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Assembly of Three Phase Distribution Transformer

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ABSTRACT: At present, discovering a convenient as well as a suitable area for installing a distribution transformer is one of the main challenges faced by the distribution company. Especially in urban areas, it is severe so power departments need to plan for an appropriate place for installation by considering the load, load center, possibility & further development, etc. This type of transformer can be arranged on a single pole or H pole based on the size, weight, and requirements of the transformer.
Accordingly, the choice for installation of this transformer can be done by the distribution company depending on the capability and availability of space.The distribution transformer has been in use by utilities throughout the twentieth century. Until now, it has consisted of a configuration of iron or steel cores and copper/aluminum coils, with mineral oil serving as both coolant and dielectric medium. Inherent in this type of construction are regulation, significant weight, losses, environmental concerns, and power quality issues. For the 21st century, a new kind of distribution transformer is proposed; one that can be made self-regulating, oil-free, and able to correct power quality problems. A Distribution transformer has been analyzed, simulated, prototyped and tested.

KEYWORDS: Distribution transformer, power quality, configuration

I.INTRODUCTION

DISTRIBUTION TRANSFORMER
A distribution transformer or service transformer is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer. The invention of a practical efficient transformer made AC power distribution feasible; a system using distribution transformers was demonstrated as early as 1882.
If mounted on a utility pole, they are called pole-mount transformers. If the distribution lines are located at ground level or underground, distribution transformers are mounted on concrete pads and locked in steel cases, thus known as distribution tap pad-mount transformers.
Distribution transformers normally have ratings less than 200 kVA although some national standards can allow for units up to 5000 kVA to be described as distribution transformers. Since distribution transformers are energized for 24 hours a day (even when they don't carry any load), reducing iron losses has an important role in their design. As they usually don't operate at full load, they are designed to have maximum efficiency at lower loads. To have a better efficiency, voltage regulation in these transformers should be kept to a minimum. Hence they are designed to have small leakage reactance.

A distribution transformer is also known as a typical kind of isolation transformer. The main function of this transformer is to alter the high voltage to the normal voltage like 240/120 V to use in electric power distribution. In the distribution system, there are different kinds of transformers available like single phase, 3-phase, underground, pad-mounted, pole-mounted transformer.
Generally, these transformers are available in different sizes with efficiencies along with insulating oil. These transformers are available in various sizes and efficiencies. The selection of this transformer mainly lies in the requirement and budget of the user. There are four types of **distribution transformer connections**available like star-star, delta-delta, star-delta, delta-star and delta zigzag.

II.LITERATURE SURVEY

Thales, a Greek scholar called the "father of science", is considered to be the first person to have experimented with electricity and magnetism.
In 1831**Michael Faraday** discovered the principle of induction (Faraday's induction law) and did the first experiments

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with induction between coils of wire, including building a pair of coils on a steroidal closed magnetic core.
In 1878 **Thomas Alva Edison** an American inventor, founds the Edison Electric Light Co. in New York. In 2979, he presents his first incandescent light bulb, which stays lit for 45 hours.
In 1882 **Edison** Inaugurates the first "electric plants" (producing DC power), built in London and New York. The first DC electric power transmission line is constructed in *Germany*: 2400V, 59 km
In 1886 **George Westinghouse**, an American inventor and industrial entrepreneur, shows an interest in industrial electricity and founds the Westinghouse Electric Corporation. After having obtained a patent in 1887 for a transformer, he creates the first AC supply system for lighting in Buffalo, NY. He wins an installation contract, defeating Edison, for all electric infrastructures in the US. It's for this reason that AC distribution is imposed throughout the entire world today.
In 1924: Construction of the north-south 110 KV overhead power line linking German coal-fired electric power plants located near the Rhine to hydro-electric plants in the Alps.
In 1967: The extra-high voltage networks (380 kV) of France, the Federal Republic of Germany and Switzerland are interconnected for the first time at the Laufenberg substation in Switzerland.

