



Line Loss Calculation, Reduction Analysis and Load Current Variation in Amarkantak to Jabalpur (MPPTCL) Transmission Line

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Abstract—This paper described line loss calculation, reduction analysis and load current variation in AMARKANTAK to JABALPUR 220 kv Transmission line. This system reduce Transmission losses, improved Power Quality and improved Power Factor. With using of SHUNT COMPENSATOR technique, losses are reduced and give better voltage profile. In this system we increase load current, by adding additional load in transmission line for showing voltage sag. Using shunt compensation we get good voltage profile and better voltage graph. Then a brief description of the implemented solution is made, including references to software tools used for simulation and system development. Experimental results are also presented, showing the good performance of the developed SHUNT COMPENSATION

Keywords—Shunt compensator, power quality, power factor, MPPTCL (Madhya Pradesh power transmission company limited).

1. INTRODUCTION

High voltage transmission line are used to transmit electric power over relatively long distance, usually from a central generating station to main station. They are also used for electric power transmission from one centre station to load station. High voltage transmission line are made of high voltage lies

between 132-765 kv. We taken 220 kv Amarkantak to Jabalpur (MPPTCL) transmission line .One of the key concerns in transmission of electricity in power loss in transmission, dissipated as heat due to the resistance of conductor.

Basic principal of power compensation in transmission system

Figure 1 shows the simplified model of a power transmission system. Two power grids are connected by a transmission line which is assumed lossless and represented by the reactance X_L . $V_1 \angle \delta_1$ and $V_2 \angle \delta_2$ represent the voltage phasors of the two power grid buses with angle between the two.

$$\delta = \delta_1 - \delta_2$$

The magnitude of the current in the transmission line is given by

$$I = \frac{V_L}{X_L} = \frac{|V_1 \angle \delta_1 - V_2 \angle \delta_2|}{X_L}$$

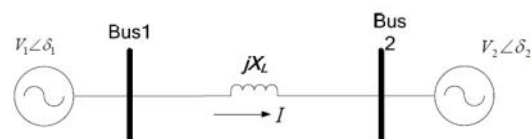


Fig 1 Simplified model

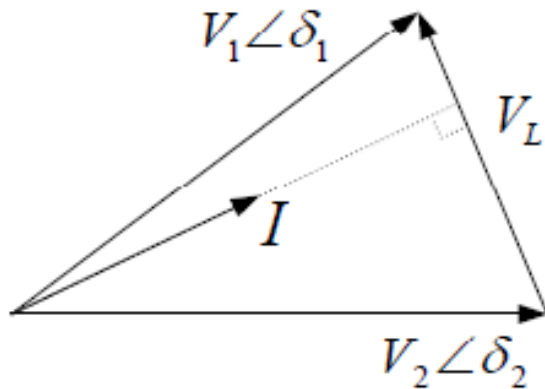


Fig 2 The corresponding phasor diagram

The active and reactive components of the current flow at bus 1 are given by:

$$I_{d1} = \frac{V_2 \sin \delta}{X_L}, \quad I_{q1} = \frac{V_1 - V_2 \cos \delta}{X_L}$$

The active power and reactive power at bus 1 are given by

$$P_1 = \frac{V_1 V_2 \sin \delta}{X_L}, \quad Q_1 = \frac{V_1(V_1 - V_2 \cos \delta)}{X_L}$$

Similarly, the active and reactive components of the current flow at bus 2 can be given by:

$$I_{d2} = \frac{V_1 \sin \delta}{X_L}, \quad I_{q2} = \frac{V_2 - V_1 \cos \delta}{X_L}$$

The active power and reactive power at bus 2 are given by:

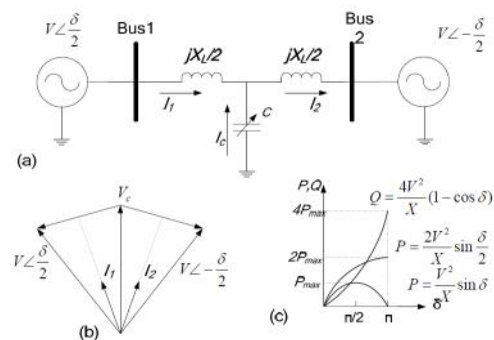
$$P_2 = \frac{V_1 V_2 \sin \delta}{X_L}, \quad Q_2 = \frac{V_2(V_2 - V_1 \cos \delta)}{X_L} \quad (1-5)$$

Equations (1-1) through (1-5) indicate that the active and reactive power/current flow can be regulated by controlling the voltages, phase angles and line impedance of the transmission system. From the power angle curve shown in Figure 1, the active power flow will reach the maximum when the phase angle δ is 90° . In practice, a small angle is used to keep the system stable from the transient and dynamic oscillations.

