International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Oil Based Transformer Health Monitoring System

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Abstract: ***The fault free operation of transformers gives more impact on economic and safety in power supply to utilities and industrial and domestic consumers. A sudden breakdown/fault in a power Transformers will affect unexpected production interruption, down time of the equipments in industries and the repair/replacement of the transformer; it may lead to huge investment and expenses. The insulating oil in a transformer can tell a lot about the actual state of transformer and its longevity. This proposed work mainly focuses on condition monitoring of transformer oil by using PLC, SCADA with suitable sensors for sensing parameters of oil like moisture content, temperature can be found. By using these data the analysis can be done. In addition to this, this system incorporated with the GSM module to alert the maintenance authority when the transformer under goes faulty condition, so that the transformer can be saved from the huge damage.***

Keywords: Moisture content, BDV, PLC, GSM technology.

1. Introduction

Transformers are a vital part of the transmission and distribution system. Monitoring transformers for problems before they occur can prevent faults that are costly to repair and result in a loss of service. Transformers being the essential part of power transmission system are expensive, as is the cost of power interruptions. Because of the cost of scheduled and unscheduled maintenance, especially at remote sites, the utility industry has begun investing in instrumentation and monitoring of transformer.

A low cost system for determining the health condition of transformer by using the parameters of oil like moisture content, BDV, temperature rise in the oil are presented. These parameters are continuously monitored and are sent using GSM technology to prevent premature failure of transformers and improving reliability of services to the customers. An Embedded based hardware design is developed to acquire data from electrical sensing system. It consists of a sensing system, advanced embedded hardware for middle level computing (PLC and Microcontroller), a powerful computer network for further transmission of data to various places and SCADA to display the parameter values and faults. A powerful GSM networking is designed to send data from a network to other network for proper corrective action at the earliest. Any change in parameters of transmission is sensed to protect the entire transmission and distribution. The condition and faults occur in the transformer can be determined by knowing the transformer oil parameters values such as, moisture content and particular temperature rise of oil.

2. Transformer fault Analysis

Transformer is a essentially a static electromagnetic device consisting of two or more windings which link with a common magnetic field. The main components of the transformer are core, windings, insulation(solid or liquid) and tank. Transformer insulation is provided mainly through mineral oil and kraft paper. This insulation oil[2] and its parameters provides major information about the actual status of transformer and its remaining life time.

The parameters of oil like moisture content, temperature rise should be in its optimum range. If parameters values goes beyond range that gives a means to determine the health of transformer. As load to transformer increases the temperature of the oil correspondingly increases. Increase of temperature in transformer is undesirable and causes faults in transformer.
The faults that may occur due to temperature rise in transformer are:

2.1Temperature rise in oil

The temperature in the oil [1]starts increasing as working time of transformer increases .This faults occurs in the transformer if the temperature of oil start rising above 65 ^{o}C.

2.2 Over load fault

As load to the transformer increases that increases the temperature of the oil due to drawn of large currents. If the temperature rises above 90 ^{o}C the over load fault may occur.

2.3 Insulation failure in oil

The average temperature rise[1] in the oil should not exceed above the 110 ^{o}C. If it rises above this temperature it causes insulation failure in oil and gases starts dissipating.

3. Block diagram of oil based transformer health monitoring system

Figure.1. It consists power supply, sensors, PLC, microcontroller, MAX232,GSM module and SCADA system. Based on temperature values the faults will be displayed in SCADA.

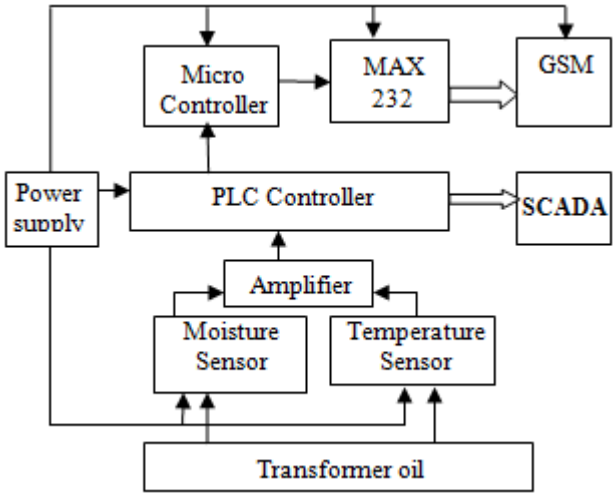

Figure 1: basic block diagram

3.1 Sensors

The sensors are immersed in the transformer oil to continuously determine the changes in the oil parameters. The sensors used here include:

3.1.1Temperature sensor

It is used to detect the changes in the temperature of the transformer oil The temperature sensor used here is PT100 sensor which is a platinum resistance thermometer. It changes its resistance as changes in temperature. For 1 ^{o}C change in temperature 0.38ohm resistance will change.

3.1.2Moisture sensor

It is used to detect the moisture content present in the oil When the oil gets heated up the moisture content present in the oil changes this changes will be sensed by this sensor. The moisture content sensor used here is FC28.

3.2 PLC Controller

PLC (programmable logic controller) is a digital computer used for automation processes. It has multiple input and output. The purpose of PLC here is to take the analog inputs from the sensors and gives the automated digital output. These output digital values are given as input to microcontroller.PLC used here is Micrologicx 1400 of Rockwell automation company.