III.CUIRCUIT DIAGRAM

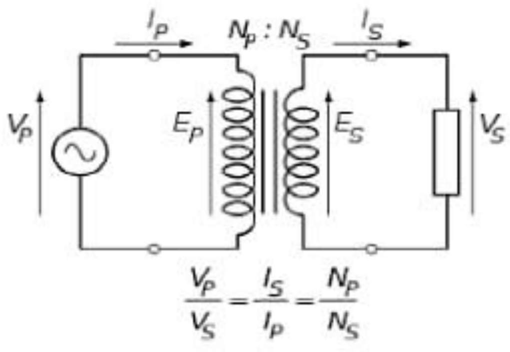

Fig No:-1 Circuit Diagram

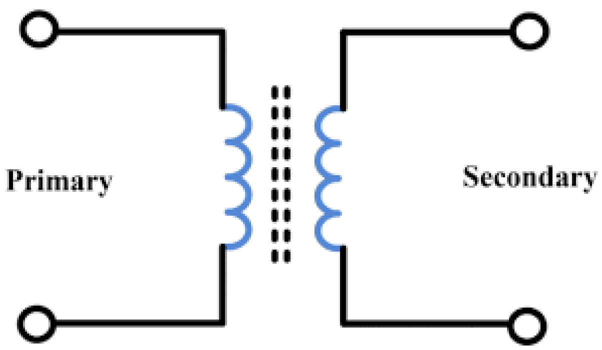

Fig No:-2 Symbol

IV.MATERIAL DESCRIPTIONS

CORE MATERIAL

Distribution transformers consist of amagnetic core made from laminations of sheet silicon steel (transformer steel) stacked and either glued together with resin or banded together with steel straps, with the primary and secondary wire windings wrapped around them. This core Distribution substations inside a small tower-likebuilding are common in Europe. Near Jelenia Gora,Polandconstruction is designed to reduce core losses, dissipation of magnetic energy as heat in the core, which are an economically important cause of power loss in utility grids. Core losses are caused by two effects; hysteresis loss in the steel, and eddy currents.Silicon steel has low hysteresis loss, and the laminated construction prevents eddy currents from flowing in the core, which dissipate power in the resistance of the steel.

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Efficiency of typical distribution transformers is between about 98 and 99 percent.Where large numbers of transformers are made to standard designs, a wound C shaped core is economic to manufacture. A steel strip is wrapped around a former, pressed into shape and then cut into two C-shaped halves, which are re-assembled on the copper windings.

A magnetic core is a piece of magnetic material with a high magnetic permeability used to confine and guide magnetic fields in electrical, electromechanical and magnetic devices such as electromagnets, transformers, electric motors, generators, inductors, magnetic recording heads, and magnetic assemblies. It is made of ferromagnetic metal such as iron, or ferromagnetic compounds such as ferrites. The high permeability, relative to the surrounding air, causes the magnetic field lines to be concentrated in the core material. The magnetic field is often created by a current-carrying coil of wire around the core.

The use of a magnetic core can increase the strength of magnetic field in an electromagnetic coil by a factor of several hundred times what it would be without the core. However, magnetic cores have side effects which must be taken into account. In alternating current (AC) devices they cause energy losses, called core losses, due to hysteresis and eddy currents in applications such as transformers and inductors. Soft magnetic materials with low coercively and hysteresis, such as silicon steelor ferrite, are usually used in cores.

WINDINGS

HV and LV windings shall be wound from Super Enamel covered /Double Paper covered Aluminum / Electrolytic Copper conductor. LV winding shall be such that neutral formation will be at top. The winding construction of single HV coil wound over LV coil is preferable.

Inter layer insulation shall be Nomex /Epoxy dotted Kraft Paper.

