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Design and performance analysis of HV AC machines

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ABSTRACT High voltage rotating machines are widely used in the power stations, sugar mills, steel mills, cement mills etc. Insulation is an essential component for proper operation of electrical machines without any fault and the condition of insulation of an electrical machine mainly determines its life period. The economic aspects of its periodic maintenance like the loss in production due to breakdown and the investment cost due to frequent replacement with a new machine is huge. The insulation condition of the machine can be assessed by measuring the various parameters like insulation resistance, polarization index, leakage current, capacitance, dissipation factor, partial discharge magnitude and surge voltage withstanding strength. To assess these parameters of the stator winding insulation used in high voltage rotating machines, a number of measurements have been made on actual stator coils of machines. For various test voltages, the leakage current, capacitance and dissipation factor are measured and correlated as a function of test voltages. By using artificial neural network algorithm we going to predict, status of the insulation of the AC machines.

I. INTRODUCTION

To conduct various diagnostic tests like Insulation Resistance, Polarization Index, Leakage Current, Capacitance, Dissipation Factor, Partial Discharge magnitude and Surge Comparison test on

the stator winding of high voltage rotating machine. While the machine going to testing, megger, DCR value, surge comparison test have been taken for testing a machine. In many case it shows good and better values in megger & DCR value but within some it may be damage due to winding shorts. This incident is due to insulation resistance, polarization index, leakage current, capacitance, dissipation factor, partial discharge magnitude and surge voltage withstanding strength of the insulation within the machine. An artificial neural network is an information processing system that has certain performance characteristics in common with biological neural networks. A biological neuron has three types of components that are of particular interest in understanding an artificial neuron: its dendrites, soma and axon. Dendrites receive signal from other neurons. The signals are electrical impulses that are transmitted across a synaptic gap by means of a chemical process. The soma or cell body sums the incoming signals. When sufficient input is received, the cell fires; that is, it transmits a signal over its axon to other cells. By using artificial neural network method we are going to predetermine the insulation property weather good or bad.

II. RELATED WORK

This section describes appropriate related works on the development of Circular system. By using below tests we can predetermine the insulation proper of the high voltage machine.

IR, PI, AND LEAKAGE CURRENT:

The most widely used diagnostic test for windings of rotating machines is IR/PI test and this test successfully locates pollution and contamination problems in windings. In older insulation systems, the test can also detect thermal deterioration. Insulation Resistance (IR) and Polarization Index (PI) tests have been in use for more than 70 years. Both tests are performed with the same instrument, and are usually done at the same time.

The IR test measures the resistance of the electrical insulation between the copper conductors and the core of the stator. Ideally, this resistance should be infinite. In practice, the IR is not infinitely high. Usually, lower the insulation resistance, it is more likely that there is a problem with the insulation.

The PI test is a variation of the IR test. PI is the ratio of the IR measured after voltage has been applied for 10 minutes (R_{10}), to the IR measured after just one minute (R_1), i.e. PI is defined as

$$PI = \frac{R_{10}}{R_1}$$

A low PI indicates that a winding may be contaminated or wet.

$$R_t = \frac{V}{I_t}$$

where V is the applied DC voltage and I_t is the total current measured after t minutes, as the current is not usually constant. There are at least four currents that may flow, when a DC voltage is applied to the winding.

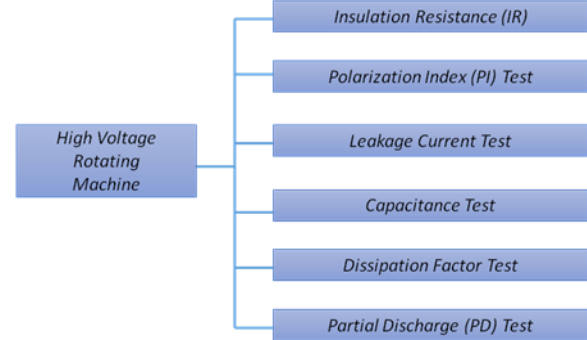
Surface Leakage Current:

This is a constant DC current that flows over the surface of the insulation caused by oil or moisture mixed with dust, dirt, fly ash, chemicals on the surface of the windings. If this current is large, it is likely that contamination-induced deterioration (electrical tracking) may occur.

IV. HARDWARE REQUIREMENT:

MEGGER:

The device enable us to measure electrical leakage in wire, results are very reliable as we shall be passing electric current through device while we are testing. The equipment basically use for verifying the electrical insulation level of any device such as motor, cable, generator winding.



SURGE COMPARISION TESTER:

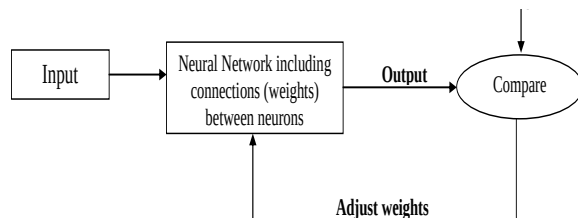
The Surge Comparison tester checks the strength of ground insulation that consists of enameled insulation. It detects the insulation failures such as turn to turn shorts, layer to layer shorts, coil to coil shorts, winding to winding shorts, and phase to phase shorts. Open circuit and ground detection are other benefits of surge testing.

DCR TESTER:

The DC resistance test is performed to measure the resistance of the stator by circulating a suitable direct current and then measuring the voltage drop between terminals. The test, if taken with the motor cold (at room temperature) provides a check for the calculated values, or a basis for the estimation of efficiency. There is a test for R1 independent of R2, X1 and X2. This test is called the dc resistance test, basically, a dc voltage is applied to the stator windings of an induction motor. Because the current is dc, there is no induced voltage in the rotor circuit and no resulting rotor current. Also, the reactance of the motor is zero at direct current. Therefore, the only quantity limiting current now in the motor is the stator resistance, and that resistance can be determined.

Testing machine: The testing machine is either squirrel cage induction motor, slip ring induction motor or alternator.

V. SOFTWARE TECHNIQUES:



Neural network:

An artificial neural network is composed of neurons with a deterministic activation function. The neural network, trained by adjusting the numerical value of the weights, will contain the non-linearity of the desired mapping, such that difficulties in the mathematical modeling can be avoided. The BP training algorithm is used to adjust the numerical values of the weights and the internal threshold of each neuron. The network is trained by, initially

selecting small random weights and internal threshold and then presenting all training data. Weights and thresholds are adjusted after every training example and presented to the network, until the weight converges or the error is reduced to an acceptable value. The structure of BPN Network for analysis of the insulation performance.

A three layer neural network suitable for training with BPN algorithm as shown in Figure 3.10. The input (first) layer serves only as distribution points; they perform no input summation. The input signal is simply passed to the weights on their outputs. Each neuron in the subsequent layers produces output signals according to the activation function used. A neuron is associated with the set of weights that connects to its input. This network is considered to consist of three layers. The input or distribution layer is designated as layer 0, the second layer called hidden layer is denoted as layer 1 and the output layer as layer 2.

Programming interfaces:

Taking the reading of applied voltage, leakage current, capacitance value has measured from the hardware. By applying those values in the algorithm we can predetermine the insulation condition weather strength or week.

Program execution and result:

By the following conditions provide to the algorithm is completely verify the partial discharge and compare with the present value of the machine. It shows the magnitude of the PD value which is has defined by the magnitude of the wave form. While the voltage obtain peak value measure the magnitude of the PD magnitude so we can judge insulation status of the AC machine.