Basics of Transformer

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Abstract- *Transformers are component of a high voltage electrical transmission network .These are used to adjust voltage level to full fill the distinctive need of electric power clients at consistent power.*

This electrical machine is built out of copper, steel, paper and protecting oil. All these material are made into various segments. The fundamental ones are winding, tap changer switch, tank body, core, and bushing.

Keywords- power transformer; power factor; fault in transformer; core of transformer; winding of transformer; Insulation system; transformer tank.

I. INTRODUCTION

We know that electrical energy available everywhere in the world. Generation and Transmission of electrical energy is possible by the use of transformer.

Transformer is associate electromagnetic equipment consisting of two or additional freelance electrical circuits (winding) connected by electromagnetic induction, converts one or additional electricity systems to One or additional electricity system while not the use of rotating components. The essential perform of transformer, in specific, is to transform electrical power at one voltage to another voltage while not affecting a lot of on electrical power that it's meant. For its operation the transformer depends on the development of magnetism induction that generates electrical phenomenon (emf) during a closed semi conductive circuit by a modification in magnetic flux linking that circuit. According to Faraday's Laws of electromagnetic Induction, if an alternating voltage is applied to at least one winding placed during a closed magnetic circuit, associate alternating flux can generate within the magnetic loop, the direction of that is indicated in fig.1.

If the magnetic circuit has over one wingding, each winding can link the flux (i.e., cut the flux) and can generate associate Electromotive force (E.M.F.). The magnitude of E.M.F. depends upon the quantity of turns in every winding and amount of flux generated within the magnetic circuit

Operation of transformer is based upon Faraday's principal. Only rotating element in this transformer operation is flux, which moves electromagnetically (not physically), rest everything is stationary and thus transformer is a static electrical instrumentation.

The evoked electrical phenomenon depends upon the quantity of turns every of primary and secondary winding. Since the flux round the winding are same and also the only variable is that the variety of turns within the winding, the induced electromotive force within the winding are directly proportional to their turns. Just in case of transformer, the secondary turns are over the primary turns.

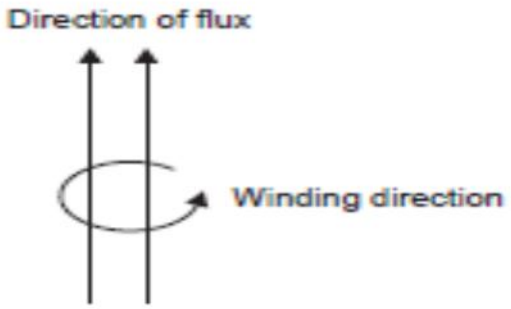

Fig.1.Direction of flux

II. ACTIVE PARTS OF TRANSFORMER

The active a part of a transformer is formed of the elements that are connected with the voltage and also the current, and are primarily composed of winding, core, tap changer switch, insulation and bushings.

A. Core of Transformer

Transformer core is intended to make a path for the flux to flow around that is important for induction of the voltage between the two winding.

Construction of a transformer is depending upon type of core. However the primary and secondary winding are wound round the central laminated steel core. The two most typical and basic designs of transformer construction are the Closed-core transformer and therefore the Shell-core transformer. In the core type transformer, the primary and

secondary coils are wound outside and surround the core ring. Among the shell type transformer, the first and secondary coil pass among the steel magnetic circuit (core) that forms a shell round the winding as shown in fig.2and3.

Core is formed of skinny layers or lamination of electrical steel. The laminations are often wound type or stacked type.Wound type cores have few joints in order that they carry flux nearly uninterrupted by gaps. The core is wound into a continual "coil". The core is then cut so it may be inserted round the coils. It is use in small distribution transformer.

