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MODELING AND EVOLUTION FOR TRANSMISSION LINE WITH /WITHOUT UPFC: A REVIEW

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ABSTRACT

In this work the impact of fact devices on the performance of distance relay is addressed and a transmission line algorithm is developed for proper classification of fault in the transmission line. UPFC (Unified power flow controller) which address the issue of adaptive protection of a transmission line where this device is located at the different position of transmission line like middle of the transmission line, sending end and receiving end of transmission line. Design and simulating the UPFC incorporated in transmission line is done, when the fault occur before as well as after UPFC in the transmission line. The impact of UPFC on the distance relay is described by impedance trajectory, disturbance in voltage and current and apparent impedance is carried out in the presence of UPFC for different fault calculation.

KEYWORDS : UPFC, PSCAD/EMTDC, FACTS, Apparent Impedance

I. INTRODUCTION

The development of power electronics applications in power systems provides great benefits in technical or economical terms. Applying FACTS series compensators is one of the electronics controllers that enhanced power transfer capability, transient stability and damping of power transfer through transmission lines. However, one of the difficulties of having FACTS compensation is that the calculation of capacitor voltage drop cannot be estimated using conventional methods [1] [2].

The operation of FACTS devices introduces harmonics and non linearity's to the power system, which adversely affect the protection systems and the fault detection methods. Transmission power systems today are complex networks which include long transmission lines necessary to transport energy from large generation units to bulk consumption loads. The compensation of transmission lines is a mature technique which can greatly increases the amount of power to be transported. The improvements in the field of power electronics have had major impact on the development of the concept itself. These controllers are based on voltage source converters and include devices such as Static Var Compensators (SVCs), Static Synchronous Compensators (STATCOMs), Thyristor Controlled Series Compensators (TCSCs), the Static Synchronous Series Compensators (SSSCs), and the Unified Power Flow Controllers (UPFCs).

II. MATERIALS AND METHODS

2.1 Modeling of Transmission line:

2.1.1 Transmission line without UPFC:

A test power system was modeled in the PSCAD/EMTDC program. A case of the modeled power system without using UPFC is shown in Fig.2.1. Transmission line is modeled in the Bergeron model available in PSCAD library, because the Bergeron method is based on a distributed L-C parameter travelling wave line model with lumped resistance. This model produces constant surge impedance and is essentially a single frequency model. The Bergeron method can be used for any general fundamental frequency impedance studies such as relay testing or matching load flow result. Single line diagram of power system is shown in Fig.2.1.

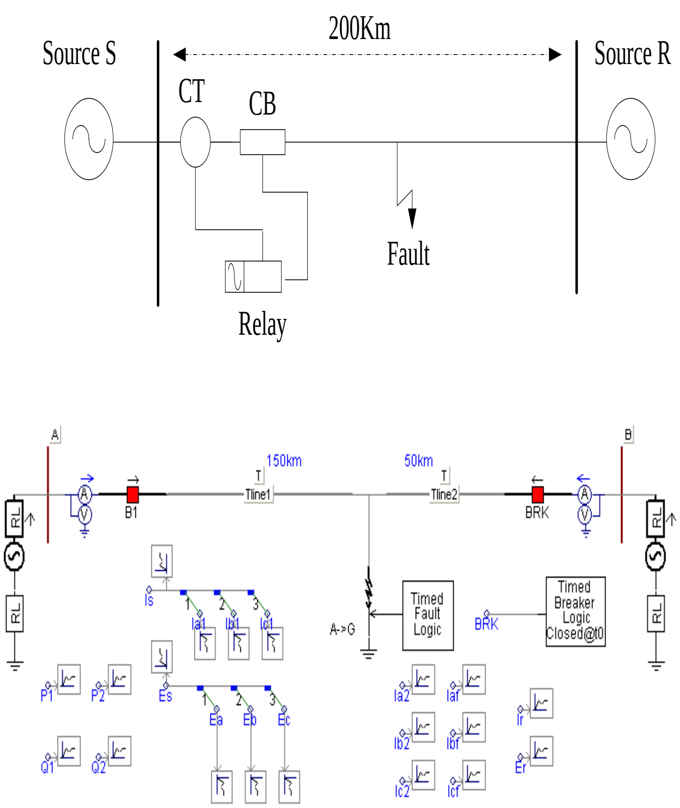

Fig.1: Single Line Representation of the Simulated Power System

Transmission line with UPFC:

A typical six-pulse voltage-sourced inverter type, 100 MVA UPFC operating on a 230 kV ac, 50 Hz transmission system connected at the mid-point of the power system is shown in Fig 5.12. In its simplest form it consists of six self-commutated semiconductor switches, (IGBTs or GTOs), with the reverse-parallel diode connected across each switch for Shunt converter as well as in the series converter. Basically, a UPFC is a high power inverter/rectifier which uses a capacitor for energy storage. A leading or lagging current is produced by appropriate control of the switching devices, so that the UPFC controls the dc side voltage, Controls ac volts.

