UPFC

In this model of transmission line, there is a 22 kV voltage source is feeding to an RL load. For measurement of current a current measurement block named CT is connected in the circuit, whose output can be taken from the scope 'current' connected to this block. A block for voltage measurement named V is connected across the load. The output of this voltage measurement block is fed to the scope named voltage for voltage waveform. Further a block for power measurement is connected the circuit to calculate the power consumed by the load. This power measurement block is further connected to the demux, for obtaining the power in terms of real and reactive power. The power outputs of this demux can be obtained from the two scopes connected to it. All the blocks used in this transmission line model are taken from the SimPower System toolbox of Matlab Simulink.

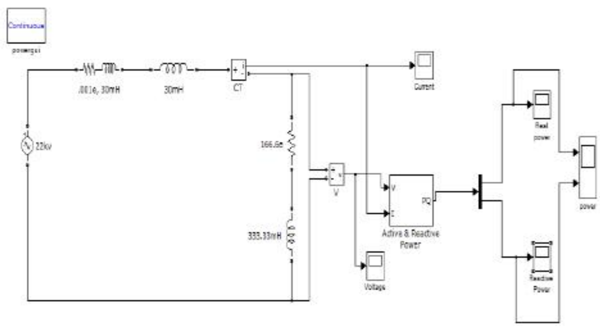

Fig. 4: Simulink Model of 22 k V Transmission Line without UPFC

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3.2 With Conventional UPFC

The following model in fig 5 shows the Simulink model of 22kv transmission line when conventional UPFC is incorporated in system. The conventional UPFC consists of two voltage source inverter with common DC link capacitor.

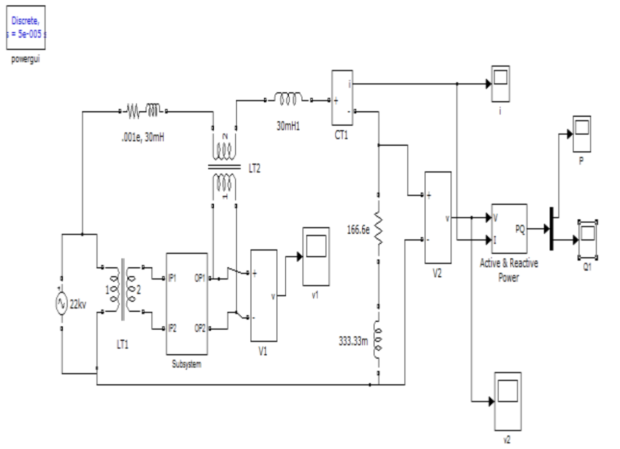

Fig. 5: Simulink Model of 22 k V Transmission Line with conventional UPFC

3.3 With Modified UPFC

The following model in fig 6 shows the Simulink model of 22kv transmission line when modified UPFC is incorporated in system.

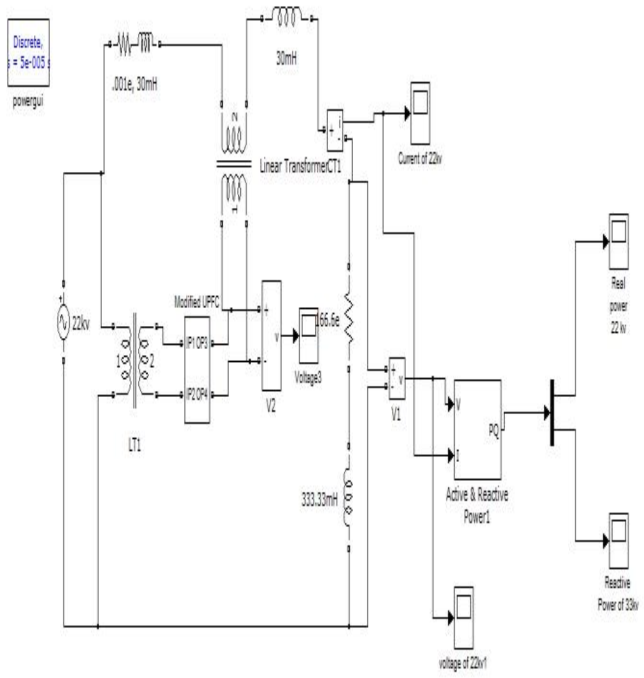

Fig. 6: Simulink Model of 22 k V Transmission Line with modified UPFC

IV. SIMULATION RESULT

4.1 Without UPFC

The following fig. shows the reactive power waveform of 22kV transmission line without UPFC (Simulink model of 22kV transmission line is developed in fig.4). At the steady state time t=0.02 sec the Reactive Power is 0.62 MVAr.

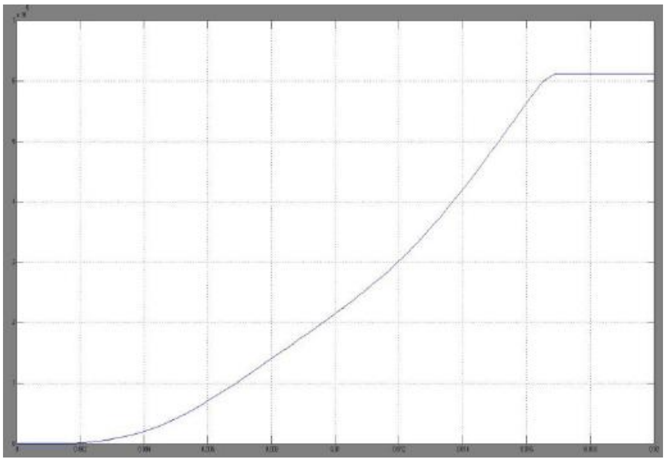

Fig. 7: Reactive Power waveform of 22kV line without UPFC

4.2 With Conventional UPFC

The following fig. shows the reactive power waveform of 22kV transmission line with conventional UPFC (Simulink model of 22kV transmission line is developed in fig. 5). At the steady state time t=0.02 sec the Reactive Power is 0.70 MVAr.