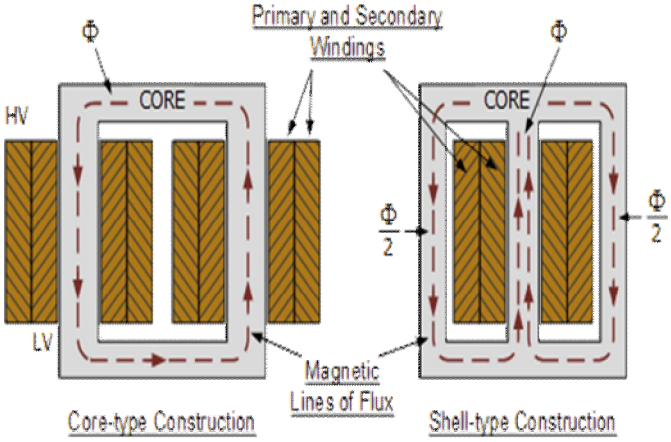

Fig.2.Single Phase core type and shell type transformer

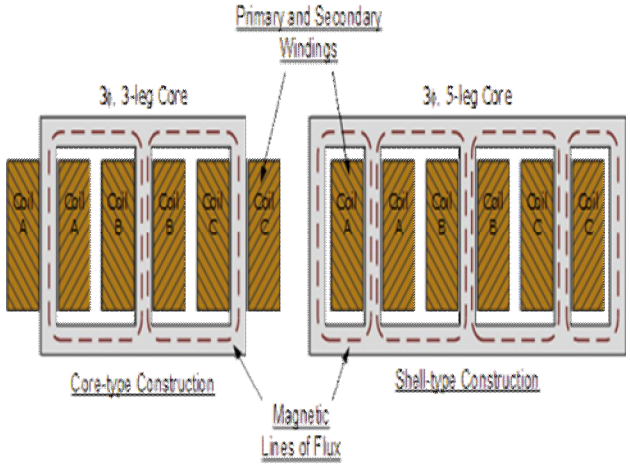

Fig.3.Three phase core type and shell type transformer

Stacked type cores have gaps at the corners wherever the core steel changes direction. This leads to poorer magnetic characteristics than for wound cores. The coils are circular cylinders that surround the core. So the well-liked cross-sectional of the core is circular since this can maximize the flux earning space. It is Use in large power transformer.

The core is largely a fabric with magnetic material that helps confine magnetic fields in transformers. The subsequent are the categories of materials used for manufacturing magnetic cores for the transformers-

Amorphous Steel

This is often one amongst the favored choices for making magnetic cores in transformers. These cores are made of many paper-thin bronze tapes that facilitate scale back the flow of eddy currents. Amorphous steel cores have fewer losses than different magnetic cores, and might simply operate at high temperatures than commonplace lamination stacks. The amorphous steel cores are most typically utilized in high potency transformers that operate at medium frequencies.

Solid Iron Core

These cores give magnetic flux, and helps retain high magnetic fields while not iron saturation. The cores don't seem to be counseled for transformers in operation at AC applications as a result of massive eddy currents are created by the force field. These eddy currents manufacture heat at high frequencies.

Silicon Steel

Si steel has high electrical ohmic resistance. The Si steel core provides stable performance over the years. Si steel offers high saturation density. A couple of years past, characteristics of Si steel were altered with chemical changes, and today, the new product is understood as AISI kind M6. The M6 steel has high permeability and low losses, and it's utilized in superior applications.

B. Winding of Transformer

The winding includes the current-carrying conductors wound around the sections of the core, and these should be properly insulated, supported and cooled to resist operational and take a look at conditions. Copper and aluminum are the first materials used as conductors in transformer winding. Whereas aluminum is lighter and customarily less costly than copper, a bigger cross section of aluminum conductor should be accustomed carry a current with similar performance as copper. Copper has higher mechanical strength and is employed nearly solely altogether however the smaller size ranges, wherever aluminum conductors is also utterly acceptable. The conductors utilized in power transformers are usually stranded with an oblong cross section.
In transformer use many types of winding are-

Distributed Cross-over winding

When many coils are created circular cross-section and are placed in series, then Distributed Cross-over winding are created. Distributed Cross-over winding are appropriate for current not extraordinary concerning 20 Amps. Distributed Cross-over winding are largely utilized in high voltage winding in little transformers within the distribution vary. Each section of coils is separated from different section of coil by insulating material to produce insulation moreover as duct for cooling.

Spiral Winding

When several strip conductors are wounded tightly on a press board cylinder or plastic cylinder in axial direction, then Spiral winding is created. Spiral winding are unremarkably burnt up to 33kv and lower current rating. Thickness of the conductor employed in spiral winding ought to be sufficient compared to its dimension, in order that the winding stay twist-free.

Multi-layer spiral winding are shaped by joining two single layer spiral winding by oil duct So that, beginning and finishing leads lie at one end of the coil, that is additional advantageous for creating the terminal gear.

Helical Winding

When many conductors are placed one over the opposite to make one turn and are wound during a helix on the axial direction with every turn is separated from the opposite flip by duct, then helical winding are created. Conductor's accustomed kind one turn may well be completely different in length. Because of completely different length of conductors, there's a formation of unequal impedance, resulting in eddy current losses because of the current between the conductors. To reduce the eddy current losses, the spiraling winding are given transposition of the conductors that equalize the impedance of the parallel conductors. Helical winding are used for low-voltage and high-current ratings.

Continuous Disc Winding

When four to five conductors of various sizes are connecting asynchronous and are placed within the axial direction, then Continuous Disc Winding are created. Here, ducts are placed between every conductor to scale back eddy losses. Continuous Disc Winding is used for voltage between 33kv and 132kv and medium current rating.

Electrical Grade Insulating Paper (EGIP) is generally used for covering the bare conductor. EGIP has certain properties which makes it a superior material to use as insulation in electrical equipment's.
These are-

- Flexibility
- Easy to use
- Higher insulation with lesser thickness
- Higher resistance to oil
- Reasonable heat resistance while in contact with oil
- Good compatibility with transformer oil
- Low chloride content.

C. Insulating Materials

The three most common insulating materials for the power transformers are: oil, paper and press board in numerous forms. Transformer oil is factory-made by processing the crude oil feed stock. Transformer Oil Feed Stock is obtained as initial distillation below vacuum distillation of crude when eliminating lighter cuts like fuel, kerosene, and middle distillation (diesel) at air pressure. The oil ought to be clear, clear, and free from suspended matter or sediments. Maximum density of oil at 5°C is 0.89 g/cc. Flash purpose of oil is 110°C and Pour purpose is 6°C.Electric strength BDV (Breakdown value) of oil for unfiltered oil is 40 kV and for filter oil is 60 kV.

