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## Microcontroller Based Transformer Cooling Control System

Bhushan S. Rakhonde<sup>1</sup>, Nikita A. Tekade<sup>2</sup>

<sup>1</sup>(Electrical Department, D.E.S.s C.O.E.T. / S.G.B.A.University, India)

**ABSTRACT :** The aim of developing, this paper is to managing the system in such a way, that we are using microcontroller in cooling control system of transformer. In transformer there are many faults occurring in the system such as, short circuit in winding, less number of turns, also the problem like short circuit in core. To overcome these faults within short interval, having better flexibility and efficiency, so the microcontroller ATmega8L is used. It is used to sense the temperature from temperature sensor and when temperature goes above set limit transformer cooler fan will on and motor speed is depends on temperature and using PWM (pulse width modulation) technique for speed control.

**Keywords-** Microcontroller, Oil temperature indicator, Octocoupler

### I. INTRODUCTION

Transformer is a static device which is used to step up and step down the voltage working on the principle of electromagnetic induction. There are many faults occurring in this device such as, faults in winding, Faults in core, etc. As we have gone through industrial visit we have found out number of problems. Problems such as faults in winding like short circuit in winding, less number of turns, height problem etc. Also they face problem in core like short circuit in core, height problem etc. But all such problems they were find out during testing of transformer but not able to find out before testing. One more problem is there in cooling control panel of transformer in which they are using timers, contactors, relays, etc. to start the fans for cooling purpose of winding if the winding temperature is increased by certain limit. Use of timers, contactors, relays in cooling control panel makes it very complicated and expensive.

### II. NEED OF COOLING CONTROL OF TRANSFORMER

The paper discusses the significance and the necessity of measuring temperatures and optimizing cooling of large power transformers. Ever since the invention of a transformer, we have been facing the trend of increasing its nominal power the requirements set by the technological progress and the related increasing demand for electric power. Together with the increase of nominal power, losses in transformers increase as well, while a transformer's own capability of cooling decreases. Large transformers thus need more Intense cooling to remove thermal losses. For this different type of cooling system are recently used. These are,

- Oil Natural Air Natural (ONAN)
- Oil Natural Air Forced (ONAF)
- Oil Forced Air Forced (OFAF)
- Oil Forced Water Forced (OFWF)

The above methods have some demerits like, a large losses are occurred in transformer. due to these efficiency is decreased. Also it required expensive arrangement. For better the accuracy, reliability and efficiency, we are using microcontroller ATmega8L. In our regular used transformer temperature control by traditional method using analog temperature meter in Oil forced Air forced(OFAF) cooling system and in that system when temperature goes above the set temperature, cooling fan will on and therefore we are using the Microcontroller to sense the temperature from temperature sensor and when temperature goes above set limit transformer cooler fan will on and motor speed is depends on temperature and using PWM (pulse width modulation) technique for speed control.

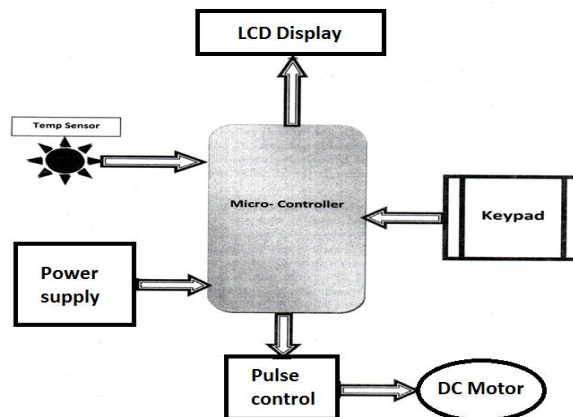


Fig.2.1. Block Diagram

The heat is transferred to the heat sinks and there, there are fans provided outside the transformer to cool the transformer walls. The numbers of fans are connected in the parallel connection outside the transformer. Here in the above diagram the heating of the transformer is shown.

