ABSTRACT

Distribution systems occupy a prominent role in the definition of a power system. The basic function of a distribution system is to deliver electrical energy from a transmission substation or small generating stations to the customers, transforming the voltages at suitable places.No doubt, electricity is very important in our lives, we cannot even imagine a day without it. Nowadays, when the technology rapidly grows, so, we use a number of appliances in our day-to-day activities that are too precious to us. A Transformer, which ensure the safe power supply from one circuit to another with electromagnetic induction.The electrical motor is a device that has brought about one of the biggest advancements in the fields of engineering and technology ever since the invention of electricity. A electro-mechanical device that converts electrical energy to mechanical energy. It's because of motors, life is what it is today in the 21st century. All services work with transformer and motor, its applications at its core. This report mainly focuses on study of transformer and their working with on field experience. This internship gave me the skill to face an office environment. The objective of this training is to expose student's actual environment, this training also helped me to apply my academic knowledge practically. This report gives an outline on how the transformer and motor works

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INTRODUCTION TO NLCIL:

NLC India Limited (NLC) (formerly Neyveli Lignite Corporation Limited) is a government-owned-fossil fuel miner and thermal power generator under the ownership of the Ministry of Coal, Government of India. It produces about 30 million tonnes of Lignite from opencast mines at Neyveli in the state of Tamil Nadu in southern India and a Barsingsar in Bikaner district of Rajasthan state. The lignite is used at pit-head thermal power stations of 3640 MW installed capacity to produce electricity. Its joint venture has a 1000 MW thermal power station using coal. Lately, it has diversified into renewable energy production and installed 1319 MW solar power plants to produce electricity from photovoltaic (PV) cells and 51 MW electricity from windmills. It was incorporated in 1956 and was wholly owned by the Government of India. A small portion of its stock was sold to the public to list its shares on stock exchanges where its- shares are traded. It is under the administrative control of the Ministry of Coal.

HISTORY:

Lignite deposit was a chance finding when some "brown substance' gushed out with water in Rao Bahadur M. Jambulingam Mudaliar's 620 Acre own farm artesian well during 1934. He acted swiftly and contacted the then British Raj, which sent geologists to Neyveli. It was later identified as 'Lignite'. He generously extended a substantial portion of the sprawling land-bank for soil exploration. Through his effort and donated his 620

acres land to the Madras Government. NLC has been a forerunner in the country in the energy sector for 62 years, contributing a lion's share in lignite production and significant share in thermal power generation. It was inaugurated by the first Prime Minister Jawaharlal Nehru in 1956. NLC operates four opencast lignite mines of a total capacity of 30.6 million tonnes per annum (MITPA) at Neyveli and Barsingsar; Six Lignite based pithead thermal power stations with an aggregate capacity of 3640 MW - at Neyveli and Barsingsar and a 1000MW coal based thermal power Station at Thoothukudi, Tamil Nadu through its subsidiary, NLC Tamil Nadu Power Limited (NTPL), a joint venture between NLC and TANGEDCO (equity participation in the ratio of 89:11). NLC recently commissioned a 1x500 MW unit at Neyveli which is also Asia's largest lignite fired Boiler.

NLC has also forayed into renewable energy sector with commissioning of a 1319 MW Solar Photovoltaic Power Plant including 1 MW rooftop project at Neyveli and a 51 MW wind energy plant at Kaluneerkulam village of Tirunelveli district in Tamil Nadu. The company is also setting up 1209 MW Solar Power Projects at Tirunelveli, Virudhunagar and Ramanathapuram districts of Tamil Nadu, of which, 300 MW have been commissioned. NLC is aiming to achieve a total renewable energy capacity of 4251 MW. NICIL has a target of becoming a 20,000+ MW company by 2025. Works are under progress for the lignite based Neyveli New Thermal Power Plant (1000 MW), Bithnok TPS and Barsingsar TPS Expansion (each 250 MW). Further, NLC, jointly with the Uttar Pradesh Rajya Vidyut Utpadan Nigam

Limited. (UPRVUNL), is setting up a 3x660 MW coal based thermal power plant at Ghatampur in Uttar Pradesh, through its subsidiary company Neyveli Uttar Pradesh Power Limited (NUPPL) (equity participation in the ratio of 51:49). Apart from the above, the addition of thermal capacity to the tune of 6040 MW by way of installation of new plants and acquisition of power assets to the tune of 3000 MW is in the pipeline. NLC has also contributed significantly to socio-economic development for more than half a century.

POWER PROJECTS:

NLC India has five pithead Thermal Power Stations with an aggregate capacity of 4240 MW. Further, NLC India has so far installed 51 wind turbine generators of 1.50 MW each and also commissioned 140 MW solar photovoltaic power plant in Neyveli, resulting in an overall power generating capacity of 4431 MW (excl. JVs)

THERMAL POWER STATION II:

The 1470 MW Second Thermal Power Station consists of 7 units of 210 MW each. In February 1978, the Government of India sanctioned the Second Thermal Power Station of 630 MW capacity (3 X210 MW) and in February 1983, the Government of India sanctioned the Second Thermal Power Station Expansion from 630 MW to 1470 MW with addition of 4 units of 210 MW each. The first 210 MW unit was synchronised in March 1986 and the last unit (Unit-VID was synchronised in June 1993. The power

generated from Second Thermal Power Station after meeting the needs of Second Mine is shared by the Southern states viz., Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Union Territory of Puducherry.

THERMAL POWER STATION-I EXPANSION:

Thermal Power Station-I has been expanded (2x 210 MW) using the lignite available from Mine-I expansion. The scheme, TPS I Expansion, was sanctioned by the Government of India in February 1996. Unit-I was synchronised in October 2002 and Unit-II in July 2003. The power generated from this Thermal Power Station, after meeting the internal requirements, is shared by the Southern States viz., Tamil Nadu, Kerala, Karnataka, and Union Territory of Puducherry.