III. RESULTS AND DISCUSSION

The fault analysis has the main purpose of understand the temporal behavior of line current and voltage at one end of the transmission line at different fault location and compensation levels by using impedance trajectory. The results provided are needed to determine particular traces helpful to discriminate between fault events occurring before or after the UPFC. Table 1 shows the general data of the test system.

The transmission line is simulated in two ways and for single phase - ground fault (A-G); in the first case compensation is not providing with the line and fault is created in the different location from the source end. Fig.2 & 3 shows the result of case 1 And in second case compensation is providing with the transmission line and fault is created in the line at a distance of 150 km and 50 km from the source i.e. after the UPFC and before the UPFC. Fig.4 shows the result of case 2. In Fig 3& 4; the Mho characteristic shows the effect of the UPFC when it is connected in the transmission line.

In Fig. 4 are for the fault after the UPFC and by comparing this to the Fig.2, it shows that how the apparent impedance seen by the relay is change and in Fig.5 & Fig.3 have same impedance characteristic, the fault after the UPFC i.e. 50 km from the source has same impedance characteristic as in the transmission line which do not have the UPFC compensation. This describes how the apparent impedance changes, when the UPFC is incorporated with the transmission line.

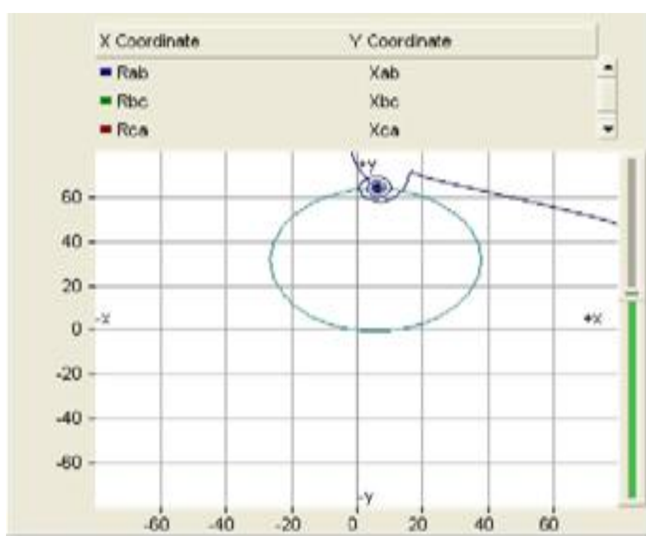

Fig. 2 Mho Characteristic for A-G Fault at (a) 150 km

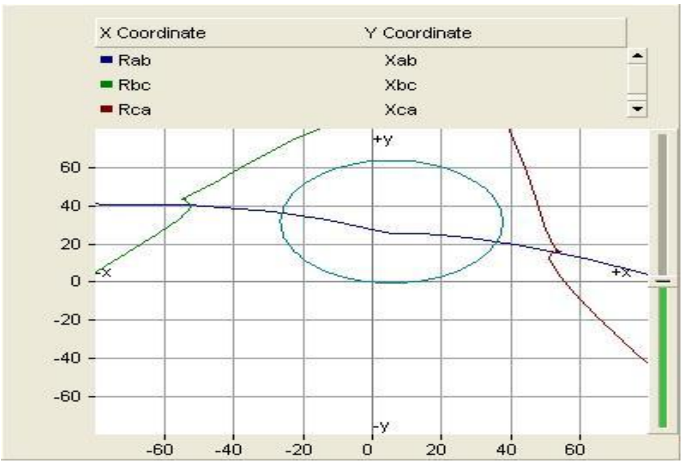

Fig. 3 Mho Characteristic for A-G Fault at 50 km at the source end

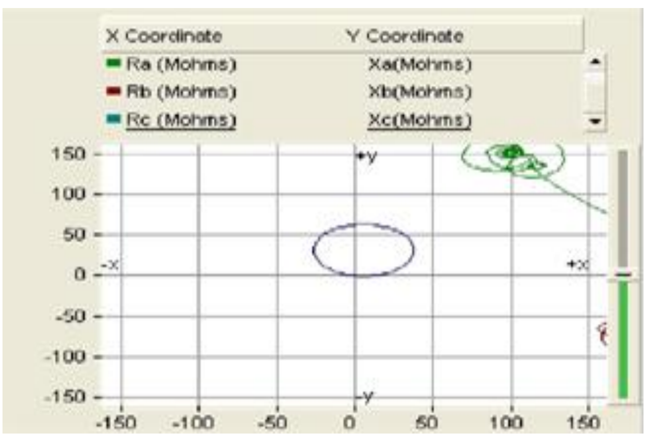

Fig.4 Mho Characteristic for A-G Fault (a) 150 km i.e. after UPFC

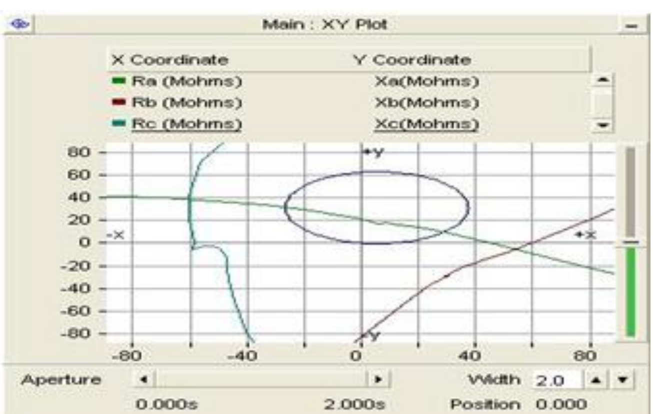

Fig.5 Mho Characteristic for A-G Fault (a) 50 km i.e. before UPFC

By using the above simulated result, the change in the apparent impedance seen by the distance relay is shown in below figure. When the UPFC is connected at the mid point of the transmission line then apparent impedance seen by the relay is same for the fault, which occour before the UPFC. For fault after the UPFC, the change in the apparent impedance is much higher then the fault before UPFC. Fig 6 (a) shows, the percentage change in the apparent impedance for single phase ground fault.