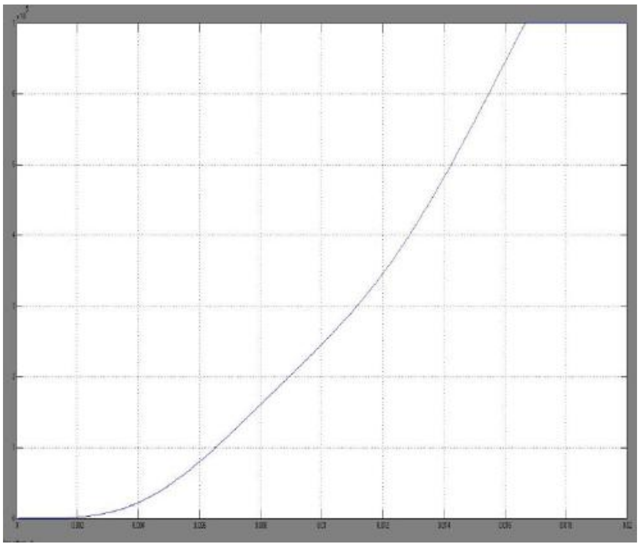

Fig. 8: Reactive Power waveform of 22kV line with conventional UPFC

4.3 With Modified UPFC

The following fig. shows the reactive power waveform of 22kV transmission line with modified UPFC (Simulink model of 22kV transmission line is developed in fig.6).

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At the steady state time t=0.02 sec the Reactive Power is 0.69 MVAr.

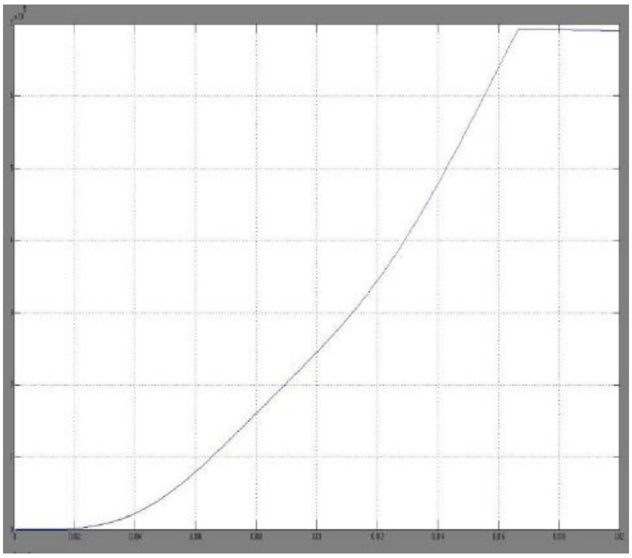


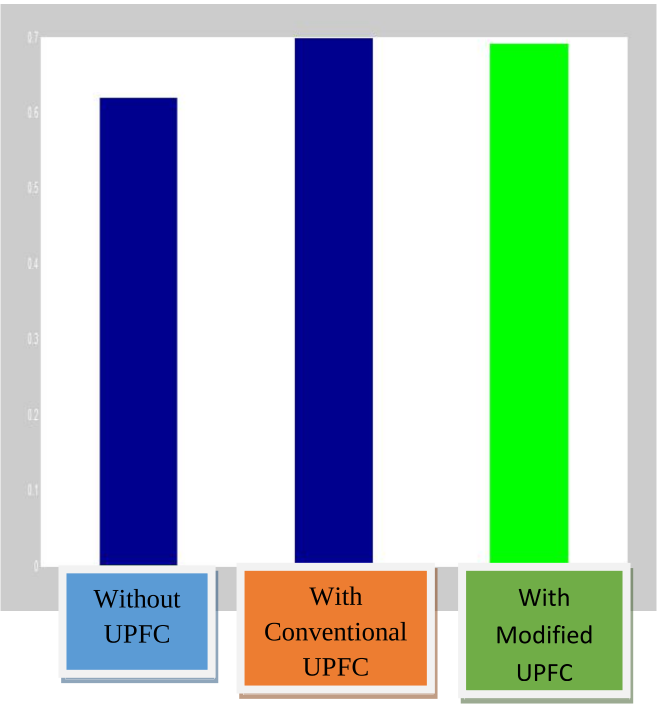
Fig. 9: Reactive Power waveform of 22kV line with modified UPFC

4.4 Comparison of Result

The summery of above results for 22KV line is given below in table.

Parameters	Without UPFC	With Conventional UPFC	With Modified UPFC
Reactive Power	0.62 MW	0.70 MW	0.69 MW

The summery of above results for 22KV line is given below using bar chart.



V. CONCLUSION

This work presents a single phase new UPFC concept of transmitting power with modified DC link between series and shunt part of UPFC, which gives more flexibility of UPFC installation. The active power exchange between shunt and series is transmitted through a single DC transmission line. The UPFC can be install at different location with extended DC link which will reduces the effect of harmonics problems encounter in UPFC with eliminated DC link. However it reduces the power transmission capability slightly as shown in result and additional lossless in the transmission line and transformers. But both the modified UPFC have the full function as conventional UPFC. The separated series part of this UPFC will reduce the cost significantly and have a lot of extra benefits, such as higher reliability, convenient for installation and maintenance.

The performance of the proposed schemes has been analyzed with MATLAB/Simulink assuming that the UPFC is connected with the 22 kV transmission line of sample power system. The proposed schemes of UPFC interfaced in the power system accomplish a similar performance as that of a traditional scheme.

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