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Condition Monitoring and Faulty Insulator Locating using Park's Transformation

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Abstract - *This paper proposes a condition monitoring technique of insulators in a transmission line. Transmission power network for overhead line, most of cases, uses porcelain insulator for the isolation[8]. It is very important to localize the fault in transmission line to supply uninterrupted power supply. In this proposed technique by using park vector approach condition monitoring of insulator is possible. Remote monitoring is a essential part in power transmission and it can be done from the control room by using this technique. Main fault in transmission line insulators are the slow developing faults due to its aging effect. Therefore a surface leakage current, due to the formation of a outer layer of dust particles and other particles on the surface, is produced which creates the fault. Sometimes environmental degradation is the cause of failure of insulator. By using the proposed technique it is possible to identify the faulty insulator at running time and replace it in a proper time to prevent major faults. This technique is based on the graphical analysis based on the insulators capacitance and the position and phase.*

Key Words: Park vector transform, Health monitoring of insulator, Over head transmission line

1. INTRODUCTION

For large power transmission high voltage overhead transmission lines are used. Long distance overhead transmission lines are very essential part of power transmission [3]. To maintain the proper health of the transmission line condition monitoring is needed. Condition monitoring can be done continuously or by a time interval. The main problem is the condition monitoring of the total line from the sending end. In this proposed work it is possible to monitor the condition of the insulators in the transmission line. Nowadays porcelain insulators are used in power transmission network between the line and the support[8]. Insulators may be indoor type or outdoor type according to their applications. But the outdoor type insulators, most of cases, get damaged due to pollutions [1].Due to pollutants in the outer surface of the insulator it creates a layer which may conducts a leakage current which may be the cause of failure of insulator. Nowadays Now a days Extra-High and Ultra-High voltage transmissions are more concentrated. For that type of transmission proper insulation is required. For high voltage over 11KV string insulators are used. For calculation the leakage current we consider each insulator as a capacitor. The current through each capacitor depends on its health. Insulator faults also occur due to aging effect. Mainly the faults in the insulators are the slow developing faults. So by using this proper condition monitoring technique it is possible to identify the region where the insulator condition is not good and the faulty insulator is replaced by routine maintenance.

2. WORKING OF THE SYSTEM

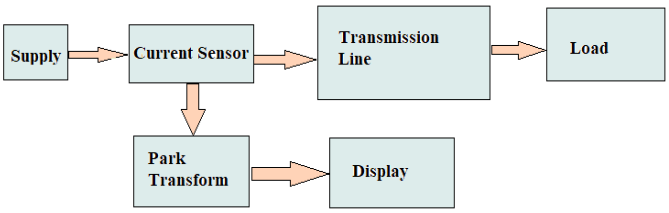

Fig -1: Block diagram of the system

The total system can be monitored from the sending end. That means it is one type of remote monitoring technique. This proposed technique based on the graphical analysis of park's transformation. From the sending end all the phase currents are measured and by the help of the park's transform of the current components a waveform can be generated. All the output waveforms are compared to the ideal output. Therefore it is possible to find out the region where the faulty insulator is located and in which phase the fault has occurred. The output patterns are different according to location, phases and capacitance value. So if we compare the practical output with the simulated value then we can locate particular location and present health condition of insulators . If the capacitance value of two faulty insulators is same but they are located in different locations then their output pattern will be different. Again if their locations are same but in different phases then the pattern will also be different. The total system is based on the magnitude and phase angle of the current.

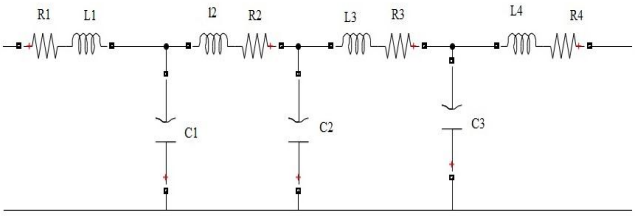

Fig -2:Schematic diagram of the transmission network/phase

3. PARK'S TRANSFORM

Park's transformation is a mathematical tool. It is used in this project as a signal processing tool. This tool is able to simplify the analysis of the current components and very efficient to analysis the fault. This arithmetic tool is able to convert three variables to two variables as a, b, c, is converted into d, q. As it is considered that the main data for analyzing the system is the three different phases current I_A, I_B, I_C can be converted into two components I_d and I_q. These two current components depend upon the value of magnitude and phase angle of the three current components I_A, I_B, I_C. So from the plot I_d vs. I_q it is possible to find out easily the unsymmetrical condition made in the transmission network.

