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Automatic Cooling Of Distribution Transformer

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***Abstract—** The Automatic Transformers Heat Reducing System is a novel project that controls transformer temperatures by activating a pump and commencing an oil-cooling process via condensation. This project is based on mechanical engineering and uses the concept "CHANGE" as its driving principle. The motivation for this endeavor originates from both technological improvements and societal demands, indicating our entry into the field of temperature management within the framework of temperature gear and transformer health surveillance, which includes current and voltage measurements. Transformers heat up rapidly when subjected to overload or short-circuiting situations. A sensor for temperature is used to detect the heat and provide an indication to the control module. The control unit then starts the pump, which causes the heated oil to condense through a condenser with a blower configuration. The microcontroller plays an important part in this process by showing the transformer heat on an LCD panel.*

***Keywords—** Arduino Controller, LCD Display,* Temperature *Monitoring,* Power Monitoring, Cooling effect *etc.*

I. Introduction

A transformer is an important component in electrical systems because it converts voltage levels while maintaining system frequency. During this process, heat losses happen in the core or windings, reducing the transformer's final power to slightly under its source power. Heat generation increases proportionally with the transformer's ratings and capacity. Cooling systems that cool this electrical unit use a variety of media, including air, water, or oil. Previously, oil and water refrigeration systems were operated manually, which presented difficulties such as identifying overheating concerns (Bharathidasan et al., 2019).

Transformer design takes thermal behaviour into account, and correct temperature calculations are critical to achieving optimal performance, quality, and lifetime. The difference in temperature between the wire and oil is caused by gradients in the solid wrapping insulation as well as the boundary material at the wound surface. The gradient inside solid insulation is determined by elements such as enamel the thickness, paper insulation, with oil pockets between the wire and the paper wrapping. Heat transmission at the transformer's winding surface is affected by the cooling conditions.

Transformers play an important part in the movement and distribution of power from generators, providing electricity directly to low voltage consumers in power networks. Transformer operational state is a requirement for network functioning. The principal reasons of failure in distributive transformers are overloading. This is oil temperature, current under load, and poor cooling. Manually measuring the status of each transformer is impracticable when there are so many of them spread out across such an area. As a result, a transformer monitoring apparatus is required to track critical parameters and rapidly communicate this data to the monitoring system.

This system provides critical information regarding the transformer's functionality and heat reduction approach. It assists utilities in optimizing transformer consumption, improving equipment longevity in distribution networks..

II. Problem Identification

A transformer is a static device that uses electromagnetic induction to increase or decrease voltage. This device is prone to a variety of defects, including winding & core troubles. Several difficulties were discovered during industrial visits, including winding flaws such short circuits, inadequate turns, and height problems, along with core-related concerns including short circuits and elevation issues. These faults are often uncovered during transformer testing, however they can go unnoticed before to testing.

An further risk exists in the cooling controller panel, whereby timers, contactors, relays, and other devices are used to activate fans to cool the winding whenever its temperature surpasses a particular threshold. The employment of timers, contactors, along with relays inside a cooling control panel adds to the complexity and cost.

Transformer design involves a strong emphasis on thermal behaviour, needing exact temperature estimates for maximum quality, performance, and longevity. The temperature gradient among the conductor and oil is caused by gradients in the solid conducting insulation as well as the boundary material at the wound surface. The gradient inside solid insulation is determined by elements such as enamel thickness, paper insulating material, and oil pockets that lie between the conductor and the paper wrapping. Heat

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transmission at the winding surfaces is determined by the cooling circumstances approach, which includes two typical methods: Natural Convective Cool (ON) and Directed Convective Cooling (OD).

III. Objectives

The primary goal is to increase the dependability of transformer operations by embracing contemporary technology breakthroughs. This endeavour attempts to achieve constant surveillance and easy control for the transformer's cooling impact.
Specific duties include:

- Implementing a display with an LCD to monitor the transformer's voltage and current condition.
- Continuous temperature measurement is used to start or stop the cooling effect, preventing transformer damage.
- Using a Cooling Thermal electricity module to convert hot oil into cooled oil.
- Evaluate the influence of power and heat after using the cooling strategy.
- Identifying and analysing obtained results and outputs.

IV. Literature survey

The technology aims to properly manage the device's electrical system by incorporating a microcontroller into the cooling system. The ATmega8L microcontroller can quickly handle common defects in electrical devices, including contact on the winding, inadequate turns, and touch in the core, while also improving flexibility and efficiency. This microcontroller senses temperature using a thermometer and activates the electrical device cooling fan when the temperature rises beyond the set limit. The temperature determines the fan's motor speed, which is controlled using the Pulse Width Modification (PWM) technology. The PLC-based Transformer Management and Cooling System (TMCS) is designed for permanent installation at a specific electrical equipment, offering automated, dependable, and cost-effective control via a computer equipped with PLC ladder logic.