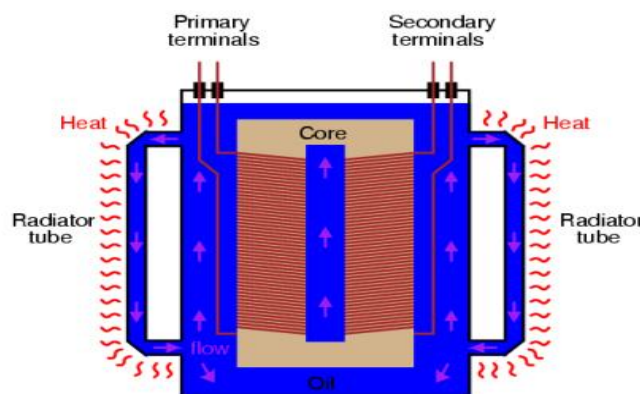


Fig.2.2. Transformer Heating

There are number of tubes from which the heat is transferred in the natural air. But for the high rating transformers the heating is much more due to the more losses in the core. So, there are fans provided for the better cooling of the transformer. The transformer oil is the primary insulating material. In the normal transformers there is the Winding Temperature Indicator (WTI) and the Oil Temperature Indicator (OTI) is used for the temperature measurement of the transformer. There is cooling control panel in the transformer for the control of the temperature of the core in the transformer. The cooling control panel contains WTI, OTI, MCBs, Thermocouple, Timers, Contactors, Alarm and etc. The MCBs are used for the protection of the cooling control panel. The WTI and OTI are used for the temperature measurement. They are situated in the transformer tank. The timers are used for the operation of the switches within the time. The thermocouple is used to measure the temperature and gives the analog signals as the output. OTI and WTI are instruments which are important, if not the most important, protection and control devices for transformers. They are used to control the transformer cooling equipment, such as fans and pumps if available, they provide alarm signals and they typically also trip the transformer – or in other words take the transformer out of operation, should the temperature become too high. The transformer size from which the usage of this kind of equipment starts can vary but in many cases the power rating of the transformer is above 2 MVA, but depending on requirements and application, it may start at even lower ratings. The instruments are of direct reading mechanical dial type and should be self-powered, meaning no power source is required for the indication and function of the devices. They basically consist of three parts assembled together to one complete instrument; a case where the indication dial and switches are

housed together with the mechanics that drive the indication and switch operation, a sensing bulb which is the actual temperature measuring part and then a capillary that connects the sensing bulb to the case. The complete sealed measuring system can be filled with a gas (pressurized system) or more popular with a liquid (non-pressurized system) to obtain the temperature from the transformer. The instruments are compensated for ambient temperature changes, necessary because of the large ambient temperature operating range.

### **2.1 Winding Temperature Indicators (WTI): -**

WTI measures the temperature of the winding. In this there is one rod that is put nearer to the winding and that rod senses the temperature. WTI only measures the temperature of the winding there is one another instrument used to measure the temperature is called OTI. The below is the diagram of the WTI.

