Reactive Power Management by Shunt and Series Compensation Technique in 765 kV Transmission Line

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***Abstract*- This paper represents an overview of the reactive power and static VAr compensation technologies. VAr compensation involves the management of reactive power for the improvement of electric power system stability. The reactive power management for 765 kV Extra High Voltage AC (EHVAC) transmission system is studied and the effect of shunt and series compensation on the transmission line is discussed. In this model, 765kV transmission line between Seoni – Bilaspur in India is simulated. Static series and shunt VAR compensation techniques is used to investigate for the improvement of the system stability and power transfer capability of electric power system.**

***IndexTerms* - 765kV line, Reactive power, Stability, EHV AC transmission, Power system**

I. INTRODUCTION

Reactive power is an important factor in the design and operation of alternating current in an electric power systems. For the transmission of active power, reactive power plays an important role and it is necessary for the transmission either the reactive power is generated or absorbed. But if the unwanted reactive power is generated or absorbed then the losses will takes place [2,3]. Therefore, the compensation of reactive power is required. Reactive power management is defined as compensation of reactive power flow to improve the stability and reliability of the power system. I.S Jha et.al.[4], in their paper discussed about the different challenges faced while installing the EHV i.e. 765KV line and describe the detail study of techno-economic design of EHV lines by carefully selecting the electrical parameters of the transmission line.

Effects of Reactive Power Flow in Line-Network

After studying from several research papers, came into conclusion that the reactive power have various effect on the transmission line. The various effect which commonly occurred in the transmission line are:-

a. Poor transmission efficiency
b. Poor voltage regulation .
c. Low power factor
d. Need of large-sized conductor
e. Reduction in the handling capacity of all system elements
f. Increase in KVA rating of the system equipment

II. SYSTEM DESCRIPTION

The model represents double circuit transmission line of 675 km long between Seoni and Bilaspur which comes under Western Zone of India. The transmission line is Frequency Dependent phase Model. This type of transmission model i.e. Frequency dependent (phase) Model are robust. Equivalent sources at Seoni - Bilaspur is represented by 3- phase , 50Hz, 765 KV infinite source. Receiving end source phase angle is adjusted. The length of transmission line is divided into two equal halves. The fixed line reactors of 240 MVAr are connected on each line at both the end of the transmission line. Power transfer through the line is 2000 MW.

III. SIMULATION MODEL

The 3 phase, 765 KV double circuit transmission line between Bilaspur and Seoni is represented in PSCAD with using the standard block of library. PSCAD is used for simulation of the given power system and for analysis of the active and reactive power with and without compensation. Figure 1 shows the single line diagram of Seoni-Bilaspur 765 kV transmission system.

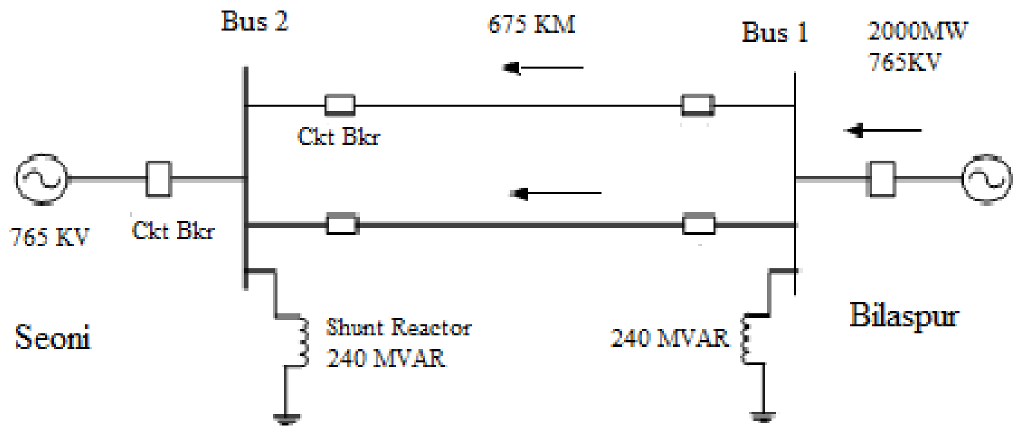

Figure 1: Schematic Diagram of Transmission Line.

- **Simulation during Normal condition i.e. Without Compensation**

Under normal condition different output results for Bilaspur side. The system is simulated and loaded without any reactive power compensation. Voltages, current and power flow i.e active and reactive power are plotted . The simulation time is taken as 5 sec. The voltage at Bilaspur side i.e source side is shown in figure 2. The instantaneous voltage supply from Bilaspur Grid Station is value of voltage 610 kV for 3 phase. Current at Bilaspur side under normal condition ie. without any compensation is shown in figure 3 The instantaneous current drawn from the Bilaspur grid station is 2.45 kA.

