Design And Implementation of Leakage Current Detector In Substation Transformer Bushings

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Abstract- *The substation consists of many transformers. Bushings are one of the main components of transmission and distribution lines and also in substations. Its function is to isolate the phase conductor to other phases and also between conductor and ground. Hence it is made up of good insulation material to prevent breakdown. The insulators installed are commonly in the open air, its performance is influenced by the aging of insulators, microclimatic changes, and the local air pollution which results in leakage of current. Generally, pollutants are conductive so that they will reduce the resistance of the insulator surface. Insulator conductivity gets increased in wet conditions caused by moist air or fog. This decreases the performance of the insulator. Thus, the pollution of the insulator results in a reduction of surface resistance in the insulator. Leakage of current on the insulator causes insulator fault. This paper investigates, the location of the substation where insulator fault occurs. The insulator fault is detected and solved in the initial stage by using different types of sensors mainly the hall effect sensor. This sensor is used for proximity switching, positioning, speed detection, and current sensing application. This project helps to overcome the demand for power which is one of the major problems faced by our country.*

I. INTRODUCTION

Outages in a transmission line occur due to failures that can develop abruptly, intermittently or incipiently. The incipient form of outage allows the monitoring and prediction of a possible fault. The incipient faults are often due to insulation problems, whether due to stresses, natural degradation or vandalism. Due to insulators operating in extreme environmental conditions, they typically undergo the deposition of various contaminants on their surface. The deposition of the contaminants decreases the resistivity of this surface, leading to the flow of a leakage current on the insulator due to the stress in its dielectric. The leakage current increases as higher the level of pollution, which eventually leads to the occurrence of a flashover, affecting long-term insulation performance. Due to the local heating that results in the formation of dry bands, the resistive surface of the insulators begins to present non-linear characteristics, which consequently cause a leakage current with several odd harmonics. Therefore, monitoring based on the leakage current allows observing the operating conditions of the insulators and performing diagnostics, and determining the probable causes of the failure. Recent research has sought to diagnose insulation faults in transmission branches. For this purpose, partial discharges and leakage current are used to characterize faults in insulator chains. In both methods, the measured signals are searched for patterns that can characterize the fault, for localization purposes. The characterization allows the development of mathematical models of transmission lines, to insert the model of the fault insulator. obtaining the leakage current to validate and develop diagnostic methodologies. In this paper, the leakage current to be characterized by the predictive maintenance methodology is obtained in transmission lines sections, from the input and output currents measured at substations located. at the terminals in the transmission line section. Predictive maintenance is possible from the acquired signals by sensors and network data that compose the Online Monitoring of Transmission Lines System MOLLTS. Therefore, the model to be used in this diagnosis methodology is composed of several leakage current signals with faulty insulators installed along this transmission line section. The contribution of this paper is validated by simulation of the leakage current signals using equivalent circuit models of faulty insulators. Also, the harmonic spectrum of characterized signals is used to develop and validate a predictive maintenance methodology based on Fuzzy inference.

II. RELATED WORK

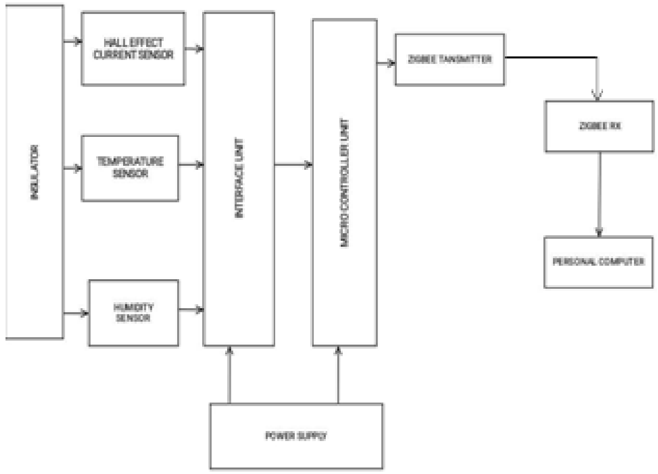
[1]"Temperature-Dependent Surface Charge and Flashover Behaviors of Oil-Paper Insulation Under Impulse with Superimposed DC Voltage" by B. Du, R. Chang, J. Jiang, and J. Li. The effects of ambient temperature and superimposed voltage on surface charge and flashover behaviors in an oil-paperinsulation system. Surface potential decay (SPD) experiments were performed under superimposed voltage with various polarity and amplitude combinations and at a temperature ranging from 20° to 80°C. [2]"Trap energy distribution in polymeric insulating materials through surface

