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Transformer Core Fault Detection and Control

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Abstract

This paper describes the protection of oil-cored and air-cored transformers from core faults. In oil cored transformer buchholz relay is used to detect the core faults, but the buchholz relay can be used only in oil immersed transformers equipped with conservators and it can detect only faults below oil level of the transformer and this device cannot be used for air cored transformer. So it is necessary to implement new technique to detect the core fault, it is done by the circuit comprising of 'thermocouple' which detects the internal temperature of transformer and 'temperature sensor(LM35)' used to sense the temperature of the surroundings in location of transformer, these two signals are fed to the comparator this compared signal is fed to micro controller , the 'micro controller' is programmed such that if the difference value exceeds the normal temperature it sends information about the fault to the substation through GSM module, if temperature inside increases over extreme limit the micro controller send signal to trip circuit then after the fault is cleared i.e after the temperature difference becomes normal then micro controller sends signal to turn-on the circuit. This same technique can be applied to air cored transformer. The entire circuit can be powered using solar panel with rechargeable batteries or from the power line using step down transformer.

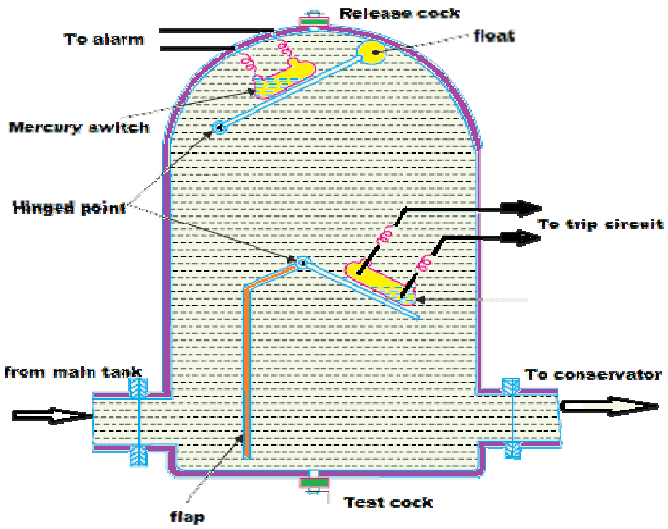
Keywords: Buchholz relay, transformer, thermocouple, LM35, comprator, micro controller, GSM, trip circuit, solar panel.

1. Introduction

The electrical equipment and circuits in a substation must be protected in order to avoid or to control damage due to abnormal currents and/or voltages. All equipment normally used in power system installations has standardized short-time withstand ratings for over current and overvoltage. The role of protective scheme is to ensure that this withstand limits can never be exceeded. In general, this means that fault conditions must be cleared as fast as possible without missing to ensure coordination between protective devices upstream and downstream the equipment to be protected. This means, when there is a fault in a network, generally several protective devices see the fault at the same time but only one must act. fuses which clear the faulty circuit directly or together with a mechanical tripping attachment, which opens an associated three-phase load-break switch and Relays which act indirectly on the circuit-breaker coil. The transformer protection is very important in electrical distribution system. The protection is done by Buchholz relay.

Buchholz relay is a special type of relay which is widely used for internal protection of a transformer. According to the history, this relay is named after Max Buchholz in 1921. This relay is mainly used in oil immersed transformer for providing protection against all types of internal faults like any insulation breakdown. By definition, Buchholz relay is oil and gas actuated relay which is located in the pipeline connecting the transformer main tank and the conservator

(a) Construction of Buchholz Relay:-



The main tank and the conservator, designed in the form of a vessel filled with oil which is dome in shape, as shown in the respective diagram which contains the total constructional details. The device can be easily subdivided into two portions inside the vessel depending on its purpose and also its structure, i.e. the upper part and the lower part.

Upper part: - The upper part contains a float which is directly connected to a hinge and a mercury switch is just kept over the float. On the other side the mercury switch is kept in such a way that the terminals of the switch when made to contact with the alarm circuit's terminal, it makes a close circuit. Thus the float is made to move up and down in the oil immersed vessel so that the terminals of the mercury switch gets connected and closing the alarm circuit for making us alert at the time of some internal faults. So the actual purpose of this upper part is to alarm us about the faults.

Lower part:- The lower part of the Buchholz relay is concerned with the detection of serious or major faults and thus completes the trip circuit to open the circuit breaker operating the transformer. It contains a hinged type flap, on which another mercury switch is kept. The mercury switch on the other side is placed in such a way that with the movement of the flap, the terminals of the switch will connect with the terminals of the Trip circuit. The flap plate is placed in just between the flow path of the oil and gas between the main tank pipe mouth and the conservator pipe mouth. The vessel of the Buchholz relay also contains a release tap at the top, to exhale the extra gas from creating any types of damage due to pressure.

(b) Working principle of buchholz relay:-

The main working principle of buchholz relay is depended upon the generation of hydrogen gas inside the transformer oil tank. When the transformer oil is subjected to a considerable amount of heat, then it gets decomposed and produces hydrogen gas (H_2). Generally, an alarm circuit and a trip circuit are connected with relay mechanism. The tripping procedure of both coils and hence the working principle of Buchholz relay is described as follows.

Working of alarm circuit: - The main reason of attaching an alarm circuitry is to alert the working personnel about the fault. If any fault occurs inside the transformer, then a huge amount of heat will be produced. So, this critical amount of heat will decompose some part of transformer oil from the main oil tank. This decomposition of oil generates a considerable amount of hydrogen gas inside the tank. We know that hydrogen gas is lighter than the oil. As the conservator is situated at the top position of a transformer, so after generation the entire amount of gas tends to reach the conservator tank by flowing in upward direction. But as the Buchholz relay is located at the pipeline, so when flowing to the conservator, some amount of gas is also entrapped by the upper portion of Buchholz relay. More amount of heat leads to generate more amount of hydrogen gas and thus more gas will be accumulated inside the relay chamber. When the amount of gas tends to approach a predetermined safety value, then it creates a pressure to the float which leads to tilt the float. After the movement of float, the upper mercury switch will get closed circuited and create a complete circuit for the alarm. In this way, the alarm circuit is working under any faulty condition.