Generally, the compensation of transmission systems can be divided into two main groups: shunt and series compensation.

Shunt compensation

Shunt compensation, especially shunt reactive compensation has been widely used in transmission system to regulate the voltage magnitude, improve the voltage quality, and enhance the system stability [5]. Shunt-connected reactors are used to reduce the line over-voltages by consuming the reactive power, while shunt-connected capacitors are used to maintain the voltage levels by compensating the reactive power to transmission line.



A simplified model of a transmission system with shunt compensation is shown in Figure 3. The voltage magnitudes of the two buses are assumed equal as V , and the phase angle between them is δ . The transmission line is assumed lossless and represented by the reactance X_L . At the midpoint of the transmission line, a controlled capacitor C is shunt-connected. The voltage magnitude at the connection point is maintained as V .

$$P_1 = P_2 = 2 \frac{V^2}{X_L} \sin \frac{\delta}{2} \quad (1-6)$$

The injected reactive power by the capacitor to regulate the voltage at the midpoint of the transmission line is calculated

$$Q_c = 4 \frac{V^2}{X_L} (1 - \cos \frac{\delta}{2}) \quad (1-7)$$

From the power angle curve shown in Figure 3, the transmitted power can be significantly increased, and the peak point shifts from $\delta=90^\circ$ to $\delta=180^\circ$. The operation margin and the system stability are increased by the shunt compensation.

The voltage support function of the midpoint compensation can easily be extended to the voltage support at the end of the radial transmission, which will be proven by the system simplification analysis in a later section. The reactive power compensation at the end of the radial line is especially effective in enhancing voltage stability.

3. CIRCUIT DISCRPTION

In this system we consider a 3 phase generator connected with step up transformer. Through Bus bar 1 and 2, transmission line is connected. We consider a medium transmission line in this system, because the length of this transmission line is 182 km and it's come in medium transmission system. 2 RLC load is connected at receiving end side, for generating over loading condition. Shunt compensator is connected parallel in a circuit for compensate reactive power to reduce loss and give better voltage profile.