These result shows that how much distance relay is affect by the presence of the UPFC in transmission line. this huge apparent create very big problem to the convetional distance relay and also for the power system stability. For solving this problem there is method which addressed that how we overcome this problem. As the distance of the fault is increases the % change in the apparent impedance seen by relay is increase rapidly. This is divert the main objective of installing the UPFC in the transmission line.

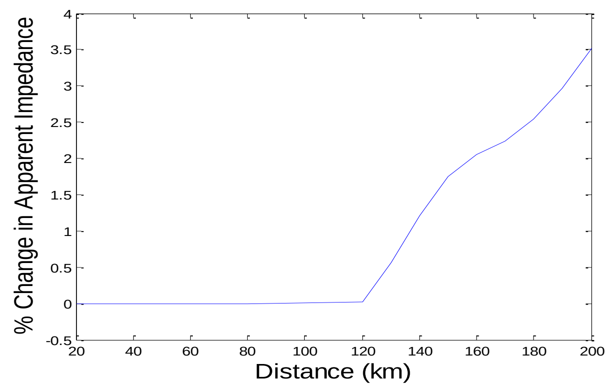

Fig.6 The percentage change in the apparent impedance for single phase ground fault

V. CONCLUSION

Higher the compensation level and closer the fault to the UPFC greater the difficulties for a distance relay to determine the fault location. This is because most of the reactance of the portion of the faulted line is cancelled, so the total equivalent impedance of the non faulted section of the line is smaller for compensated systems than for non-compensated system. In other words, the electric length of the compensated line looks shorter than the non-compensated one. The fault analysis carried out was fruitful in providing information useful to establishing the criteria for implementing the new algorithm The simulation result shows the impact of UPCF on the relay characteristic, the impact on the performance of a distance relay is significantly higher when the full UPFC is operated instead of without

UPFC because the Mho characteristic is not same as the Mho characteristic of distance rely of transmission line without UPFC. When comparing the results at different fault location from UPFC, there is a tendency for distance relay to under reach more in case of UPFC. The result shows that there is a basic problem of protection of transmission line when the UPFC is connected in the transmission line or in power system network.

Table 1 : Parameter of Simulated Power System Model

Source S	Positive Sequence Impedance	0.238+5.72j (Ω)
	Zero Sequence Impedance	2.738+10j (Ω)
	δ	15^o
Source R	Positive Sequence Impedance	0.238+6.19j (Ω)
	Zero Sequence Impedance	0.833+5.12j (Ω)
	δ	0^o
Frequency		50 Hz
Voltage		230 (kV)
Line Length		200 (km)
Line Resistance	Positive Sequence	0.0275 (Ω/km)
	Zero Sequence	0.275 (Ω/km)
Line Inductance	Positive Sequence	1.345 (mH/km)
	Zero Sequence	3.725 (mH/km)
Line Capacitance	Positive Sequence	9.483 (nF/km)
	Zero Sequence	6.711 (nF/km)
Sampling Frequency		10 kHz)

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