Working of trip circuit:- When a serious fault is occurred, then a heavy amount of heat will produced inside the main tank. So, a huge amount of oil is decomposed and this leads to generate a heavy amount of hydrogen gas. The inrush of gas is much higher in that case, and when rushing upward to the conservator tank via the Buchholz

relay, then a considerable amount of gas entrapped into the relay and immediately tilts the flap arrangement. After the movement of flap, the mercury switch is automatically closed and provides a closed contact for the trip circuit. In this way, tripping mechanism takes place and isolates the transformer from the healthy bus bar.

(c) Advantages and Disadvantages of Buchholz relay:-

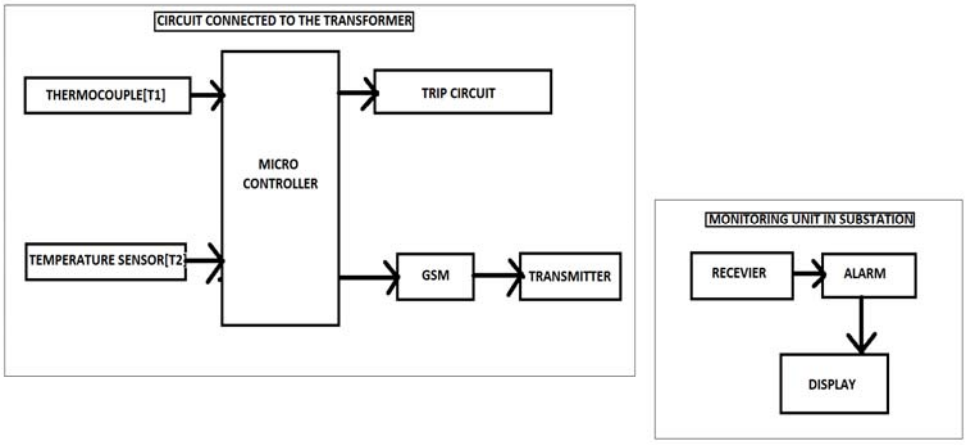
Advantages:-

1. It is the simplest form of transformer protection.
2. It detects the slow developing faults at a stage much earlier than other forms of protection.

Disadvantages:-

1. It can only be used with oil immersed transformers equipped with conservators
2. The device can detect only faults below oil leveling the transformer.

The following modernized design will help to overcome the above disadvantages and provide effective protection of the transformer.



2. BLOCK Diagram

The block diagram illustrates how the circuit is tripped from the mains when internal fault occurs in the transformer.

The thermo couple [T1] is placed inside the transformer Temperature sensor [T2] (LM35) is placed outside the transformer.

It consists of two blocks

1. Circuit connected to the transformer:

It consists of

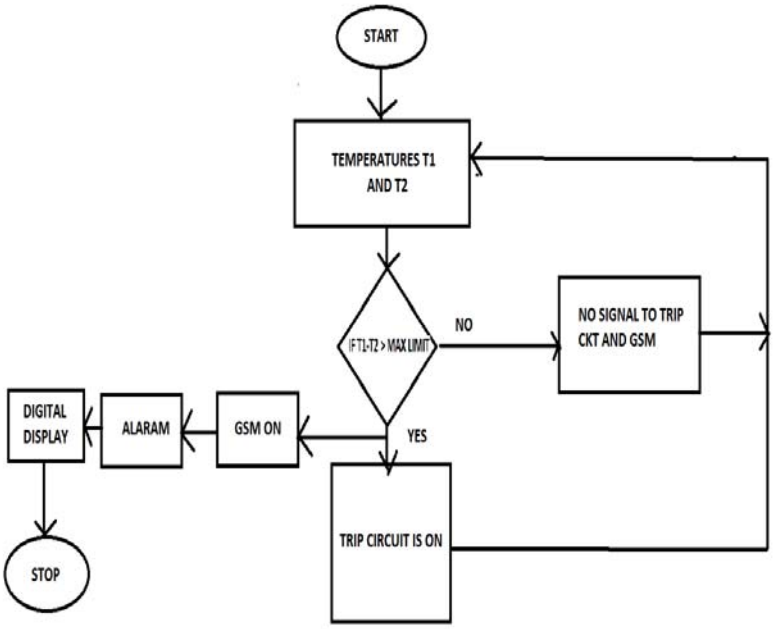
a) Thermo couple
b) LM35
c) Micro controller
d) GSM module

2. Monitoring unit in substation:

a) Alarm
b) Receiver
d) Digital display (display the temperature readings)

3. Working

The working can be explained as per the following flow chart-



During internal fault condition the temperature inside transformer (T1) changes. The temperatures T1, T2 data from the temperature sensors is fed to micro controller. The micro controller is programmed such that if the difference of temperatures T1, T2 is exceeding the maximum temperature limit then it will send the signal to trip circuit to turn on and circuit breaker breaks the circuit. At the same time signal is fed to the GSM. It sends data to the substation causing alarm to turn on .and temperatures are displayed in digital display. After the temperature inside the transformer come to normal range the trip circuit is turned off and transformer starts to work normally. Using this technology it is easy to monitor and control the operation of transformer.

4. Conclusion

Using this technology we can overcome the disadvantages in the buchholz relay like, buchholz relay can only be used with oil immersed transformers equipped with conservators. And it can detect only faults below oil leveling the transformer.

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