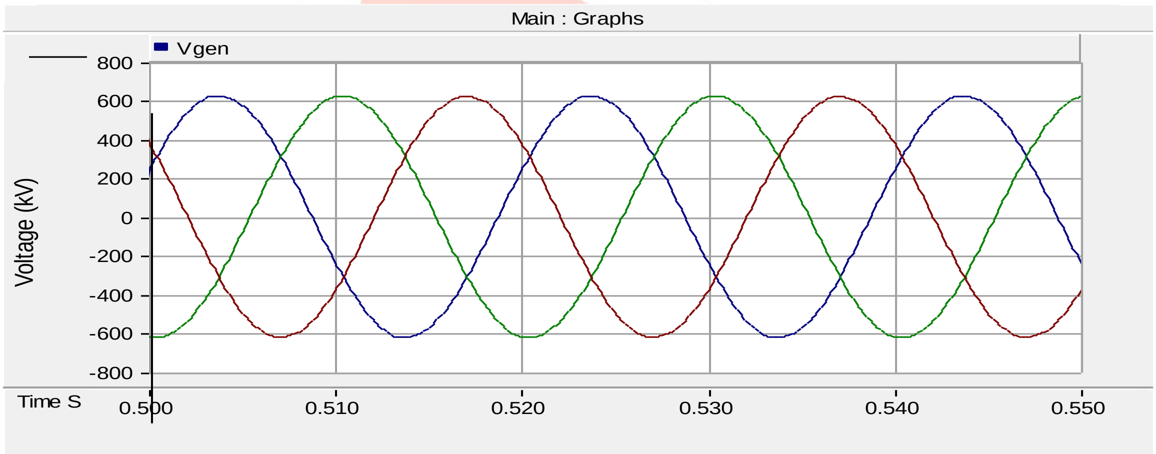

Figure 2 Measured Instantaneous Voltage at Bilaspur end

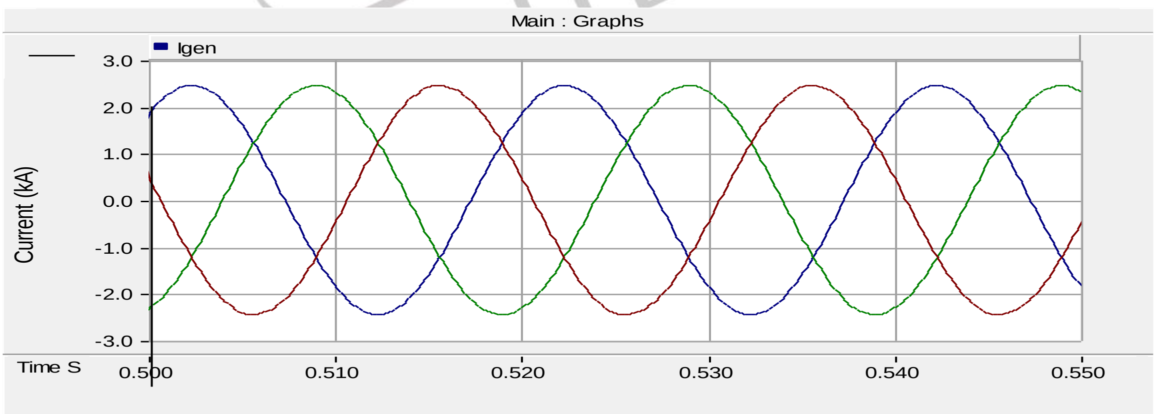

Figure 3 Measured Instantaneous Current at Bilaspur end

- **Simulation With Compensation**

Shunt Compensation When the shunt compensation is applied at both the ends i.e. on Bilaspur and Seoni end. Firstly, fixed shunt reactor is connected to both the ends and the graphs are plotted. The simulation time is taken as 5 sec. Active power and reactive power are plotted with shunt reactor. Figure 4 and figure 5 show the active and reactive power with shunt compensation. The instantaneous value of active power at source side with shunt compensation and without compensation is 2100 MW and 2000 MW respectively. The instantaneous value of reactive power at Bilaspur side with shunt compensation and without compensation is 535 MVAR and 1000 MVAR respectively.

Series Compensation When fixed series compensation is applied at the mid-point of the transmission line. Secondly, series compensation is applied to the transmission system. figure 4 and figure 5 shows the active and reactive power with series compensation. The instantaneous value of active and reactive power at source side with series compensation and without compensation is 2500 MW and 2000 MW respectively. The instantaneous value of reactive power at Bilaspur side with series compensation and without compensation is 875 MVAR and 1000 MVAR respectively.