The dial indicating the actual temperature should be large and clearly visible, also from a distance. Commonly a white dial with black letters and black pointer is used, but also the opposite can be found. A large dial deflection eases the readability over the entire measuring range which often is 0 to +150 °C, but also other ranges are used. Normally every 2 °C are marked on the dial, but occasionally some instruments instead show every 5 °C. Different accuracy tolerances are offered – normally from 2% to 1% depending on requirements. Important is that the indicator is equipped with a resettable red colored maximum indication pointer to show the maximum temperature since the last reset. This provides valuable information on the possible degradation of the insulation material inside the transformer. Lately the number of instruments equipped with remote reading capability has increased. This is due to the fact that many transformers are in remote places or hard to get access to, to check the actual temperatures. The remote reading, typically a 4-20 mA signal, but also other signals are available, can be connected to a SCADA system (supervisory control and data acquisition system), a computer or network, or to a remote indicator of analogue or digital type – or to a combination of these functions – which certainly facilitates the access to the actual temperatures. The switches are of micro switch type, available with different ratings depending on application and voltage that are being used with the switch. Typically the usage for AC switching up to 15 A, for Voltage of 110 or 220 VDC and for mA signals require different types of micro switch contact material – meaning different types of switches – also combinations of different switch types in the same instrument are becoming more popular. The switches should be of SPDT (single pole, double throw) type so that either the normally open or the normally closed function (or both) can be chosen. However, sometimes DPTD (double pole, double throw) switches are required, when exactly the same switching point for two contacts is necessary. This can for instance be used for simultaneous trip and alarm functions. More information on switches and settings for instruments can be found under the respective part on OTI and on WTI. The temperature sensing bulb is mounted on the top of the transformer for IEC style transformers and typically on the side for ANSI style transformers. To avoid moisture getting into the transformer oil, should the replacement or upgrade of the instrument become necessary, the bulb is close to always put into a pocket (also sometimes referred to as a well). The pocket can be welded or connected by a thread to the transformer tank – and offers a threaded connection for the sensing bulb. The size and thread dimensions can vary and is depending on standards and common practice in different countries. Basically there are two versions of the pockets – dry-type and oil-filled pockets. On IEC transformers the most commonly used version is the oil-filled pocket, which often comes with thread size G3/4", G1" or M22 x 1,5 mm, but also other sizes can be found. The dry-type pockets are found on ANSI style transformers and on IEC transformers from certain manufacturers, and offers a very tight fit between the bulb and the pocket to allow for a good heat transfer. The oil-filled pockets are larger in size and therefore need the oil inside for the heat transfer. Oil-filled pockets should never be completely full once the bulb is put into the pocket, since the oil in the pocket expands with increased temperature and thus need space for the expansion. A rule transformer- either a mineral or a silicon type. The temperature sensing bulb is connected to the case by the capillary. The required lengths range from 1 m up to well above 20 m, although the mostly used versions are 4 to 8 m. The capillary is a metal tube that allows the liquid (or gas) to be transmitted between the bulb and case. The inner diameter is very small, around 0.5 mm is common – while the outer diameter as well as choice of material vary between different brands. The recommendation to avoid damages if persons should step on the capillary or bend it too sharply is to use Copper-Nickel alloy material and an outer diameter of 3 mm. In addition the capillary should be housed inside a protective hose or amour for increased safety. These amours could be a stainless steel protection or a PVC hose where the former provides superior mechanical protection. The instruments are typically used outdoor, although in certain cases there may be requirements on installations inside cubicles. They are normally found in eye-height mounted directly to the transformer tank wall. Since transformers vibrate with a frequency (the same as the network frequency, 50 Hz or in certain countries 60 Hz) or a multiple thereof, the use of anti-vibration

mountings is highly recommended. This is to avoid wear of parts and prolong the lifetime of the instrument. Stainless steel mountings are preferred based on vibration reduction and lifetime versus rubber parts which wear because of sun and environmental influences and thus have shorter expected life time. Transformers are used all over the world, so the instruments should be designed for climates ranging from arctic to tropical including a large ambient temperature operating range. Transformers and their accessories, including the temperature indicators, are expected to have a long life time – requirements of min 20 years expected life time are common. Therefore the choices of materials, paint and overall quality of the instruments are very important to consider. Furthermore the OTI's and WTI's are required to be maintenance free as well as free from additional recalibrations throughout the life time of the devices which put high demands on these gauges.



Fig.2.1. Winding Temperature Indicator

## **2.2 Oil Temperature Indicator (OTI) :-**

Liquid immersed distribution transformers, power transformers and reactors are using oil as insulating media and for cooling. The temperature of the oil increases by the load of the transformer. In fact it is mainly the resistance in the transformer windings that increases the temperature of the winding and then subsequently the oil – the higher the current through the winding is the higher the temperature will get. The winding is cooled by the oil – which is then heated up. Since the life time of the transformer is depending on the deterioration of the insulating material around the windings, typically some kind of paper material – and this material is aged quicker at higher temperatures, it is important to check and control the oil temperature. This is done by the use of Oil Temperature Indicators, usually called OTI's. They are designed to measure the oil temperature and provide a clear temperature indication as well as providing the option of starting/stopping cooling equipment, giving alarm and trip signals. All transformers larger than 2 MVA are equipped with minimum one OTI – in certain countries the use of two separate OTI:s on each transformer is common, especially on larger size transformers where the oil temperature might differ slightly depending on the location of the pocket and temperature sensing bulb. Apart from the general description above, some important features to consider are listed below.