BARSINGAR THERMAL POWER STATION:

The Government of India sanctioned the Barsingsar Thermal Power Station 250 MW (2 X 125 MW) in October 2004. The units were commissioned in December 2011 and in January 2012. The power generated from this Thermal Power Station after meeting internal requirements is shared by the DISCOMS of the state of Rajasthan

POWER PLANTS AND ITS CAPACITY:

POWER PLANTS		CAPACITY
NNTPS	Neyveli, Tamil Nadu	1000MW
TPS- Il (210x7)		1470 MW
TPS-I EXPANSION (210x2)		420 MW
TPS-II EXPANSION		500 MW
SOLAR POWER PLANT		140 MW
WIND POWER PLANT	Nellai, Tamil Nadu	51 MW
BARSINGAR TPS		250 MW
TOTAL		3831 MW

SPECIAL FEATURES OF THERMAL POWER STATION-I EXPANSION

Thermal power station-I expansion is unique power station by virtue of sophisticated operating system using microprocessor based Distributed Digital Control System

(DDCS)and management information system with an optimum deployed manpower.Pneumatic dry ash collection system, a new technology introduced for the first time in NLCIL is employed to collect the fly ash in silos. Then it was sold to neighbouring cement factories and transported through trucks.

SPECIAL FEATURES ON ENVIRONMENT

- 100% Dry ash collection of fly ash and bottom ash.
- Electrostatic precipitator with an optimum efficiency of 99.5% to control suspended particulate matter Flue gas outlet lesser than 100mg/Nm
- Low NO, burner,
- Bi flue chimney of 220m height
- Proposed green belt development of 55000sq.m
- Green belt developed so far-45000sq.m

MILL DECELERATION DEVICE:

Normally when mill stops or gets tripped, its speed comes to zero slowly but in this plant a deceleration device is incorporated to stop the mill instantly by injecting 220V DC voltage through its power cable itself. To avoid damage to the mill rotor when foreign material entered into the mill and resulting in breakdown of mill.

SALIENT FEATURES OF THERMAL POWER STATION-I EXPANSION

- Cold gas recirculation system to prevent slag formation in the boiler furnace. Additional air flow system to ensure low NO, level in the exit flue gas.
- Provision of TV cameras in the furnace for the first time on line monitoring of the flame. Non-explosive type submerged scraper conveyors.
- Distributed digital control and management information system for fully automated operations of units.
- Electronic governing system of turbines to ensure perfect control over the Speed
- Low specific lignite consumption and consumption to TPS -I and TPS-II

TRANSFORMER

2.1 INTRODUCTION:

A transformer is a static machine used for transforming power from one circuit to another without changing frequency. The history of transformer was commenced in the year 1880. In the year 1950, 400KV electrical power transformer was introduced in high voltage electrical power system. In the early 1970s, unit rating as large as 1100MVA was produced and 800KV and even higher KV class transformers were manufactured in year of 1980.

2.2 PRINCIPLE :

Transformer works on Faraday's law of mutual induction.

Faraday's law of electromagnetic induction states that, when a change takes place in the magnetic flux which is linked with a circuit, an electromotive force current will induce in the circuit.

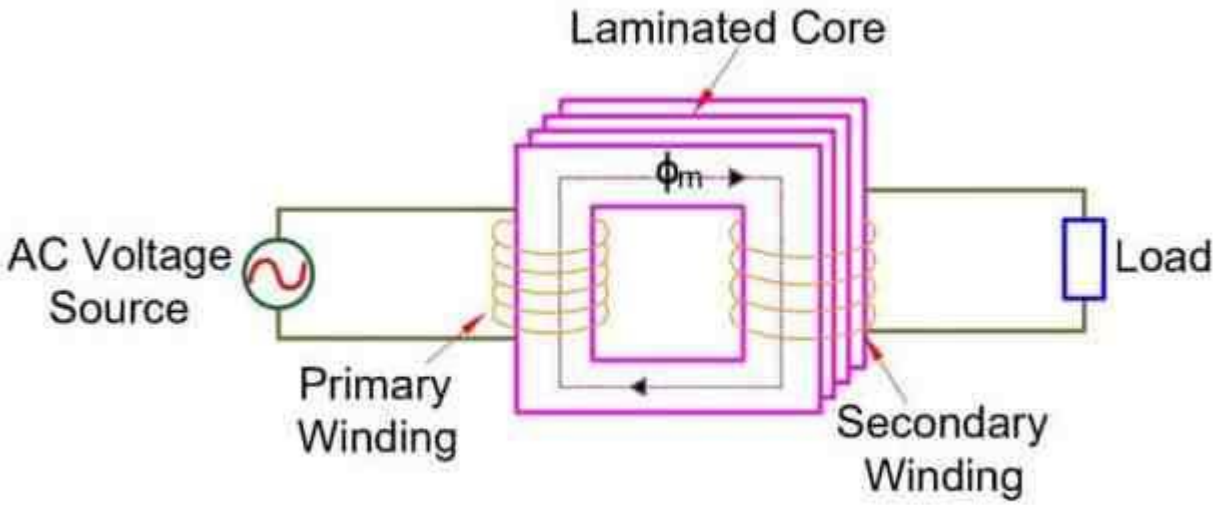
The transformer consists of two separate winding placed over the laminated silicon steel core.

The winding to which AC supply is connected is called primary winding and to which load is connected is called secondary winding.

It works on the alternating current only because an alternating flux is required for mutual induction between the two winding.

When the AC supply is given to the primary winding with a certain voltage, an alternating flux sets up in the core of the transformer, which links with the secondary winding and as a result of it, an emf is induced in it called Mutually Induced emf.

The direction of this induced emf is opposite to the applied voltage.



TRANSFORMER

transformer increases or decreases the voltage level depends on the relative number of turns between the primary and secondary sides of the transformer. If there are more turns on the primary coil than the secondary coil then the voltage will decrease (step down).

If there are fewer turns on the primary coil than the secondary coil then the voltage will increase (step-up).The rate of change of flux linkage depends upon the amount of linked flux with the second winding. So ideally almost all of the flux of primary winding should link to the secondary winding. This is effectively done by using a core-type transformer. This provides a low reluctance path

common to both of the windings.The purpose of the transformer core is to provide a low reluctance path, through which the maximum amount of flux produced by the primary winding is passed through and linked with the secondary winding.

The current that initially passes through the transformer when it is switched on is known as the transformer inrush current.

