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Condition Monitoring of Transformer Oil with Alert Generation using IOT

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Abstract: Whenever there is any contamination or deterioration of transformer oil, it can lead to tripping of the transformer or breakdown of the transformer or failure of the transformer and may even result in fire or explosion causing extensive damage to life and property. Therefore, it would be of great advantage to have a checking and reporting system to detect problems in the early stages so that they can be fixed and both damage and cost can be reduced. The current paper proposes a system to enable condition monitoring of transformer oil using IOT, with an option to generate conditional alert. Wireless Sensor Networks and a Raspberry Pi board is used to monitor the oil using the RF data encountered and alert notifications are sent via push messages.

Keywords: Transformer oil, condition monitoring, WSN, IOT, Raspberry Pi

I. INTRODUCTION

Deterioration in the condition of transformer oil is one of the key causes of failure of the transformers. Assuming that, even when everything else is healthy and well- conditioned for a transformer except the oil, which is essentially not a part of the craftsmanship for the construction of a transformer the contaminated or deteriorated oil can consequently result in some serious casualties along with tripping or failure or breakdown of the transformer. Therefore, monitoring the condition of transformer oil is of essential significance. To guarantee a less troublesome, secured, inexpensive, safe and uninterrupted power supply a regular, repeated and cyclic inspection of transformer oil is compulsory. Deterioration and damage of the transformer oil is embarked from the very moment it is filled in the transformer particularly due to ageing and oxidation. Unwanted products like acids, sludge and moisture etc. are even produced by the transformer oil. Therefore, even under the normal operating conditions the transformer oil is endangered and vulnerable to decaying. In few applications, whenever the oil is in direct exposure with the air, thereby making it prone to oxidation and the process being accelerated by the presence of catalysts. Consequently, darkness in the colour of transformer oil and increase in the acidity increases the formation of sludge and consequently causing other electrical properties such as dissipation factor to a rapid increase, ultimately, hindering and shortening of the life span of the transformer.

A transformer failure can have catastrophic effects, which includes some significant property damage, serious interruption to a business. Since large quantities of transformer oil present in the transformers are exposed to direct proximity with a number of high voltage components and hence increasing the chances of fire and explosion of the transformer, thereby risking life. Thus, one failure can lead to many problems and have different impact. Life expectancy of transformer is directly dependent on the good condition of transformer oil. Hence, transformer oil is one of the most important components to save the transformer in the long run. Conventionally, the transformer failures are not initiated with an event of electrical breakdown or fire. However, they often come into existence much earlier and can be traced before the actual breakdown or failure of the transformer. Therefore, the transformer oil must be periodically tested for the stability and smooth functioning of the transformer. The checking cannot be done manually. Hence, the aid of the proper instrument is needed. Whenever there occurs any change in the condition of transformer oil and these changes exceed beyond the permissible range, the sensors detect these changes and send an alert via push messages.

The current work aims to propose an IOT based system controlled by a Raspberry Pi board interfaced wirelessly with sensors to monitor the condition of the transformer oil. Section II surveys some of the recent research in the domain. Section III describes the system proposed in the paper. Section IV concludes the paper with a brief deliberation on future research in this area.

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II. LITERATURE SURVEY

The conditional monitoring of transformer oil has been investigated by many scholars for its potential implications and benefits, and review of techniques in this domain have been carried out by many researchers throughout the years [1]. Researchers have studied the effects of dissolved gases in transformer oil and proposed corresponding monitoring techniques [2]. Process monitoring for transformer oil using multivariable statistical evaluation has been carried out by researchers [3]. Rise of temperature has also been used to monitor oil health [4]. The use of controllers and advanced techniques has increased in recent years [5] [6]. The advent of IOT has allowed for implementation of distributed control for condition monitoring. Neural networks have also been used by some researchers for this purpose [7].
Most of the proposed are complex, and, although the results obtained by them are by and large good, their complexity is quite high and the setups in many cases are quite expensive. Thus the authors have endeavoured to present a comparatively inexpensive model which uses IOT to interface a Raspberry Pi board with sensors for monitoring the condition of the transformer oil.

III. PROPOSED SOLUTION AND RESULTS

Oil, used in the transformers, can be stable at high temperatures and has brilliant insulating property. Transformer oil is in three types, which are oil in paraffin, naphtha and aromatic bases respectively. This insulating oil serves some purposes in transformer like working as coolant and insulator (due to the high dielectric strength of the transformer oil). The specifications of transformer oil are low viscosity to minimize flow resistance, and yellow colour. The colour changes of the transformer indicate the class and quality of the oil, as seen in the following table 1.

Table 1: Colour changes in Transformer Oil

Colour of Transformer oil	**Class and quality of the transformer oil**
Pale Yellow	Oil is in the best condition for use
Yellow	Good condition of oil
Bright Yellow	Negligible deterioration in the condition of oil
Amber	Poor quality oil
Brown	Very low quality oil
Dark Brown	Unsatisfactory and unacceptable oil
Black	Faulty, inappropriate, unsuitable, imperfect- oil should not be used further

Different types of sensors, like colour detector, viscometer, ph meter, flash and pour point tester are connected with the transformer. These sensors can detect the changes in oil and get the value. This value is acted like signal, which is wirelessly sent to the Raspberry Pi board through RF Module. And it is monitored with the help of ADC through wireless message processing system. The schematic of the proposed setup is seen in Figure 1 below. This setup allows for comparatively cheap, robust and efficient monitoring of the transformer oil.

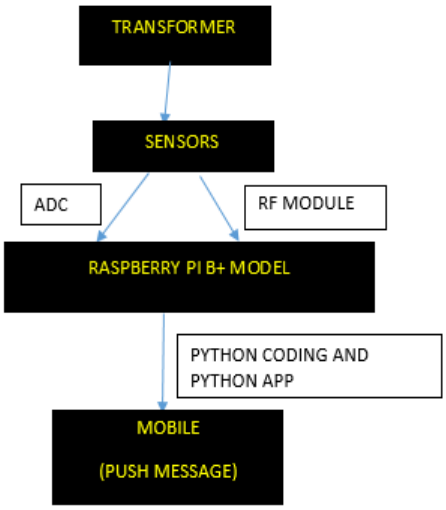

Figure 1: Schematic Diagram of Setup

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IV. CONCLUSION

The current work accomplished in this paper can be improved upon in many ways. Machine-learning algorithms can be implemented to run on the processor to predict the deterioration in condition of the transformer oil well in advance and maintenance including replacement of the oil can be scheduled accordingly. Also, using machine learning algorithms such as k-means clustering, faults can also be predicted in advance from the sensor datasets generated continually. Another valid approach is the use of artificial neural networks for the abovementioned purpose.

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