Insulation paper is created from pure cellulose that has superb mechanical strength, oil absorption and impedance. Its high chemical purity means that paper is a very sensible insulation material for electrical machines fertilized with rosin, capacitors fertilized with oil or rosin and significantly oil-filled transformers.

Press board could be a special product supported the purest cellulose, extracted from fibered cone-bearing trees. These are shaped into a non-woven material while not exploitation any extra binding agents and so pressed. The high chemical purity means that press board is a very appropriate insulation material for electrical machines (impregnated with resin), capacitors (impregnated with oil or resin) and significantly oil-filled transformers.

D. Tap Changer Switch

Tap-changers use in regulating power transformers used in electrical energy networks. In power system use on load and off load taps changer but in transformer we mostly use on load tap changer.

On-load tap changers as a result of the name suggests, enable tap dynamic and so voltage regulation with

the transformer on-load. Tap changing is typically done on the HV winding for two reasons:-

1. Because the currents are lower, the tap changer contacts, leads, etc., is smaller.
2. As the HV winding is wound outside the cardinal winding, it's easier to induce tapping connections dead set the tap changer.

Figure 4 below shows the connections for an on-load tap changer that operates on the HV winding of the transformer

The tap changer has four essential features-

Switches

These switches select the physical tap position on the transformer winding and, because of their construction, cannot and may not build or break the load current.

Reactors

The load current must not be interrupted throughout a tap modification. Therefore, throughout each faucet amendment, there is an interval where two voltage taps are spanned. Reactors are used within the circuit to increase the impedance of the selector circuit and limit the quantity of current because of this voltage distinction. Beneath ancient load conditions, equal load current flows in every halves of the reactor winding and so the fluxes balance out giving no resultant flux inside the core.

With no flux, there's no inductance and, therefore, no voltage drop owing to inductance. There'll be but, a really small voltage drop owing to resistance. During the tap modification, the selector switches are designated to totally different taps (see Figure 2) and a current can flow within the reactor circuit. This current can produce a flux and therefore the ensuing inductive electrical phenomenon can limit the flow of current.

Vacuum Switch

This device performs the duty of a breaker that produces and breaks current throughout the faucet dynamical sequence.

Bypass Switch

This switch operates during the tap changing sequence but, at no time, does it make or break load current, though it does make before break each connection.

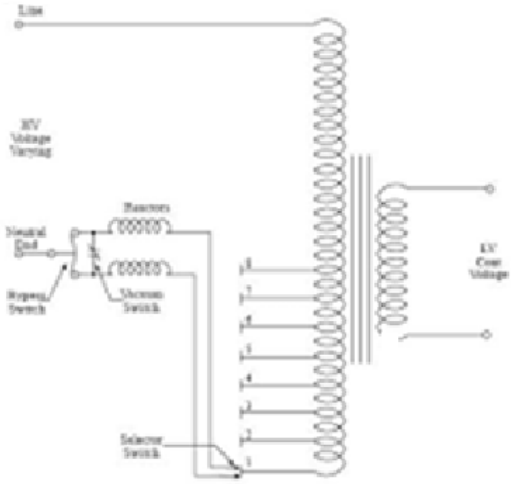

Fig.4.On load tap changer

E. Tank Body

Transformer tank body acts as a liquid crammed enclosure of the active part, i.e., core-coil assembly. Terminations of high voltage and low voltage winding are done through ceramic ware bushings. Since the tank is full of oil, it's necessary to make sure that there's no seepage or outflow of oil from any of the joints of the tank.

When an electrical transformer is loaded, the present starts flowing through its winding. Because of this flowing of electrical current, heat is made within the winding, this heat ultimately rises the temperature of transformer oil. We all know that the rating of any electrical instrumentation depends upon its allowable temperature rise limit. Hence, if the temperature rise of the transformer insulating oil is controlled, the capability or rating of transformer is extended up to important vary. The radiator of transformer decreases the heating rate of transformer oil. So; it plays an important role in increasing loading capability of a transformer.

The bushings are the parts that link the winding to a network through the grounded tank. High voltage bushings are technically advanced and, in some cases, their failure will result in a transformer explosion quite quickly. this is often as a result of one amongst the very best voltage gradients is between the HV bushing central half at full potential, and also the grounded tank at the space of simply some centimeters. The insulating oil slightly below is extremely ignitable and if the bushing is sparking, it might generate plenty of energy, open the tank slightly so ignite the oil, that could lead on to an explosion. For this reason, the HV bushing is factory-made to resist very high voltages inside a small area stuffed with paper and oil between the bushing and transformer tank.

III. CONCLUSION

In this paper we have discussed about the basic facts about transformers and the main transformer parts and components. In this we have discussed about core of transformer, type of core, type of lamination use in core, type of magnetic material use in core, winding of transformer, type of winding of transformer, tap changer switch, insulation papers, kraft paper, insulation oil, tank body, radiator, bushings.

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