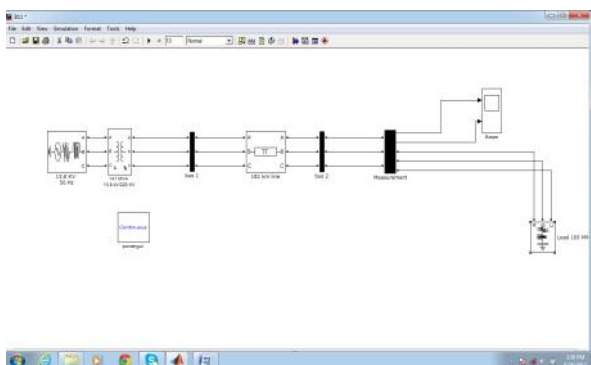


Fig 4 simulation model of MPPTCL Line Birasingpur to Jabalpur

4. RESULTS

System consist three case

CASE I

Transmission line under normal condition

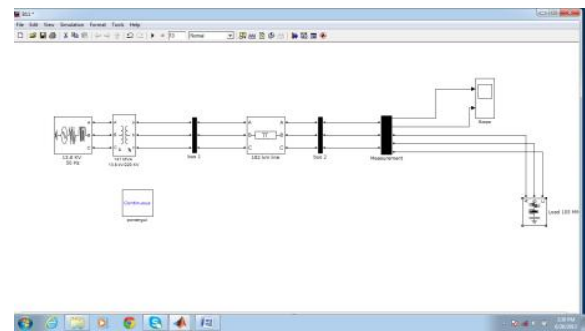


Fig 5 transmission line under normal condition

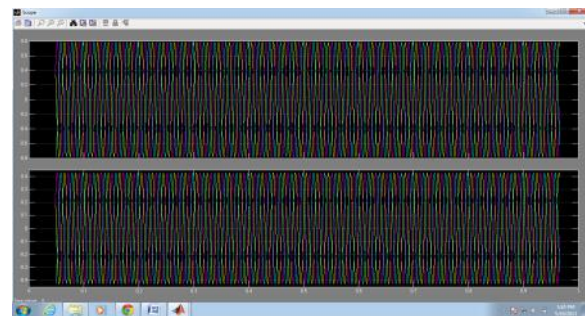


Fig 6 output response before loading condition

CASE 2

When transmission line at over loading condition

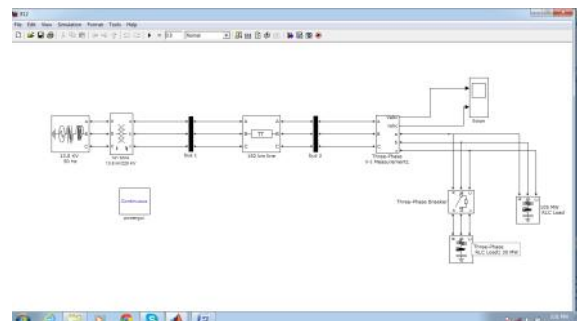


Fig 7 Transmission line at over loading condition

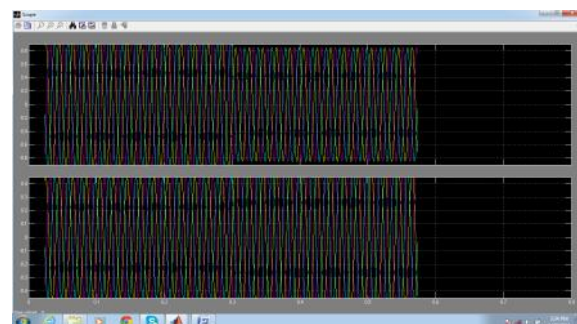


Fig 8 output response after loading condition

CASE 3

When transmission line at overload condition with shunt compensator

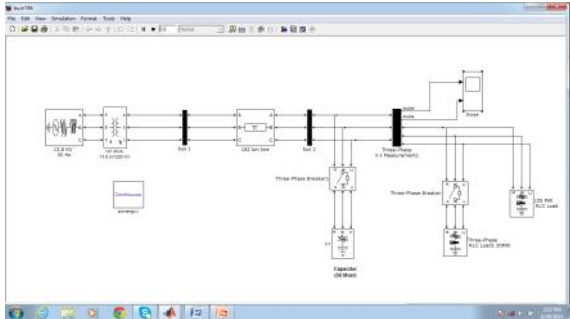


Fig 9 transmission line at overload condition with shunt compensator

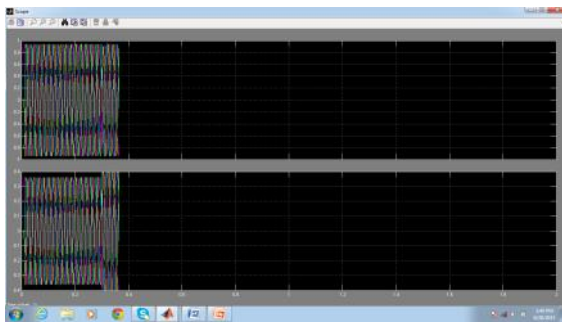


Fig 10 output response When we add shunt compensator

Simulation tools

Simulation is a powerful way to reduce development time and ensure the proper fulfilment of critical steps. During the development process of the shunt compensator, simulations were performed, which allowed the study of its behaviour under different operation conditions, and permitted the tuning of some controller parameters together with the optimisation of the active filter components values. There are not many simulation tools that allow working with electrical systems, power electronics and control systems, in the same integrated environment. *Matlab/Simulink* and the *Power System Blockset* were used as simulation tools in this case and are briefly described in the following paragraphs

Matlab/Simulink

Matlab is a high-level language oriented toward engineering and scientific applications. It has evolved over a ten-year history to

become a popular, flexible, powerful, yet simple language. It has served as an effective platform for more than twenty toolboxes supporting specialised engineering and scientific applications, covering areas from symbolic computation to digital filter design, control theory, fuzzy logic, and neural nets. It is to be used interactively, and supports also the ability to define functions and scripts, and dynamically links with C and Fortran programs. Recent trends in the *Matlab* language have focused on an object-oriented graphics capability that permits a rich Graphical User

Interface (GUI) construction [5]. *Simulink* is built on top of the *Matlab*. It is an interactive environment for modelling and simulating a wide variety of dynamic systems, including linear, non-linear, discrete-time, continuous-time, and hybrid systems. It combines the power and ease-of-use of an application package with the flexibility and extensibility of a language. The user can build block diagram models with click-and-drag operations, change model parameters on-the-fly, and display results “live” during a simulation. This tool is also a uniquely open system, allowing to choose, adapt, and create software and hardware components to suit each application [6]. Together, *Simulink* and *Matlab* provide an ideal integrated environment for developing models, performing dynamic system simulations, and designing and testing new ideas.

5. CONCLUSION

In this paper line losses are calculate and showing reduction analysis of losses using shunt compensator technique, when we increases load current, because power loss is depend upon current and resistance. When we increase current, power loss is also increases and give poor voltage profile. To compensate this power loss, shunt capacitor is used .This system also shown single line diagram according to MPPTCL norms. Parameters are also taken from MPPTCL standards. So, that this system is totally based upon real parameters, and give better output results. Line

loss in this system is approx 10%,with using SHUNT COMPENSATOR losses will reduced and it become 2-3%.

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