Proper bonding of inter layer insulation with the conductor shall be ensured. Test for bonding strength shall be conducted. Dimensions of winding coils are very critical. Dimensional tolerances for winding coils shall be within limits as specified in Guaranteed Technical Particulars (GTP Schedule I). The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions. Joints in the winding shall be avoided. However, if jointing is necessary the joints shall be properly brazed and the resistance of the joints shall be less than that of parent conductor. In case of foil windings, welding of leads to foil can be done within the winding.

TAPPING RANGES AND METHODS

No tapping shall be provided for distribution transformers up to 100 kVA rating.

For ratings above 100 kVA and up to 500 kVA, tappings shall be provided, if required by the purchaser, on the higher voltage winding for variation of HV voltage within range of (+) 5.0 % to (-) 10% in steps of 2.5%.

For ratings greater than 500 kVA, tapping shall be provided on the higher voltage winding for variation of HV voltage within range of (+) 2.5% to (-) 5.0 % in steps of 2.5%.

Tap changing shall be carried out by means of an externally operated self-position switch and when the transformer is in de-energised condition. Switch position No.1 shall correspond to the maximum plus tapping. Each tap change shall result in variation of 2.5% in voltage. Arrangement for pad locking shall be provided. Suitable aluminum anodized plate shall be fixed for tap changing switch to know the position number of tap.

OIL

The insulating oil shall comply with the requirements of IS 335. Use of recycled oil is not acceptable. The specific resistance of the oil shall not be less than 35 X1012 ohm-cm at 27oC when tested as per IS 6103.

Oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling.

The oil shall be filled under vacuum.

The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

TANK

Transformer tank construction shall conform in all respect to clause 15 of IS 1180(Part-1):2014. The internal clearance of tank shall be such, that it shall facilitate easy lifting of core with coils from the tank without dismantling LV bushings.

All joints of tank and fittings shall be oil tight and no bulging should occur during service. Inside of tank shall be painted with varnish/hot oil resistant paint. The top cover of the tank shall be slightly sloping to drain rain water. The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted by means of lifting shackle.

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Manufacturer should carry out all welding operations as per the relevant ASME standards and submit a copy of the welding procedure and welder performance qualification certificates to the customer.
The transformer tank shall be of robust construction rectangular/octagonal/round/ elliptical in shape and shall be built up of electrically tested welded mild steel plates of thickness of 3.15 mm for the bottom and top and not less than 2.5 mm for the sides for distribution transformers upto and including 25 kVA, 5.0 mm and 3.15 mm respectively for transformers of more than 25 kVA and up to and including 100 kVA and 6 mm and 4 mm respectively above 100 kVA. Tolerances as per IS1852 shall be applicable.
In case of rectangular tanks above 100 kVA the corners shall be fully welded at the corners from inside and outside of the tank to withstand a pressure of 0.8 kg/cm2 for 30 minutes. In case of transformers of 100 kVA and below, there shall be no joints at corners and there shall not be more than 2 joints in total.
Under operating conditions the pressure generated inside the tank should not exceed 0.4 kg/ sq. cm positive or negative. There must be sufficient space from the core to the top cover to take care of oil expansion. The space above oil level in the tank shall be filled with dry air or nitrogen conforming to commercial grade of IS 1747.
The tank shall be reinforced by welded flats on all the outside walls on the edge of the tank.

CONSERVATOR

Transformers of rating 63 kVA and above with plain tank construction, the provision of conservator is mandatory. For corrugated tank and sealed type transformers with or without inert gas cushion, conservator is not required.
When a conservator is provided, oil gauge and the plain or dehydrating breathing device shall be fitted to the conservator which shall also be provided with a drain plug and a filling hole [32 mm (1¼”)] normal size thread with cover. In addition, the cover of the main tank shall be provided with an air release plug.
The dehydrating agent shall be silica gel. The moisture absorption shall be indicated by a change in the colour of the silica gel crystals which should be easily visible from a distance. Volume of breather shall be suitable for 500g of silica gel conforming to IS 3401 for transformers upto 200 kVA and 1 kg for transformers above 200 KVA.
The capacity of a conservator tank shall be designed keeping in view the total quantity of oil and its contraction and expansion due to temperature variations. The total volume of conservator shall be such as to contain10% quantity of the oil. Normally 3% quantity the oil shall be contained in the conservator.
The cover of main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.
The inside diameter of the pipe connecting the conservator to the main tank should be within 20 to 50 mm and it should be projected into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. The minimum oil level (corresponding to -5 0C) should be above the sump level.

