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# Thermal Overload Protection of Distribution Transformer

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***Abstract*** **- To design and develop smart grid its need to innovate smart appliances which are more reliable and efficient. To contribute in smart work we are going to design a cost effective solution in distribution transformer, to protect it from thermal overload. In India the maximum distribution transformer is damaged due to overloading, but still there is no any smart protection is applied for it due to its high cost. One other advantage of newly designed Protection system of transformer is it having inbuilt thermal overload protection in distribution transformer. Every distribution transformer having star connected secondary winding. As concentrate on that neutral point we design contactor based system to disconnect neutral point when thermal overload is occurring.**

***Index Terms*** **- A Transformer, Winding, Thermal Overload Protection, Bimetal switch, Contactor.**

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## I. INTRODUCTION

Transformer oil or mineral oil is provide the two function in transformer for insulation and cooling purpose. Due to this it is important to maintain the good quality of mineral oil. If the quality of the mineral oil is reduced then there is problem with insulation of transformer and this creating problem in the transformer. The main cause in reduction of transformer oil quality is temperature rise in the mineral oil. Transformers contain core and winding these two are the main source of the temperature rise in the transformer. When the load on the transformer is increase the current in the transformer winding also increases.[1]This increased current in the transformer winding creates the resistive loss in the transformer winding. As current in the transformer winding increases losses will also increases. Due to this loss there is generation of heat and the rate of the heat generation in transformer is directly proportional to the current flowing through the transformer winding. Therefore it is necessary to control the temperature of the mineral oil. At no load condition there is no load losses i.e. eddy current losses which are present in the core of the transformer. Due to this the temperature of the mineral oil is increase and the insulating properties of the mineral oil decreases. The rate or chances of fault occurring in transformers are much less than the rotating devices because the transformer is a static device But though the fault possibility is rare, if fault occurs, the transformer must be quickly disconnected from the system. The rare fault if not cleared quickly can get developed into the major faults which may be very serious for the transformer hence the protection must be provided to the transformers against possible fault. The use of series fuses is very common in case of small distribution transformers instead of circuit breakers.

## II. POSSIBLE TRANSFOMER FAULTS

The various possible transformer faults are,

1. Overheating
2. Winding faults
3. Open circuit
4. Over fluxing

### *1. Overheating*

[2] The overheating in transformer is basically due to the overloads and short circuits. The permissible overload and the corresponding duration is depend on the type of transformer and class of insulation used for the transformer. Higher loads are permissible for very short duration of time because if it is for very long time it will destroy the insulation used in the transformer. The overloading which continues for longer time is dangerous as it causes overheating of transformer and it will result in the failure of transformer. Due to the overheating of transformer other problems arises are failure of cooling system, though rare, increase in pressure on the transformer tank, is another cause of overheating. Generally the thermal overload relays, sounding the alarm are used to provide protection against overheating. Similarly temperature sensors and temperature indicators are also provided to protect the transformer against overloading.[3] On the transformers, when temperature exceeds the permissible limits, the alarm sounds and the fans are started. the thermocouple or resistance temperature indicators are also provided near the winding. These are connected in a bridge circuit. When temperature exceeds the limiting safe value, the bridge balance gets distributed and alarm is sounded. If the corrective action is not taken within certain period of time then the circuit breaker trips. Thermal overload protection is based on the analysis of the behavior cause of overheating hence we have to use the bimetallic switch and contactor connected to the secondary winding against the Thermal overload protection.

## III. OVERLOAD PROTECTION OF DISTRIBUTION TRANSFORMER

A) Principle

B) Construction
C) Working

### A. Working principle

[4] In thermal over load protection system the if the temperature of the transformer is increased beyond the safe value, the transformer quickly disconnected from the system. It is done by the insertion of the control circuit in the secondary winding. This inserted circuit senses the temperature of the transformer and according to the temperature of the transformer it will work. This control circuit again senses the temperature of the transformer and if these temperature is normal then these circuit will connect the transformer to the system. In this type of overload protection the working of control circuit is automatic. Action takes place in control circuit is depend on the temperature of the transformer.

### B. Construction

1) Bimetal switch
2) Contactor

#### 1. Bimetal switch

In these type of switch the bimetallic strip is Used this bimetallic strip is used to convert a temperature change into mechanical displacement .The strip consist of two strips of Different metals which expand at different rates as they are heated, usually steel and copper , or in some cases steel and brass. The stripes are joined together throughout their length by riveting, brazing or welding. The different expansions force the flat strip to bend one way if heated, and in the opposite direction if cooled below its initial temperature. The sideways displacement of the strip is much longer than the small lengthways expansion in either of the two metals. This effect is used in switch by which according to the temperature the switch will open or close. Temperature switches are generally used in industry for limiting temperature. They monitor the temperature of machinery and equipment and, for example, switch off machinery if it overheats or switch on a fan to cool the equipment. Temperature sensing is carried out by a bimetal disc, which snaps over when the nominal switching temperature is reached. On cooling back down to the reset switching temperature, the switch returns to its original state. The reset switching temperature is typically below the switching temperature. According to the temperature bimetal switch forms two types of contact, which are normally open and normally close. In both cases, on cooling down below the reset Switching temperature, the contacts return to their original state, so that the monitored equipment can again work normally.

#### 2. Contactor

[5] A contactor is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors range from those having a breaking current of several amperes to thousands of amperes to many kilovolts. The physical size of the contactors ranges from a device small enough to pick up with one hand , to large devices approximately a meter on a side. Contactors serve function of the switch in the electrical circuit. Contactors typically have multiple contacts, and those contacts are usually normally-open, so that power to the load is shut off when the coil is de-energized. Contactors are useful in commercial and industrial application, particularly for controlling large lighting loads and motors. One of their hallmarks is reliability. However, like any other device, they are not infallible. Contactors have specific designs for specific purposes. Therefore the selection of contactor is depend on the application. A contactor relay has only two parts: the contacts and the coil. The coil energies the contactor, moving the contacts in position. The contacts transmit the current from the source to the load. Contactors are used to control electric motors , ,lighting , heating , capacitor banks , thermal evaporators , and other electrical loads.