potential decay method" by Y. Han, S. Li, and D. Min. The SPD curves in positively and negatively charged samples show a fast decay. followed by a slow decay, which is agreed with our assumption of shallow and deep traps. Two peaks are clearly observed from the trap energy distribution “Impact of temperature on surface charges accumulation on insulators in SF6-filled DC-GIL" by H. Zhou, G. Ma, C. Li, C. Shi, and S. Qin. the heat transfer surface charge accumulation model of operating DC-GIL was developed, including the nonlinear relationship between volume current in gas and electric field. Moreover, the space charge was also considered in the model. [3]"Temperature-dependent surface charge behavior of polypropylene film under DC and pulse voltages" by the capacitor faces temperature rise and multiple electrical stresses, which will influence the surface charge behavior of the polymer film. The paper is dedicated to research on the influence of temperature and different voltage waveforms on the surface charge and trap characteristics of PP film.[4]” Dynamic behavior of surface charge on double-layer oil-paper insulation under pulse voltage” by B. X. Du, J. P. Jiang, J. G. Zhang, and D. S. Liu. The surface charge behavior on double-layer oil-paper insulation under pulse voltage and inducing electrification was used to charge the oil-paper composite. Studies of various voltage amplitudes, pulse frequencies, numbers, and polarities showed that the decay is fast initially, and then becomes slower with time.

III. SYSTEM DESIGN

In our Methodology, voltage and current are measured continuously, and humidity and temperature signals areobtained from sensors installed at the bushings to be monitored are fed into a Zigbee transmitter/receiver.The measured signals are transmitted to a remote access point and a control station (personal computer). The putty platform is used for real-time continuous monitoring and data processing. The system hasa two-way communication capability that enables synchronized data transfer and acquisition. The design steps, the details of the various circuitry, and the characteristics of the different components form the complete system.

In the substation, three types of sensors are installed in the insulator. These sensors are the hall effect sensor, humidity sensor, and temperature sensor. Hall effect sensor detects very minute leakage current, and humidity and temperature sensors are used to sense microclimatic changes. If any leakage current occurs, the sensor will sense and transmit the signal toZigbee Tx/Rx. The data from Zigbee Rx are fetched into the personal computer so that the fault is recovered as quickly as possible.



Components:

Transformer:12-0-12 5Amp Center Tapped Stepdown Transformer is a general-purpose chassis mounting mains transformer. The transformer has 230V primary winding and center-tapped secondary winding. The transformer has flying-colored insulated connecting leads (Approx. 100 mm long). The Transformer act as a step-down transformer reducing AC - 230V to AC - 12V.

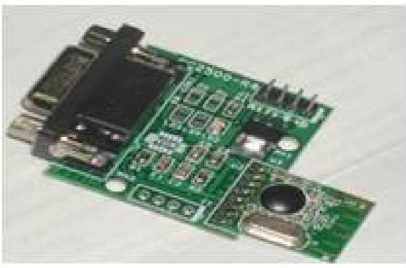
Hall effect sensor: Hall Effect sensors are used to detect variables such as the proximity, speed, or displacement of a mechanical system. Hall Effect sensors will not get damaged easily, so it has a long life. They are highly reliable. It detects the minute leakage current.