TYPES:

On the basis of output voltage

2.Step down

1. Step up

On the basis of core construction

1.core type

2.shell type

On the basis of no. of phase

1.Single phase

2.Three phase

On the basis of cooling system

1.Naturally cooled

2.Oil cooled

3.water cooled

4.forced air cooled

On the basis of output capacity

1.Auto transformer

2.Instrument transformer

On the basis of commercial

2.Distribution transformer

1.Power transformer

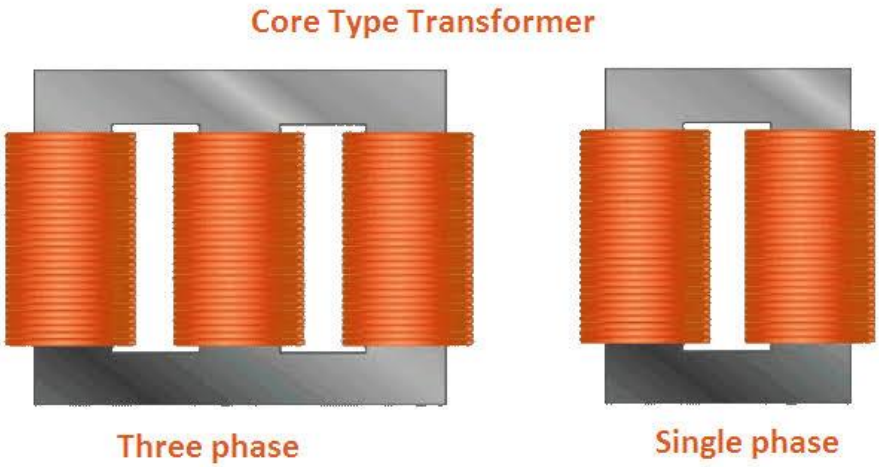
2.3 CORE TYPE TRANSFORMER:

Core type designs have one core wound around two coils. The core design has all the low voltage windings wound closest to the core,

with the high voltage windings wound around the low voltage section. This creates a low-high configuration.

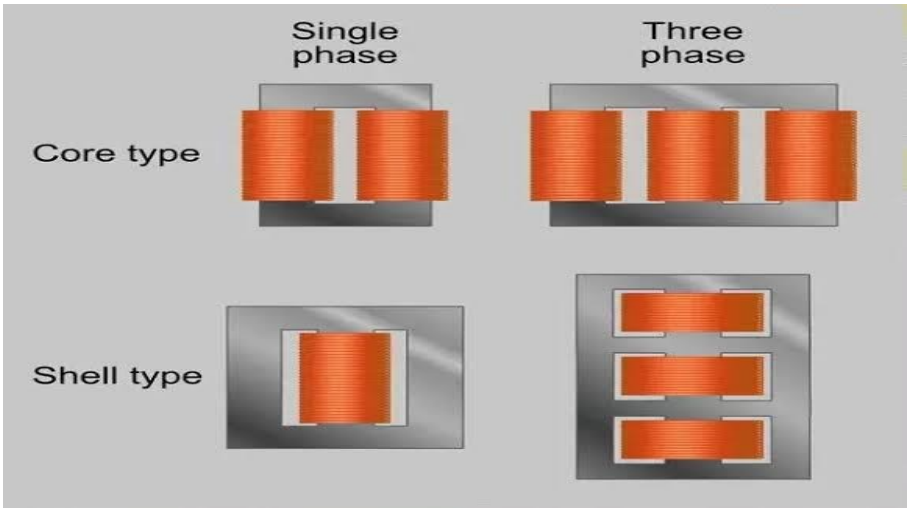
In the core type design, the low voltage section is closest to the core to optimize material use. Since the low voltage section carries more current, it uses more material. Having this section closest to the core reduces the average winding length and the amount of material needed.

The low voltage (lv) winding is placed next to the core and the high voltage (hv) winding is placed around the low voltage winding. This reduces the requirement of insulating material. Hence, the primary and secondary windings are arranged as concentric coils, thus known as concentric winding or cylindrical winding.The core type construction of transformer is easier to dismantle for maintenance. The natural cooling is good in the core type transformer. Therefore, core type transformers are suitable for high voltage and small output applications



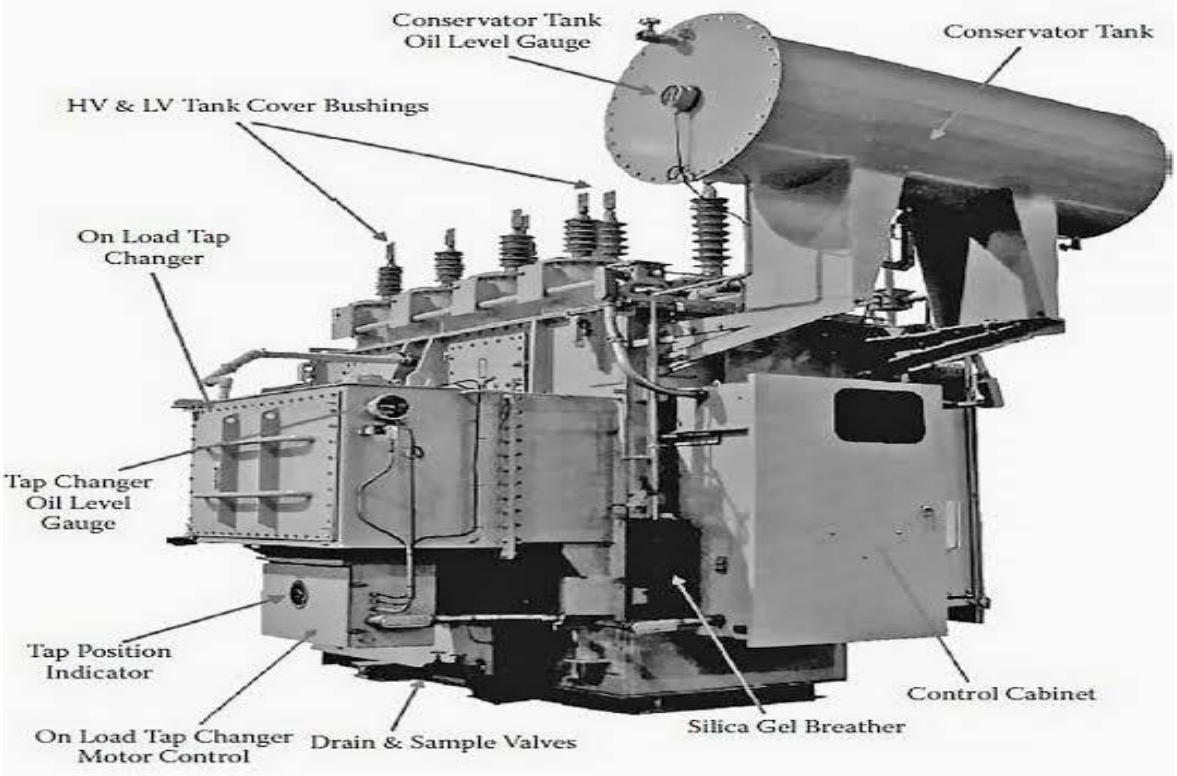
SHELL TYPE TRANSFORMER:

A shell type transformer consists of one central limb and two outer limbs as shown in the figure of shell type transformer. In the shell type transformer, both primary and secondary windings are placed on the central limb. The function of the two outer limbs is to complete the path of low reluctance for magnetic flux.In the shell type transformer, each winding is divided into subsections, where the low voltage winding and high voltage winding subsections are alternatively placed on the central limb in the form of a sandwich. For this reason, this winding is called sandwich or disc winding.The major advantage of the shell type transformer is that it gives better support against the electromagnetic forces between the current carrying conductors. Also, the shell type transformer provides a shorter magnetic path, thus it requires smaller magnetizing current. However, the major disadvantage of the shell type transformer is that it has poor natural cooling. Consequently, the shell type transformers are preferred in low voltage applications such low power circuits and electronic circuits.



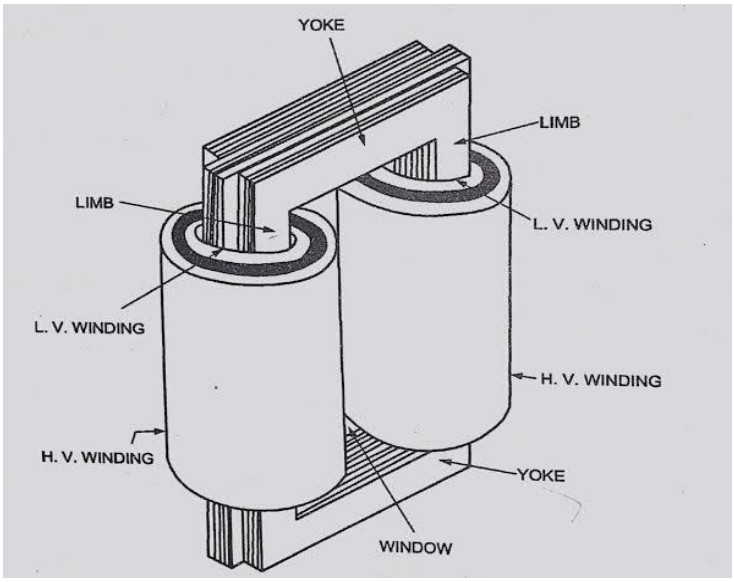
PARTS OF TRANSFORMERS:

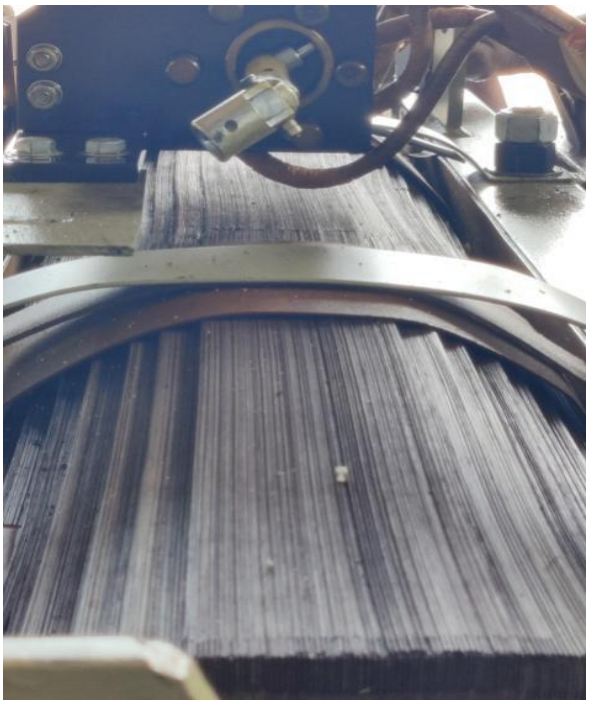
- CORE AND WINDING
- INSULATION
- TANK
- TERMINALS AND BRUSHINGS
- TRANSFORMER OIL
- OIL CONSERVATOR
- BREATHER
- BREATHER
- EXPLOSION VENT
- TAP CHANGERS
- BUCHHOLZ RELAY



CORE:

The core provides a low reluctance path for electromagnetic flux and supports the primary and secondary windings. It is made by stacking thin sheets of high-grade grain-oriented steel which are separated by thin insulating material. In order to minimize the hysteresis and eddy currents, the carbon content of the core steel is maintained below 0.1%. When it is alloyed with silicon, eddy currents can be reduced. A typical three-phase transformer core is shown in the picture above. Each limb carries the primary and secondary winding of each phase. The limbs are magnetically coupled by the yokes. There are two types of core constructions: core type and shell type.





WINDING:

The transformer carries two sets of winding per phase – Primary winding and secondary winding. These winding consists of several turns of copper or aluminum conductors, insulated from each other and the transformer core. The type and arrangement of winding used for transformers depend upon the current rating, short circuit strength, temperature rise, impedance, and surge voltages. The high-voltage winding conductors are thinner than the low-voltage conductors and surround the LV winding from the outside. The LV winding is placed close to the core. In shell-type transformers, the winding is split into several coils (few turns of a conductor). The HV coils are sandwiched between the LV coils. Whereas in core-type transformers, windings are classified into four types: Multi-layer windings, Helical windings, Disc winding, and foil winding. The choice of winding type is determined by the number of turns and its current carrying capacity.

INSULATION :

Insulation is the most important part of transformers. Insulation failures can cause the most severe damage to transformers. Insulation is required between the windings and the core, between windings, between each turn of the winding, and between all current-carrying parts and the tank. The insulators should have high dielectric strength, good mechanical properties, and high-temperature withstand ability. Synthetic materials, paper, cotton, etc are used as insulation in transformersThe core, winding and insulation are the most basic parts of a transformer and are present in all types

TANK:

The main tank is a part of a transformer that serves two purposes:

Protects the core and the windings from the external environment.

Serves as a container for oil and support for all other transformer accessories. Tank bodies are made by fabricating rolled steel plates into containers. They are provided with lifting hooks and cooling tubes. In order to reduce weight and stray losses, aluminum sheets are also used instead of steel plates. However, aluminum tanks are costlier than steel ones.