$$I_D = \sqrt{\frac{2}{3}} I_A - \frac{1}{\sqrt{6}} I_B - \frac{1}{\sqrt{6}} I_C \quad \text{.....(i)}$$

$$I_Q = \frac{1}{\sqrt{2}} I_B - \frac{1}{\sqrt{2}} I_C \quad \text{.....(ii)}$$

4. RESULT AND DISCUSSION

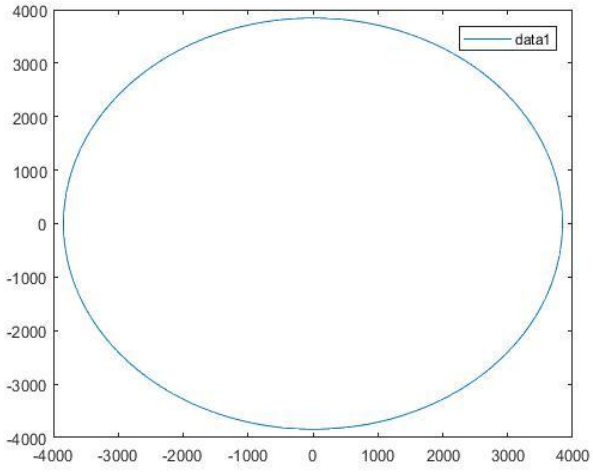

Fig -3: Case 1

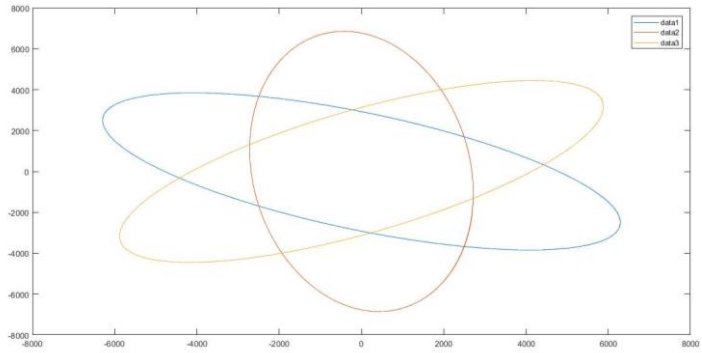

Fig -4: Case 2

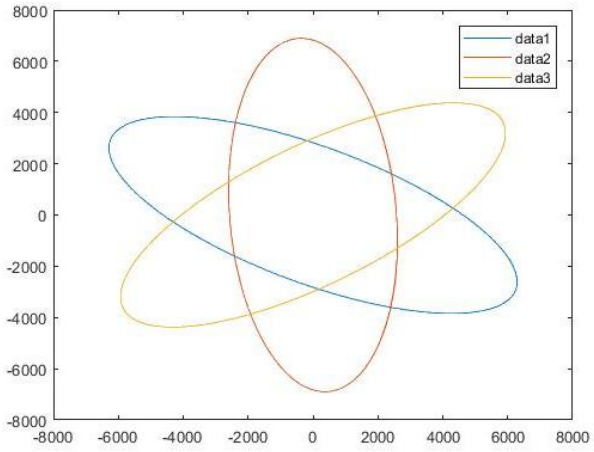

Fig -5: Case 3

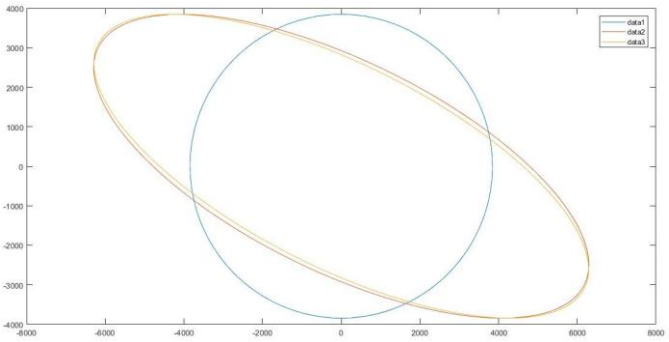

Fig -6: Case 4

Table -1: Simulation Result

Case	Data	Phase A	Phase B	Phase C
1	1	Normal	Normal	Normal
2	1	Receiving end fault	Normal	Normal
	2	Normal	Receiving end fault	Normal
	3	Normal	Normal	Receiving end fault
3	1	Sending end fault	Normal	Normal

	2	Normal	Sending end fault	Normal
	3	Normal	Normal	Sending end fault
4	1	Normal	Normal	Normal
	2	Receiving end fault	Normal	Normal
	3	Sending end fault	Normal	Normal

The designed transmission network is simulated in MATLAB Simulink for the three phase system. From the sending end, power is supplied to the network by a three phase high voltage 50Hz supply and through the transmission line, power is taken to the load. To relate this system with practical system transmission line is considered by resistance, inductance and capacitance. Here insulators are also considered as capacitors. According to the health of the insulators the value of capacitance changes because it depends upon the dielectric properties. In simulation for the fault we have only changes the capacitance value. But from the waveforms it can be seen that although having same value of capacitance for insulators, locating in different locations, waveform changes. By observing the waveforms if we try to match with a simulated waveform then by changing the capacitance value and location it should match with any one and it is possible to find out the location and health condition of the insulator.

5. CONCLUSION

This paper introduces a proper application of park's transform in condition monitoring of insulators in transmission line. Due to having high voltage in transmission line it is important to maintain the proper insulation, so condition monitoring is too much important. This designed system is highly efficient to find out the un-symmetrical faults in the transmission line. By using this proposed system it is very easy to find out the health condition of the insulator and its location. Practical application of the proposed system will decrease the insulation failure in the high voltage transmission line. For the future scope it may be possible to improve the system by which automatic fault diagnosis system will be applied by which it may automatically determine the particular insulator which has bad health condition and its exact tower number where it is located. Another development option is condition monitoring about the sag in transmission lines.

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BIOGRAPHIES

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