3.3 Microcontroller

The purpose of microcontroller is to send the faults through the GSM modem. On receiving the faulted information from PLC the particular port pins of microcontroller will be made high and that particular fault is transmitted as a message through the GSM modem. The microcontroller used here is AT89S52 controller.

3.4 MAX 232

The MAX232 IC is used to convert signals from an RS232 serial port to signals suitable to use in TTL compatible digital logic circuits. It is used to convert the RS232 level signals to TTL logic level signals and vice versa.

3.5 GSM System

A GSM modem[3] is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. The purpose of GSM modem is to send the monitoring parameters values and faults of transformer to authorized person number in control room.

3.6 SCADA system

SCADA (Supervisory Control and Data Acquisition) is a system operating with coded signals over communication channel so as to provide control of remote equipment. The purpose of SCADA system is to display the oil parameters current values and faults that occur in the transformer.

4. Experimental Results

The transformer oil is tested for different values of temperatures and moisture contents which is displayed in the SCADA as shown in figures below. Figure1 shows the schematic of transformer in proper working condition with all values in the desired range. Figure2 gives the schematic of temperature rise in the oil fault which occurs when temperature rises above 60 ^{o}C. Transformer overload fault will occur when temperature exceeds above 85 ^{o}C as shown in figure4. Figure5 shows transformer Insulation failure alert fault which will occur when temperature exceeds above 105 ^{o}C and water content above 3% and gives a prediction that BDV of oil has decreased near insulation failure.

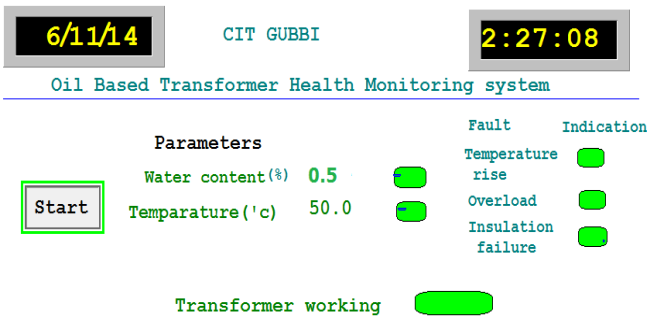

Figure 2: Schematic of Transformer With All Parameters In Normal Range Values

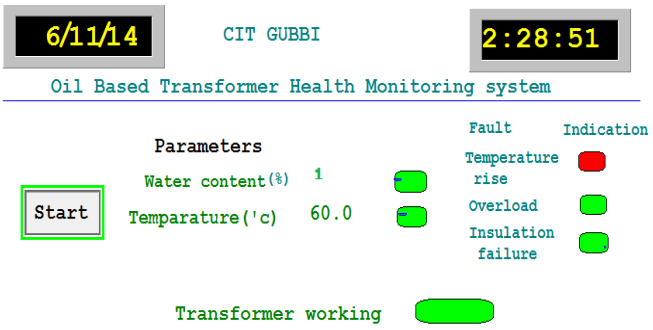

Figure 3: Transformer with temperature rise in oil fault.

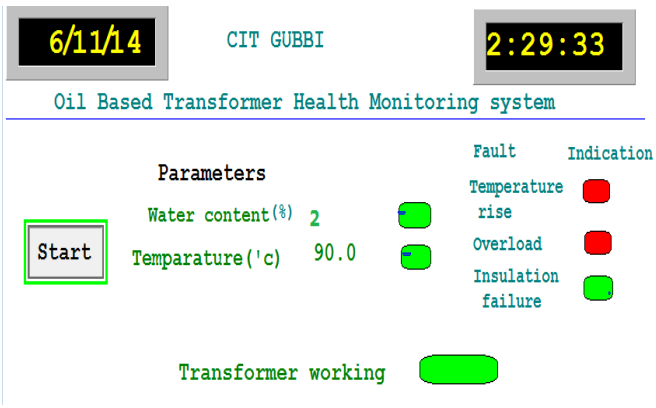

Figure 4: Transformer with overload fault.

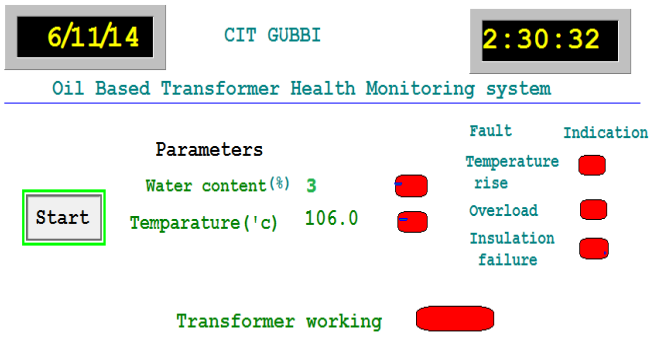

Figure 5: Transformer with insulation failure alert fault.

By sending these faults wireless through GSM to concerned authorized person to take the precautionary measures before transformer shutdown.

5. Conclusion

Transformers are among the most generic and expensive piece of equipment of the transmission and distribution system. Regular monitoring health condition of transformer not only is economical also adds to increased reliability. In this project monitoring of transformer is done using automated PLC system and advanced wireless technology for sending the fault information through GSM to operator or concerned authorized person.

So it is possible to take proper solution before converting fault in to fatal situation. This type of remote observation of health condition of transformer not only increases the life of transformer also increases reliability and decreased cost of power system operations.

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