TERMINALS AND BUSHINGS:

For connecting incoming and outgoing cables, terminals are present in transformers. They are mounted upon the bushings and connected to the windings' ends.

Bushings are insulators that form a barrier between the terminals and the tank. They are mounted over the transformer tanks. They are a safe passage for the conductors connecting terminals to the windings. They are made from porcelain or epoxy resins

There is 2 types of bushings 1.high voltage bushings and 2. Low voltage bushings in high voltage bush the insulation is high and the terminal thickness is low since it carry low current and viceversa in low voltage bushings

Low voltage bushings

High voltage bushings

TRANSFORMER OIL:

Transformer oil is a mineral insulating or cooling oil derived from crude petroleum. It is a mixture of various hydrocarbons consisting partly of aliphatic compounds (open chain compounds) with the general formula – CnH2n+2 and CnH2n.

Oil in transformer serves the purpose of cooling and insulation. For use in transformer tanks oil has to fulfill certain specification, In all oil-immersed transformers, transformer oil provides added insulation between the conducting parts, better heat dissipation, and fault detection features. Hydro-carbon mineral oil is used as transformer oil. It is composed of aromatics, paraffin, naphthenes, and olefins.

CONSERVATOR TANK:

Conservator conserves the transformer oil. It is an airtight metallic cylindrical drum which is fitted above the transformer. The conservator tank is vented to the atmosphere at the top and the normal oil level is approximately in the middle of the conservator to allow expansion and contraction of oil during the temperature variations. It is connected to the main tank inside the transformer which is completely filled with transformer oil through a pipeline

BREATHER:

Breather is present in all oil-immersed transformers that have a conservator tank. It is necessary to keep the oil-free from moisture. As the temperature variations cause the transformer oil to expand and contact, air flows in and out of the conservator tank. This air should be free from moisture. Breather serves this purpose.

The insulating oil of transformer is provided for cooling and insulating purpose. Expansion and contraction of oil during the temperature variations cause pressure change inside the conservator. This change in pressure is balanced by the flow of atmospheric air into and out of the conservator.

Transformer breather is a cylindrical container which is filled with silica gel. Insulating oil reacts with moisture can affect the paper insulation or may even lead to some internal faults. So it is necessary that the air entering the tank is moisture free. For this purpose breather is used. Breather consists of silica gel contained in a chamber. When the atmospheric air passes through the silica gel breather the moisture contents are absorbed by the silica crystals. Silica gel breather is acts like an air filter for the transformer and controls the moisture level inside a transformer. It is connected to the end of breather pipe.

RADIATOR :

The power lost in the transformer is dissipated in the form of heat. Dry transformers are mostly natural air-cooled. But when it comes to oil-immersed transformers, a variety of cooling methods are followed. Depending on the kVA rating, power losses, and level of cooling requirements, radiators and cooling fans are mounted on the transformer tank.

The heat generated in the core and winding is passed to the surrounding transformer oil. This heat is dissipated at the radiator. In larger transformers forced cooling is achieved with the help of cooling fans fitted to the radiators.

EXPLOSION VENT:

An explosion vent acts as an emergency exit for oil and air gases inside a transformer. It is a metallic pipe with a diaphragm at one end, held slightly above the conservator tank. Faults occurring under oil elevate the pressure inside the tank to dangerous levels. Under such circumstances, the diaphragm ruptures at a relatively low pressure to release the forces from within the transformer to the atmosphere. An explosion vent is a pipe, 4'' in diameter or greater, that extends a few feet above the cover of a transformer and is curved toward the ground at the outlet end of the pipe. A diaphragm fitted at the curved end breaks at a relatively low pressure to release the forces from within the transformer

TAP SWITCH:

Tap changer is a mechanism in transformers which allows for variable turn ratios to be selected in distinct steps. This is done by connecting to a number of access points known as taps along either the primary or secondary winding. Tap changers exist in two primary types,[1] no-load tap changers (NLTC), which must be de-energized before the turn ratio is adjusted, and on-load tap changers (OLTC), which may adjust their turn ratio during operation. The tap selection on any tap changer may be made via an automatic system, as is often the case for OLTC, or a manual tap changer, which is more common for NLTC. Automatic tap changers can be placed on a lower or higher voltage winding, but for high-power generation and transmission applications, automatic tap

changers are often placed on the higher voltage (lower current) transformer winding for easy access and to minimize the current load during operation.

BUCHHOLZ RELAY:

Buchholz relay is a type of oil and gas actuated protection relay universally used on all oil-immersed transformers having a rating of more than 500 kVA. Buchholz relay is not provided in relays having a rating below 500 kVA from the point of view of economic considerations.

Working:

Buchholz relay is used for the protection of transformers from the faults occurring inside the transformer. Short circuit faults such as inter-turn faults, incipient winding faults, and core faults may occur due to the impulse breakdown of the insulating oil or simply the

transformer oil. Buchholz relay will sense such faults and close the alarm circuit.

Operation:

The operation of the Buchholz relay is very simple. Whenever any minor fault occurs inside the transformer heat is produced by the fault currents. The transformer oil gets decomposed and gas bubbles are produced. These gas bubbles move towards the conservator through the pipeline. These gas bubbles get collected in the relay chamber and displace oil equivalent to the volume of gas collected. The displacements of oil tilt the hinged float at the top of the chamber thereby the mercury switch closes the contacts of the alarm circuit.The amount of gas collected can be viewed through the window provided on the walls of the chamber. The samples of gas are taken and analyzed. The amount of gas indicates the severity of and its color indicates the nature of the fault that occurred. In case of minor faults, the float at the bottom of the chamber remains unaffected because the gases produced will not be sufficient to operate it.

During the occurrence of severe faults such as phase-to-earth faults and faults in tap changing gear, the amount of volume of gas evolves will be large and the float at the bottom of the chamber is tilted and the trip circuit is closed. This trip circuit will operate the circuit breaker and isolate the transformer.