#### 1. Working

As shown in figure.1the protection system is connected to the secondary of the transformer. Secondary of the distribution transformer is usually star connected and the natural point is connected thorough the protection system. Transformer secondary is connected to the three phase three pole contactor. As shown in figure.1 the natural point of the secondary is connected to the contactor and bimetallic switch is connected to the contactor. The temperature of the transformer is sense by the bimetallic switch or strip and the output of the switch is connected to the connecter as shown in figure.1 As the temperature of the transformer is increased the bimetallic switch change the state. According to the state of the bimetallic switch the contactor is work i.e. contactor will make the contact or open the contact and due to these the transformer will in working or out of the working. when the temperature of the transformer is increased the bimetallic switch change it's state and the change in the state is output of the bimetallic switch is connected to the contactor. Then this output is serving as input to the contactor and contactor will open the contacts. Power required to the operation of the contactor is given by the Auxiliary winding.

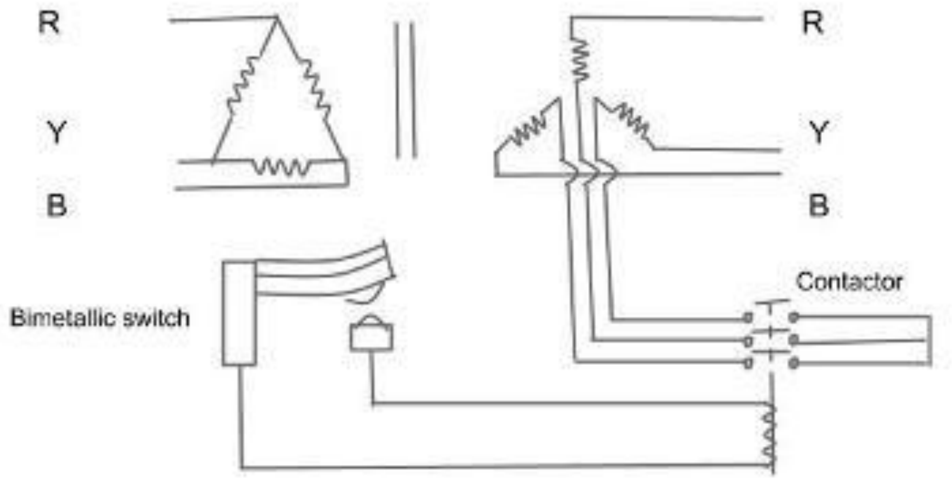


Fig.1 When transformer is overloaded

When the contactor opens the contacts the secondary of the transformer is open and the transformer is out from the system. In this operation the transformer is stop the working when it's temperature is increased above the safety limit is figure.1 show. When the transformer is cool down the temperature of the transformer is within the safety limit. The temperature of the transformer is in safety limit the bimetallic switch change the state and the contactor will connect the contact of secondary winding is shown in figure.2 Then the transformer is in working and in working till the temperature of the transformer is within safety limit.

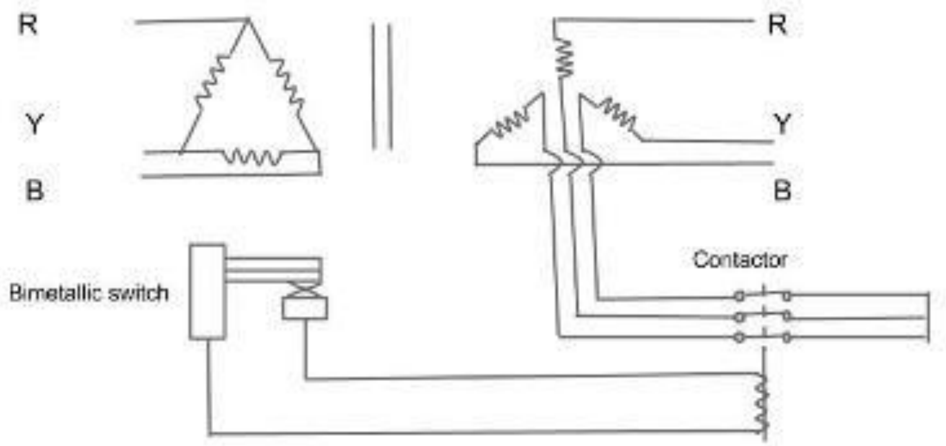


Fig.2 When transformer is not overloaded

If again the temperature of the transformer is increased the bimetallic switch will change the state and contactor will open the connection of the secondary of the transformer and transformer will stop the working. this process is done according the temperature of the transformer.

## IV. SUMMARY

Protection systems used in the transformer are generally outside the transformer. To protect the transformer from thermal overload this protection system is use. In this system the overload protection is provided by using the bimetallic switch and contactor. The overloaded transformer is taken out from the service by disconnecting the secondary of the transformer by the use of contactor. After some time the temperature of the transformer is within the safety limit the transformer is in working by connecting the secondary of the transformer by using the contactor and bimetallic switch. There is automatic type of operation to protect the transformer from the thermal overload.

## V. CONCLUSION

This paper reviews the inbuilt thermal overload protection system for the distribution transformer. A new method of distribution transformer thermal overload protection with less cost. Protection method is automatic protection method no manual work is required and with high accuracy. In this if circuit counter and GSM circuit is connected then we can monitor the transformer from remote location.

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