Fig.2.2. Oil Temperature Indicator

### III. MICROCONTROLLER

Microcontroller is an integrated computer chip that is often a part of an embedded system. The name microcontroller indicates that it is a device which controls the signal i.e. it is a general purpose device. It can read data, perform limited calculation on data and control its environment based on those calculation. The primary application of microcontroller is to control the operation of machine using a fixed program i.e. which is in its ROM and it does not change over life time. There are various types of microcontroller chip used for daily purpose. But in all that the 8-bit 8051 microcontroller chip widely used. For advancing a technology now we can use an AVR based microcontroller chip of 8-bit ATmega(L).

Atmel AVR microcontroller delivery a unique combination of performance, power efficiency and design flexibility optimized to speed time to market an easily adapt to new ones they are based on industry's most code efficient architecture for C and assembly programming. The ATmega8 (L) is low power CMOS 8-bit microcontroller based on AVR architecture. The Atmel AVR core combines a rich instruction set with 32 general purpose working register. All the 32 register are directly connected to the arithmetic logical unit allowing to independent registers to the accessed in one single instruction executed in one clock cycle.

The ATmega8(L) architecture is continuously running in power-saver mode. In standby mode, the crystal or resonator oscillator is running while the rest of device is sleeping because of this it work as fast start-up combined with low power consumption.

#### 3.1. Information About The Microcontroller AVR Based IC

The Atmel AVR ATmega8 (L) is a low-power CMOS 8-bit microcontroller based on the AVR architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed.

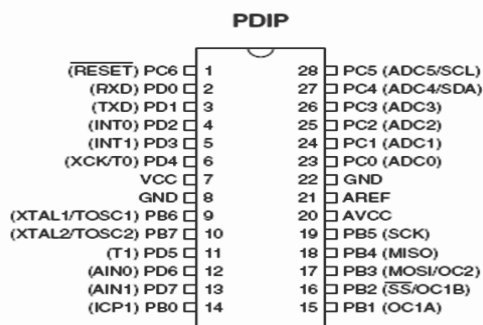


Fig.3.1. Pin diagram

#### 3.1.1 Pin Discription

VCC : Digital supply voltage.

GND : Ground

Port B (PB7...PB0)

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source Capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up Resistors is activated. The Port B pins are tri-stated when a reset condition becomes active, Even if the clock is not running

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator Amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7...6 is used as TOSC2...1 Input for the Asynchronous Timer/Counter2.

Port C (PC5...PC0)

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up Resistors is activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

PC6/RESET

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Shorter pulses are not guaranteed to Generate a Reset.

Port D (PD7...PD0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up Resistors is activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega8 as listed on.

RESET (Reset input)

A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Shorter pulses are not guaranteed to generate a reset.

### 3.1.2 Advantages Of Microcontroller

Following are the advantages of microcontroller,

- Flexibility-Ability to reprogramming by using flash , EEPROM or EPROM.
- High integration-most microcontroller are essentially a single chip computer, with on –chip processing, memory and I/O. Some contain peripherals for serial communication and analog to digital converters.
- Easy to use-just a single programe is fixed in single chip, the microcontroller have longer life.
- Cost-Its cost is reduced , due to its design and flexibility.

## IV. CONCLUSION

As we know transformer is the heart of electrical system, it's our basic aim of cooling of transformer conveniently. For sake of convenience, we are using AVR microcontroller over 8051 microcontroller. It can be four times fast operated. It consumes the power and automatic speed control of motor through the microcontroller for transformer cooling purpose.

From all these we can conclude that, studied in this project to consume the power and automatic speed control of motor through the microcontroller for transformer cooling purpose. As an electrical engineers are proud to be involved with this innovative project in India that combines power generation with energy conservation.

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