MAGNETIC OIL GAUGE:

The MOG (Magnetic Oil Gauge) is a device by which we can supervise the level of liquid/oil inside the tank or conservator of power transformer and also gives us an alert low oil level indication with making mercury switch. It is connected at the bottom of the conservator tank. Normally all Transformers are provided with an expansion vessel called Conservator, to take care of expansion in the oil volume due to rise in temperature, when the load on the Transformer increases or due to increase in ambient temperature. The oil level in the Conservator consequently goes up and conversely it fall when temperature or load reduces. It is essential that oil level in the conservator tank to be maintained at a pre-determined minimum level. Therefore all large Transformers are fitted with a Magnetic Oil Level Gauge, which are incorporated with

mercury switches which operates when oil level in the Conservator goes below minimum level and generate an alarm or Trip contact.

OIL LEVEL INDICATOR:

It is used to indicate the oil level in the transformer ,normally it is filley3/4 th of the full level.

PRESSURE RELEASING VALVE:

Winding of the transformer is housed in the transformer oil tank. The oil is used in the oil filled transformer for insulation as well as for cooling purpose.

In case of the fault inside the transformer caused by sudden and severe short circuit , the transformer oil gets heated up and enormous gases are evolved in the transformer tank which cause substantial increase in the internal pressure develops the pressure in the transformer tank. If the increased pressure is not vented outside of the transformer tank there may be potential hazard of transformer tank explosion. in this case, PRD of transformer is used to protect the transformer.

Advantages:

Vents can open with almost no inertia, so they are suitable for all sizes of vessel and for all positions on that vessel. They also are free of moving parts. They are far less affected by the weather or other wear and tear found in explosion doors, and they require minimal maintenance.

GASKETS:

transformer gasket is to prevent the entry of moisture into the transformer housing. The entry of moisture and humidity into a transformer accelerates the aging and breakdown of the insulating materials used within the transformer, leading to outright failure.

In transformer 3mm or 5mm gasket used for connecting points of Bushing , Buchholz relay, cooling fins etc. The 10mm or 8mm gaskets are being used for top cover of the transformer.

MAINTENANCE TEST:

The following tests are carried out in practice for maintenance purpose

- Vector Group Test
- DC winding resistance measurement.
- Magnetic Balance Test
- Voltage Ratio Test

Insulation resistance Test

VECTOR GROUP TEST:

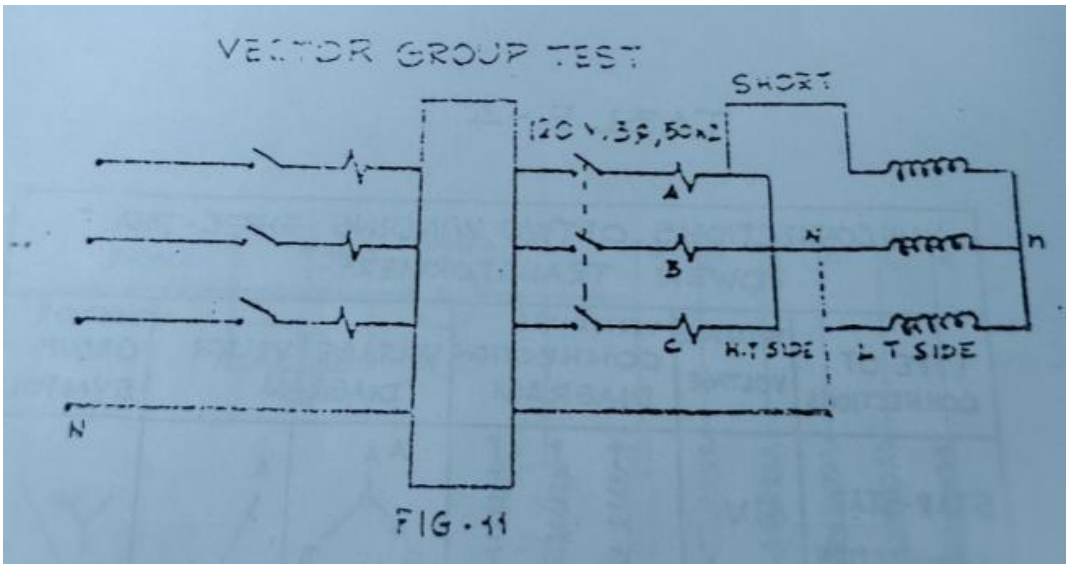


FIG - 11

The relative displacement of the vector regarding the corresponding HV Vector expressed in the number configuration is known as the vector group. ex. DY11.

Here

D- stands for HV winding connection delta

Y- stands for the LV winding connection star

n- stands for the brought out neutral of star and

11- stands for the clock number configuration. ie: LV vector.

is at 11 'o'clock position regarding the corresponding HV vector (ie) LV vector is loading the corresponding HV vector 30 degrees).

Various vector groups are available. For operating the transformers in parallel the vector group configuration is to be identical

The vector group Drawn with the measured value will be as follows

VBb = VCb

VCc < VBc.

DCR MEASUREMENT:

o check the healthiness of a transformer winding. direct current winding resistance measurement is one, Voltmeter Ammeter method is a reliable method. The above method describes the measurement of A-0 winding resistance of a 3 phase Y0Y0 transformer by the voltmeter Ammeter method. A steady-state current of about the voltage across the winding is noted. By applying Ohms law the resistance is calculated and compared with the test records.

The measurement is carried out at all taps. The deviation from the test certificate value [with necessary corrections for temperature] up to a maximum of 2% is permissible. This test not only checks the winding but also the tap changer. Enough care is to be taken to ensure the safety of voltmeters and testing personnel as high

voltages are induced while suddenly making and breaking the circuit because high inductive nature of the transformer winding.The voltmeter is to be connected only after the D.C. current becomes steady It shall be disconnected immediately after measuring switching off the battery supply. Any suitable method may be used preferably a low resistance bridge for large low voltage transformers, in which the LV winding resistance may be very small. The measurement is made at a known temperature.

MAGNETIC BALANCE TEST:

METHOD I:

This test is done to check the healthiness of the magnetic circuit. The center limb winding is energized with a certain voltage and all secondary winding voltages are measured. The voltages measured on the center limb winding will follow the ratio of transformation whereas the secondary voltage measured on the other limb windings should behalf of the center limb voltage(Secondary).

METHOD II

If any one of the winding is star connected with brought cut neutral, a low voltage is applied between middle phase to neutral. The

voltages measured between the other two phases and neutral of the winding shall be 50 of the applied voltage.