BUSHINGS

The bushings shall conform to the relevant standards specified and shall be of outdoor type. The bushing rods and nuts shall be made of brass material 12 mm diameter for both HT and LT bushings. The bushings shall be fixed to the transformers on side with straight pockets and in the same plane or the top cover for transformers above 100 kVA. For transformers of 100 kVA and below the bushing can be mounted on pipes. The tests as per latest IS 2099 and IS 7421 shall be conducted on the transformer bushings.
For 33 kV, 52 kV class bushings shall be used for transformers of ratings 500 kVA and above. And for transformers below 500 KVA, 33 kV class bushings, for 11 kV, 17.5 kV class bushings and for 0.433 kV, 1.1 kV class bushings shall be used. Bushing can be of porcelain/epoxy material. Polymer insulator bushings conforming with relevant IEC can also be used. Bushings of plain shades as per IS 3347 shall be mounted on the side of the TS for 3 Phase DT 10 Tank and not on top cover. Dimensions of the bushings of the voltage class shall conform to the Standards specified and dimension of clamping arrangement shall be as per IS 4257.Arcing horns shall be provided on HV bushings.
Brazing of all inter connections, jumpers from winding to bushing shall have cross section larger than the winding conductor. All the Brazes shall be qualified as per ASME, section – IX. The bushings shall be of reputed make supplied by those manufacturers who arehavingmanufacturing and testing facilities for insulators.

TERMINAL CONNECTORS

The LV and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. Connectors shall be with eye bolts so as to receive conductor for HV. Terminal connectors shall be type tested as per IS 5561.

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CABLE BOXES

In case HV/LV terminations are to be made through cables the transformer shall be fitted with suitable cable box on 11 kV side to terminate one 11kV/ 3 core aluminum conductor cable up to 240 sq. mm. (Size as per requirement).

The bidder shall ensure the arrangement of HT Cable box so as to prevent the ingress of moisture into the box due to rain water directly falling on the box. The cable box on HT side shall be of the split type with faces plain and machined and fitted with Neo-k-Tex or similar quality gasket and complete with brass wiping gland to be mounted on separate split type gland plate with nut-bolt arrangement and MS earthing clamp. The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the connecting rods shall be stated and shall be adequate for carrying the rated currents. On the HV side the terminal rod shall have a diameter of not less than 12 mm. The material of connecting rod shall be copper. HT Cable support clamp should be provided to avoid tension due to cable weight.

The transformer shall be fitted with suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression brass glands on LV side to terminate 1.1 kV/single core XLPE armoured cable (Size as per requirement).

LIGHNING ARRESTOR

A lightning arrester (alternative spelling lightning arrestor) (also called lightning diverter) is a device used on electric power transmission and telecommunicationsystems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrester, the current from the surge is diverted through the arrester, in most cases to earth. In telegraphy and telephony, a lightning arrester is placed where wires enter a structure, preventing damage to electronic instruments within and ensuring the safety of individuals near them. Smaller versions of lightning arresters, also called surge protectors, are devices that are connected between each conductor in power and communications systems and the earth. These prevent the flow of the normal power or signal currents to ground, but provide a path over which high-voltage lightning current flows, bypassing the connected equipment. Their purpose is to limit the rise in voltage when a communications or power line is struck by lightning or is near to a lightning strike. If protection fails or is absent, lightning that strikes the electrical system introduces thousands of kilovolts that may damage the transmission lines, and can also cause severe damage to transformers and other electrical or electronic devices. Lightning-produced extreme voltage spikes in incoming power lines can damage electrical home appliances or even cause death. Lightning arresters are used to protect electric fences. They consist of a spark gap and sometimes a series inductor. Such type of equipment is also used for protecting transmitters feeding a mast radiator. For such devices the series inductancehas usually just one winding. 9 kV, 5 kA metal oxide lightning arrestors of reputed make conforming to IS 3070 Part-III, one number per phase shall be provided.(To be mounted on pole or to be fitted under the HV bushing with GI earth strip 25x4 mm connected to the body of the transformer with necessary clamping arrangement as per requirement of purchaser.) Lightening arrestors with polymer insulators in conformance with relevant IEC can also be.