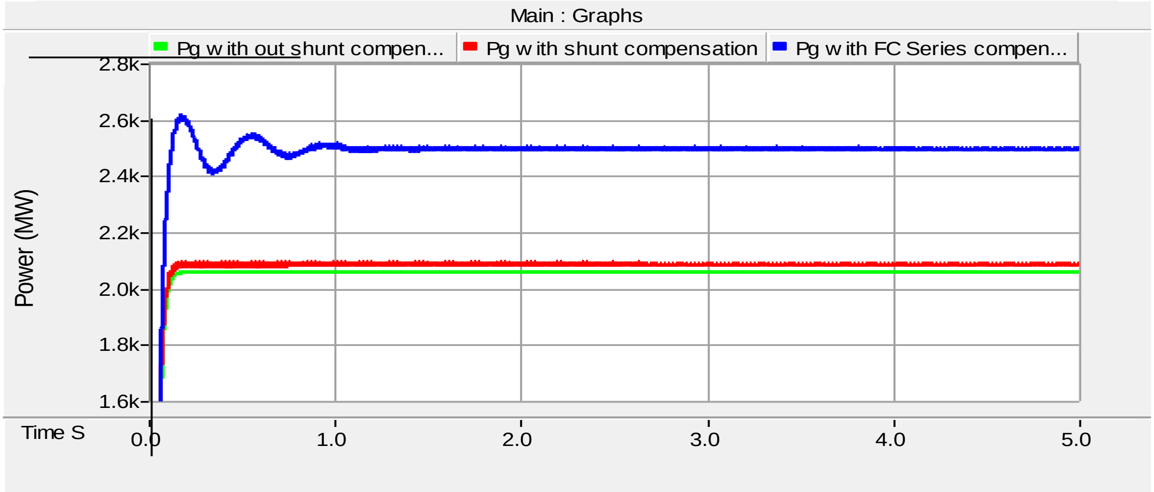

Figure 4 Active power with and without compensation at source end

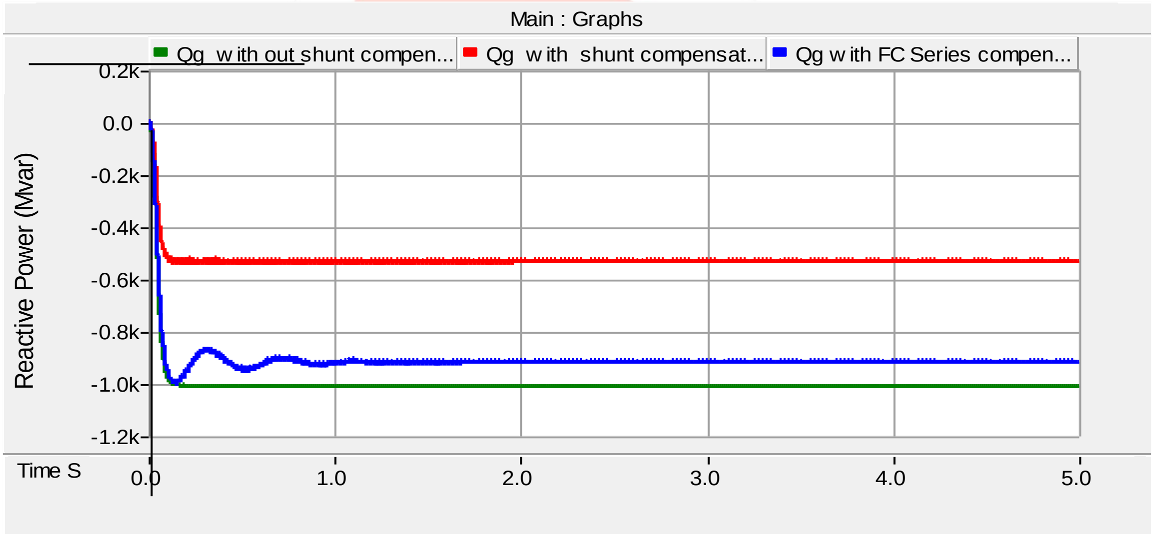

Figure 5 Reactive power with and without compensation at source end

IV.RESULTS AND DISCUSSION

Seoni- Bilaspur 765 KV transmission line is considered for study. After simulating the model in PSCAD library various results are obtained. The simulation results which are identified and graphs are plotted. Various graphs are represented below with and without compensation in the transmission line. The voltage and current for 3 phase generated at Bilaspur end is 765 KV and 2.45 KA respectively is being represented in figure 2 and figure 3 below. The active and reactive power without any compensation is plotted and compared with the active and reactive power obtained from the shunt and series compensation.

V.CONCLUSION

Thus, the method of series compensation is used for increasing the power transfer capability of the transmission line. And the shunt compensation i.e. shunt reactors are placed at the Bilaspur end, then it is observed that the obtained reactive power is compensated almost 50% of the actual reactive power. Hence, after comparing the results of shunt and series compensation techniques, it is found that series compensation reduces the series impedance of the line which in turn causes the drop in voltage and it the main factor for increasing the power transfer capability.

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