VOLTAGE RATIO TEST:

The direct measurement of voltage ratio by the voltmeter is feasible if the voltages are reasonably low. High voltage transformers with large ratios present difficulties in this respect since it is necessary to measure the lew voltages with entirely different instruments, the relation between them being subject to calibration error. The ratio test is to be performed on all taps. Assembled transformers may be checked on a ratiometer, which is essentially a potential divider excited from the same supply as the transformer under test, and subdivided to read the LV voltage in terms of the HV Balance is obtained by connecting the ratiometer tapping to the LV winding through an ammeter and adjusting the former until the current is Zero. Phase: angle difference between primary and secondary voltages can also be measured with this instrument.The ratio of the voltmeter readings V1/V2 is the turns ratio of one phase of the 3 phase YoYo transformers is repeated for other windings of the transformer.As per Indian standards, the maximum permissible ratio error is 0.5%for any tap regarding the nameplate ratio

INSULATION TESTS:

This is done using a motor-operated or hand-operated megger at an appropriate voltage level. For a transformer. normally two values are measured at 15th and 60th seconds after applying megger voltage. The ratio of megger values at 60th sec to 15th sec is called the absorption factor which should be greater than 1.3 for a healthy transformer. The insulation values are measured between.

1-HT side + LT side and earth.

2-HT side and LT side plus earth.

3-LT side and HT, side plus earth

Insulation tests for determining the insulation resistance are carried out between windings between copper and core, and between the core clamping bolts and the core.A high voltage test is made immediately after the heat run on a new transfer it may be a test by, or an induced voltage test in which the transformer is itself operated a voltage and frequency sufficiently above normal to generate in the windings a voltage of the specified magnitude

OIL FILTRATION SYSTEM:

The contaminated oil from the transformer is taken through the inlet valve with the help of an inlet pump. The pump has protection against over pressure and got interlocking arrangement between pump and the heater so as to ensure that heaters in plant get energized only when the pump is switched ON. Interlocking arrangement is also provided between the pump and the high level float switch located inside the degassing chamber to avoid excessive rise of oil in the chamber.In the first step of the filtration system, the temperature of the oil is raised to 65°C to provide latent heat which helps to separate the moisture and gases. Moreover, initial heating of the oil makes the filtration process easier as it decreases the oil viscosity.

The second step is to remove the sludge and contaminants from the oil which is done generally in two ways depending on the oil

filtration machine:1. Using Filter: Modern oil filtration machines use a series of filters. Oil is first passed through Press Filter which are held between metallic discs and helps to remove impurities bigger than 50 micros. This filer helps in removing the sludge in the oil. Oil is then passed through Cartridge Filter of 1-micron rating. They have a large dust holding capacity and needs to be replaced periodically.

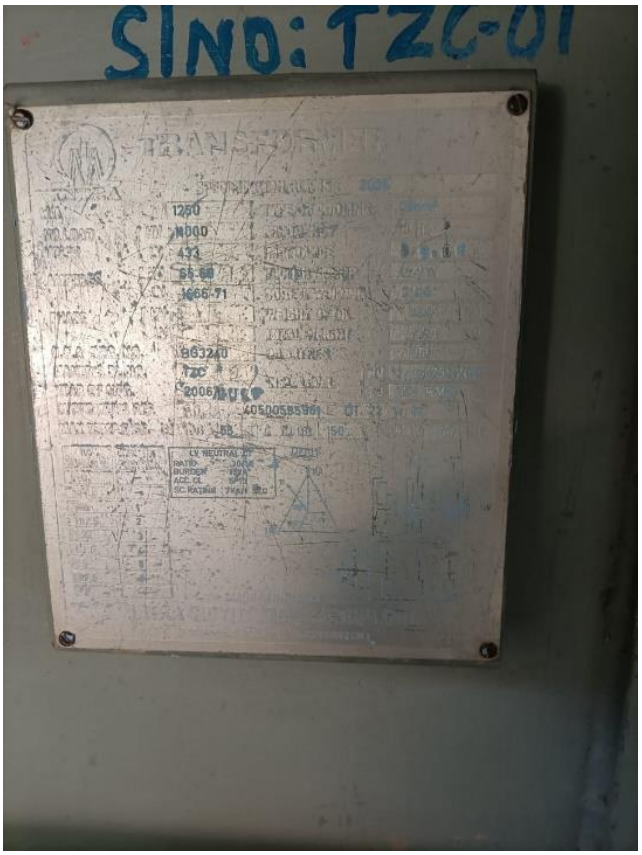
2. Using Centrifuging Action: As the name suggests, oil is filtered using centrifuging which helps to separate the dirt from the oil. The only advantage in this type of machines is that recurring cost of changing filters can be avoided.Third step involves the dehydration or dehumidification of insulating oil along with degasification which helps to remove the unwanted gases and moisture. The whole process is carried out in the degassing chamber of the machine which contains two float switches – one which is electrically interlocked with the inlet pump to avoid excessive rise of oil and the second is provided to control the low level of oil which is electrically interlocked with the discharge pump. A sampling point is provided after the discharge pump for the ease of taking a sample.Vacuum pumps are provided for the evacuation of the gas from the degassing chamber. Clean oil is then finally pumped back to the transformer using a discharge pump.The while cycle is repeated 3-5 times till the required BDV value is achieved.

BDV TEST:

Dielectric breakdown testing is a test to measure the withstand voltage of materials used for electrical insulation. Insulators are glass, resin, rubber, and other materials that do not conduct electricity. Materials with particularly high insulation resistance and high dielectric strength are called insulating materials.Insulating materials are used for the purpose of blocking the flow of electricity to unintended places. Familiar examples include the resin that covers the area around electrical outlets and the insulators used in electrical wires. Particularly in places where high-voltage power supplies are used, the reliability of insulators is required because leakage of electricity (electrical leakage) can lead to serious accidents such as electric shock, fire, and personal injury. One of the tests conducted to ensure this reliability is the dielectric breakdown test.

CASE STUDY ON INTRA TRANSFOMER:

NAME PLATE:



BEFORE DISSASEMBLY:

Fault :Humming sound during working.

