# Improving the Performance of Long Distance Tuned AC Transmission Systems

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***Abstract:- The line series reactance and shunt susceptance can be tuned by adopting series and shunt compensation. Practical, size and economic constraints will lead to limitations in location of the compensating elements at optimal points along the line. While planning long-distance transmission, it is necessary to determine not only the average degrees of compensation required, but also ensure the stable and uniform voltage profile with minimal reactive power flow.***

## I. INTRODUCTION

Now a day's our electrical power consumers have been facing the risk of depleting formal energy sources to generate adequate power is major the impact on their standard of living [1].

Southern California Edison Company is the first one that introduced the concept of transmission line for more distances with higher voltage operating in 1914, which is operated with a rated voltage of 150kV. Then, in 1924, long transmission line came into service with an upgraded operating voltage of 220kV. Afterwards, Different methods are documented in order to analyze the Long Distance Transmission Line.

The Transmission Line, whose receiving and the sending ends is about partly of a power frequency wavelength, more power transmission capability, more stable end voltage with no compensating equipments & sub stations is known as Half-Wavelength Long-Distance Transmission Line [2-4].

If the length of power transmission is between 2000km to 3000km is termed as Ultra-Long-Distance Transmission line [5].

The long distance transmission system to a significant extent governed by stability considerations. As long distance transmission systems are meant for the transfer of more power, in addition to the use of series compensation, it also requires shunt compensators to control power flow and voltage. Appropriate tuning of the compensating equipment is necessary to determine the maximum power transfer of such compensated systems.

In general, classical transmission line theory is used to find the performance of long lines. Furthermore, based on economic considerations, ELD transmission inherently implies utilization of extra-high-voltages (EHV). However, there has not been an extensive methods to find performance of such lines in the literature of the recent past; hence, it is the time to review certain principles and present some novel methods relative to tuning of long-distance transmission system. karuppiah et.al [25] evaluates the performance of transmission line by placing the FACTS Devices.

In order to control the sustained over voltages, the shunt reactors are connected at optimal locations along the line. Also, series compensation is adopted to enhance the power transfer capability,

## II. TUNING OF TRANSMISSION SYSTEM

The power flow on AC lines is controlled by the bus voltage, power angle and line parameters. In the conventional sense, since the line parameters are fixed and bus voltage variation is constrained, the only way to control the power flow is by changing the power angle. Normally the power angle i.e. the electrical angle between sending and receiving end voltages, is determined by the system conditions and is not controllable. Hence it is usually said that it is difficult to have any power control with AC transmission systems.

This problem is particularly felt with parallel AC lines when one of the lines is operated at a higher voltage level with the intension of carrying larger share of power. Due to the impedance of the interconnecting transformers for the higher voltage line, it has been generally found that lower voltage lines get overloaded. The use of static compensators, both shunt and series will overcome this problem. However, till a few years ago, most of these compensating systems were of fixed type and their full potential to improve the dynamic response of the system is not fully utilized.

The advent of power switching devices has changed the situation. It is possible to have on load tap changing to control the voltage levels in every half cycle. By injecting a phase shifted voltage, it is possible to control the power angle between sending end and receiving end bus voltages and thereby control the power flow. Thyristor controlled shunt reactor and Thyristor switched capacitor provide a fast correction to the reactive power requirement and thereby control the bus voltages within a narrow band.

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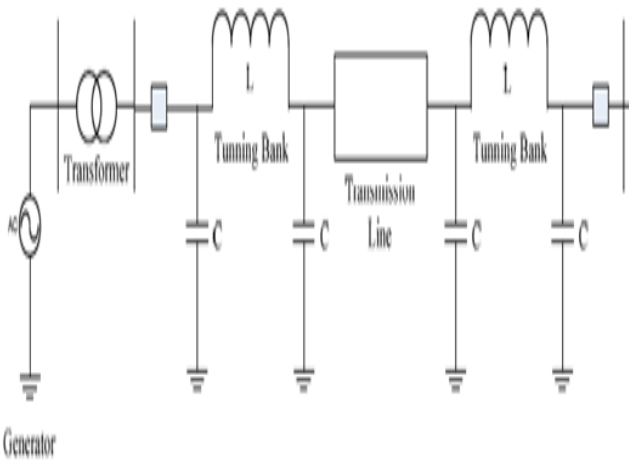


**Fig1. Long Distance Tuned AC Transmission Line**

Similarly, fixed series compensation which was used earlier for long high voltage lines can be converted to variable series compensation. Series capacitors provide for an effective control of power flow on the AC lines. For the same MVAr the series capacitor reduces the transfer impedance between the buses more than the shunt compensation. Higher the series compensation better is the power handling capability of the line and the transient stability. However, high order of compensation gives rise to sub harmonic oscillations. Therefore variable series compensation is preferable to have better steady state and dynamic response of the system. It is possible to ensure first swing stability with this tuned variable compensation approach. These tuned compensation methods; both series and shunt actually alter the line parameters (transfer impedance) and thereby control the power flow.