Amuthan et al. (2017) devised a quadrant cooling solution for transformers using solar-powered external fans. The fans, which are positioned in separate quadrants at an angle of 45 degrees difference, work similarly according to the ONAF approach, delivering rapid cooling by pushing air over the transformer's conditioning fin from four directions. A direct link to solar panels guarantees consistent cooling when UV rays are present.

Tekade and Rakhonde (2014) developed a microcontroller-based transformer cooling system that uses an ATmega8L microprocessor to automate the cooling operation. It detects high temperatures of winding or oil through indicators and automatically activates the fan or trips the transformer according on the temperature level, reducing overheating and increasing the transformer's lifespan.

Modi (2012) Using the microcontroller and a power electronics device, I completed a project centred on the transformer's control panel. Heat generated inside the transformer is transmitted to heat absorbs, and exterior fans are installed on the transformer sides to aid cooling. The outside fans are connected in a parallel manner.

V. NEED OF COOLING CONTROL OF TRANSFORMER

Large transformers require more intense conditioning to eliminate thermal losses. A variety of cooling systems have lately been deployed for this purpose. They are,
· Oil Natural Air Natural (ONAN)
· Oil Natural Air Forced (ONAF)
· Oil Forced Air Forced (OFAF)
· Oil Forced Water Forced (OFWF)

- • The described techniques have limitations, such as large losses in the transformer, which reduces efficiency. Additionally, they require pricey arrangements.

VI. Block Diagram

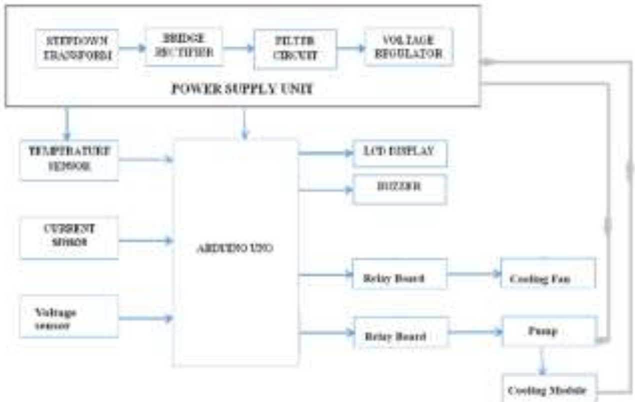

Fig.1. Block Diagram of system

VII. Working

• This system is intended for continuous monitoring of distribution transformers parameters, giving vital information on their health. This data supports utilities in optimising transformer utilisation, resulting in longer asset operation.
• This system uses a variety of sensors, such as those for voltage, current, and temperature. A dedicated power source powers both the Arduino UNO and the LCD display modem.
• The cooling effect begins automatically with an increase in temperature, using a thermoelectric cooling unit within an oil-circulated circuit to switch from heating to cooling.
• As technology has advanced, the demand for electricity has steadily increased, resulting in an increase in transformer nominal power. However, this tendency leads to higher losses and lower cooling capacity in transformer.

• In our traditional transformer arrangement, temperature regulation is accomplished using an analogue temperature metre within an Oil Forced The atmosphere Driven (OFAF) refrigeration system. When the temperature rises over the predetermined limit, the cooling air and pump operate. To improve this procedure, a microcontroller is used to detect temperature from a sensor that senses temperature and activate the transformer cooling fan if the temperature surpasses the predetermined limit. The motor's speed is temperature-dependent.
• The image above depicts the connections between all components. Sensors collect data and present it on the display panel.

Components:

- Transformer
- Voltage sensor
- Current sensor
- Temperature Sensor
- Arduino Uno
- LCD Display
- Thermoelectric Cooling module
- Relay Board
- Cooling Fan
- Cooling Block
- DC Pump
- Regulator
- Buzzer
- 7805 IC Module
- Power supply unit
- Others.

VIII. ADVANTAGES

• Constructed simply. • Operates quietly. • Portable for easy movement between locations.
• Low maintenance costs.
• The LCD monitors the transformer's current temperature.
• Continuously.
• The keyboard is employed to set the desired temperature.

IX. DISADVANTAGES

- Power requirement of the blower is high
- Initial cost is high.

X. APPLICATIONS

- E.B Station
- Industries

XI. CONCLUSION

To extend the usefulness of a transformer, an effective cooling arrangement is required, as described in this study, in which three cooling systems run simultaneously. While oil-based cooling is a common option, it may not be suitable for big transformers that handle significant power. The technology used to operate the transformer cooler has a significant impact on its thermal performance. As a result, the cooling system may be efficiently controlled to optimise transformer working conditions. In this project, a tiny computer is used to manage the transformer's refrigeration system, creating a smooth link between the software and the hardware. This method is not only effective, but also economically feasible.

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