Temperature sensor: Temperature sensors are low-cost, precise, and extremely reliable in repeated experiments. They are desirable for both embedded and surface mount applications. They have a faster response time because of the lower thermal mass. The vibrating wire type is normally full-interchangeable.

Humidity sensor: Humidity sensors work by detecting changes that alter electrical currents or temperature in the air. There are three basic types of humidity sensors: capacitive, resistive, and thermal. All three types will monitor minute changes in the atmosphere in order to calculate the humidity in the air.

Zigbee Tx/Rx: ZigBee is a low-cost, low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications. Zigbee delivers low-latency communication. ZigBee chipsare typically integrated with radios and with microcontrollers.

ZigBee is a wireless, universal control protocol used in home automation for lighting control as well as other smart home compatible products. By using a ZigBee receiver, a standard light fitting can be paired to a ZigBee network and controlled by compatible devices.



Microcontroller–PIC16F877A: PIChasonly35single-wordinstructions.Allaresingle cycle instructions except for program branches, which use two-cycle. The Operating speed of PIC in DC is 20 MHz and the clock input in DC is 200 ns instruction cycle. The PIC has8K x 14 words of Flash Program Memory, and 368 x 8 bytes of Data Memory(RAM).

LCD –Liquid Crystal Display: An LCD consists of two glass panels, with the liquid crystal materials and witched in between them. The inner surface of the glass plates is coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules maintain a defined orientation angle. One each polarizes is pasted outside the two glass panels. These polarizes would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizes and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by polarizes, which would result in activating/highlighting the desired characters.

The LCDs are lightweight with only a few millimetres in thickness. Since the LCDs consume less power, they are compatible with low-power electronic circuits and can be powered for long durations.

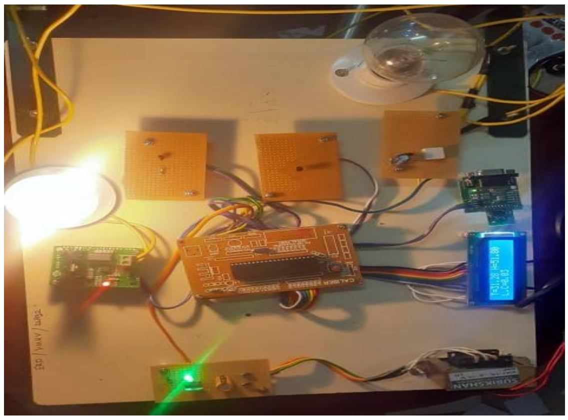
SSR Relay: A solid-state relay (SSR) is an electronic switching device that switches on or off when an external voltage (AC or DC) is applied across its control terminals. They serve the same function as an electromechanical relay, but solid-state electronics contain no moving parts and have a longer operational lifetime.

IV. RESULT COMPARISON

EXISTING SYSTEM	PROPOSED SYSTEM
Only one sensor is used	3 sensors are used
No detection of leakage current	Detection of leakage current
Difficult to maintain	Easy to maintain
Man Power is needed	There is no availability of Man Power and it saves time

V. CONCLUSION

The monitoring of the installed high voltage insulators is of great importance for the reliable operation of power networks. Until now commercial monitoring devices face a lot of disadvantages related to high cost, lack of upgrades, and a limited number of motoring channels. The proposed insulator monitoring kit due to its low cost and its advantages can cover the advanced monitoring demands of power utilities. The easy installation, the open-source code software, the autonomous power supply, and the easy modification of its operation according to the power utility needs are some of the main advantages. The preliminary setup of the fundamental structure of the insulator monitoring kit project gives encouraging results ona laboratory basis. Certainly, the laboratory system must be further advanced both in software and hardware in order to be installed in field conditions. In the future, it saves electric power. It is more useful for multinational companies for their bulk requirements. By implementing this project in the main transformer, if there is any leakage in the sub transformer the problem can be solved in the initial stage itself. Current theft can be identified easily with the location and the amount of current theft. By saving the power, it encourages to produce of more electric products for future use.



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