Thus it can be seen that in AC transmission systems the control of line parameters, bus voltages and power angle can be accomplished at a very fast rate so that the dynamic response of the system can be improved.

## III. METHODOLOGY& RESULTS

The tuning of the transmission system can be used for bulk power transmission over long distances.

It is proposed to analyze a long transmission line. The long transmission line is compensated with series and shunt tuning equipment through degree of series and shunt compensation. Since the compensating equipment cannot be distributed uniformly in practice, the same is proposed to be located uniformly all along the line. In such a system the voltage levels will be kept at the reference value only at these connecting points and there will be variation in the voltage profile over the line between consecutive tuning equipment.

The main purpose of tuning the transmission system is to increase the power handling capacity of the line, and to demonstrate that the power transfer capability is straight line, thus not depending on transmission angle.

### *A. Modeling of Power system*

The power system model proposed to study is Single Machine Infinite Bus (SMIB) model. The components involved for modeling is: (i) 3rd Generator model along with IEEE Type 1 excitation system and IEEE type power system stabilizer (ii) Tuned Transmission line both un-compensated and series-shunt compensated.

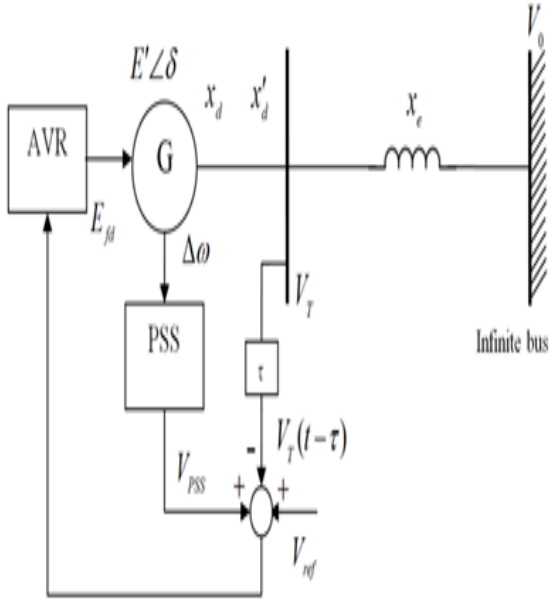


**Fig2. SMIB Model**

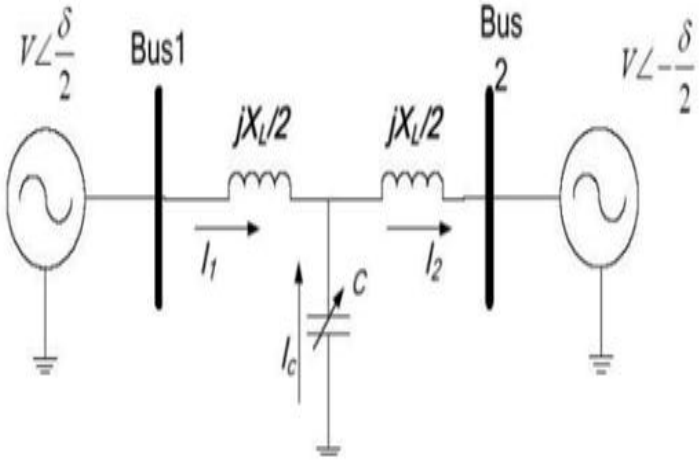


**Fig2. Series-shunt compensated Transmission System.**

### *B. Technical Novelty and Utility*

The technical novelty of the proposed power system model is that, the system can be used to study un-compensated and compensated line performance with different degree of series and shunt compensating factors, to study power transfer handling capacity and stability of the system.

It is proposed to observe the power angle curve. In general, the power – angle curve is sinusoidal. In the literature it is proved that, properly tuning the series – shunt compensation, the power – angle curve can be made straight line instead of sinusoidal, thus large amount of power can be transmitted. However, practical considerations and limitations need to be considered. Thus, this analysis will help in studying such possibilities with various combinations in tuning the transmission system.

The proposed tuned power system model will give a guideline to staff members and students to take up research projects in theme areas like compensated and un-compensated transmission systems, Wide Area protection, stability, design of conventional and advanced controllers, location of FACTS devices etc.

## IV. CONCLUSION

Long Distance AC Transmission system is being considered for power transfer. Series Shunt compensation of long distance lines consider to reduce length of the line artificially which improves the stability. Number and location of the compensation devices plays an important role especially on the size. The Shunt compensation helps in reducing over voltages. In Ac Transmission control of line parameters, Bus voltages and power angle can be done at a faster rate due to availability of power electronic devices. The power angle curve can become independent of angle unlike in conventional method the power is directly linked to angle in sine wave.

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