BUCHHOLZ RELAY

In electric power distribution and transmission, a Buchholz relay is a safety device mounted on some oil-filled power transformers and reactors, equipped with an external overhead oil reservoir called a "conservator". The Buchholz relay is used as a protective device sensitive to the effects of dielectric failure inside the equipment. A generic designation for this type of device is "gas detector relay".Depending on the model, the relay has multiple methods to detect a failing transformer. On a slow accumulation of gas, due perhaps to slight overload, gas produced by decomposition of insulating oil accumulates in the top of the relay and forces the oil level down. A float switch in the relay is used to initiate an alarm signal. Depending on design, a second float may also serve to detect slow oil leaks. If an electrical arc forms, gas accumulation is rapid, and oil flows rapidly into the conservator. This flow of oil operates a switch attached to a vane located in the path of the moving oil. This switch normally will operate a circuit breaker to isolate the apparatus before the fault causes additional damage. Buchholz relays have a test port to allow the accumulated gas to be withdrawn for testing. Flammable gas found in the relay indicates some internal fault such as overheating or arcing, whereas air found in the relay may only indicate low oil level or a leak. Through a connected gas sampling device the control can also be made from the ground. Depending on the requirements, the Buchholz relay has a flange or threaded connection. The classic Buchholz relay has to comply with the requirements of the DIN EN 50216-2 standard. Depending on the requirements, it is equipped with up to four (2 per float) switches or change-over switches, which can

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either send a light signal or switch off the transformer.The relay was first developed by Max Buchholz (1875–1956) in 192.

BREATHER UNIT

Breather consist of silica gel which absorbs the moisture from air. When there is overloading on transformer, the winding of transformergets heated so the oil inmain tank of transformeralso get heated. The hot oil started expanding. There is conservator tank at the top of transformerwhich allows adequate space for expansion of oil.

RADIATOR

The radiator of transformer accelerates the cooling rate of transformer. Thus, it plays a vital role in increasing loading capacity of an electrical transformer. This is basic function of radiator of a power transformer. Oil immersed power transformer is generally provided with detachable pressed sheet radiator with isolating valves.

USES

- The uses of the distribution transformer include the following.
- This transformer changes from high voltage electricity to low voltage electricity, used in homes & businesses.
- The main function of this is to step down the voltage to provide isolation between two windings like primary & secondary.
- This transformer distributes the power to remote areas which are generated from the power plants.
- Generally, this transformer distributes the electrical energy to industries with less voltage under 33KV and 440volts to 220volts for domestic purposes.

APPLICATION

- Pharmaceuticals
- Steels
- Engineering
- Textile
- Wind mill farms
- Hydro power project
- Refineries

FEATURES

- Primary and secondary terminals or studs.
- Steps down the high voltage to low voltage.

IV.CONCLUSION

Assembly of three phase distribution transformer taught us regarding different aspects taken into consideration while production of transformer by a company or firm. We also learned different processes a transformer under goes during its assembly. Also we learned the ie rules and criteria provided by state electricity authority. Various security aspects and protection considerations where taken into account. there are various tests performed on transformer to check it's quality by the manufacturer during the final stage a government authorities check the transformer against criteria and safety norms. It offers a complete range of distribution transformers designed to grant the reliability, durability, and efficiency required in utility, industrial, and commercial applications. The transformers are available in a variety of capacities ranging from KVA to MVA.

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