They rectified by tighting the core ,reason for this is due the over absorbtion of the oil by transformer laminations.first it oil is removed and stored in the separate can and the core with winding is removed from the tank and the following test are done :

In that the megger is used the

RESISTANCE AT LV SIDE AND BODY is above 1 GIGA OHM and at the HV side its 340 M OHM

2. 3PHASE MAGNETIC TEST:

AB	BC	CA	AN	BN	CN
412	416.4	412.19	9.41	9.50	9.40
411.4	360.8	52.12	9.37	8.23	1.19
230.6	416.3	186.7	5.21	9.47	4.24
56.97	356.1	411.4	1.30	8.11	9.37

ONE PHASE MAGNETIC BALANCE TEST:

AN	BN	CN
99.6	87.4	12.18
51.6	108.8	48.13
12.48	89.2	101.7

Ian	2.36A
Ibn	1.65A
Icn	2.35A

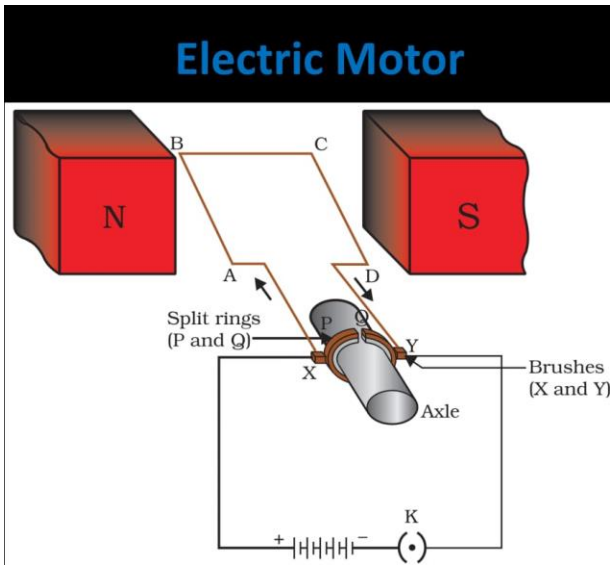
VECTOR GROUP TEST:

Bb	395.4
Bc	395.8
Cc	396.3
Cn	410.7

MOTORS

ABSTRACT:

The electric motor is an electromechanical device that converts mechanical energy into electricity energy. This mechanical energy is used for, for example, rotate the pump impeller, fan or blower, drive the compressor, lifting materials, etc.. Electric motors are used in the home (mixer, electric drill, fan) and in the industry, so it takes maximum care to maintain the efficiency of the motor. One of the factors that can affect the efficiency of the electric motor is sparking at the motor.Steps to Repair the AC motor is by a variety of processes.



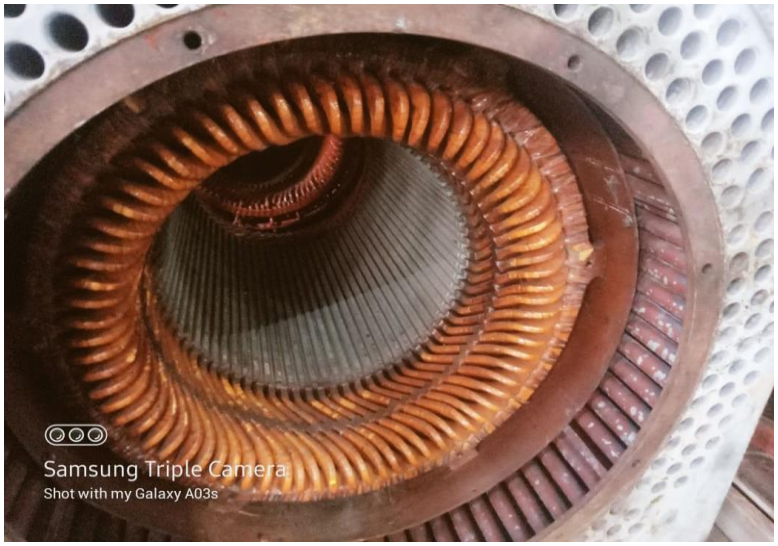
PRINCIPLE:

An electric motor is a device that converts electrical energy into mechanical energy. An electric motor (dc motor) works on the principle that when an electric current is passed through a conductor placed normally in a magnetic field, a force acts on the conductor as a result of which the conductor begins to move and mechanical energy is obtained.

PARTS:

STATOR:

The stationary parts of a motor are collectively known as a stator. The stator may contain windings or a permanent magnet. In the case of AC motors, the stator carries the armature and in DC motors it carries the field winding. The stator cores of AC motors are made of laminated silica steel while the DC cores need not be laminated.

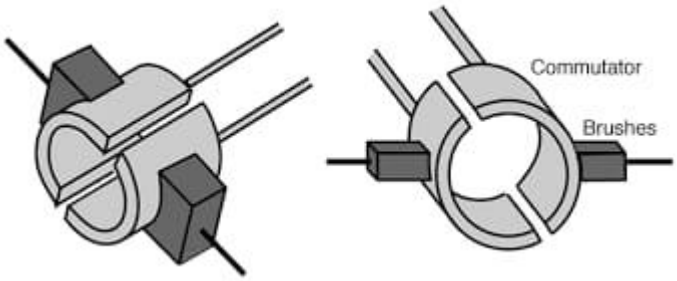


ROTOR:

The rotor is the set of winding and magnetic core attached to which the motor shaft is attached. The rotor core is made of laminated silica steel. The rotor is replaced using a cage-like structure in the case of squirrel cage induction motors. The rotor delivers mechanical energy to the shaft. In PMAC motors, rotor windings are replaced by permanent magnets.

COMMUTATOR:

Commutators are used to reverse the direction of current in the rotor in order to maintain a repulsive force between the rotor and stator poles. They are found in all motor types which requires DC supply for their rotors. Voltage is applied to the rotor using spring-loaded carbon brushes that sit over the commutator**.**



CASING ,BRUSHES AND TERMINALS:

The motor casing supports the stator and other motor components as well as protect the stator and rotor components from the external environment. Normally they are made up of aluminum.

Carbon brushes are used to supply electricity to the rotor. It maintains contact with the commutator regardless of the speed of rotation. Contact pressure is maintained with the help of spring.

The operational power is supplied to motors through their terminals.An electric motor works through the principle of electromagnetism. The rotor and stator windings that carry current act as an electromagnet, producing a force of attraction or repulsion between them. Typically DC motors working on the principle of electromagnetic repulsion whereas AC motors work through that of electromagnetic attraction.

TYPES OF MOTORS:

1. AC MOTOR.
2. DC MOTOR.

AC MOTOR:

An AC electric motor is a type of electric motor operating with an alternating current (AC, Alternating Current) voltage source. This AC electric motor can be distinguished by its resources as follows.

Asynchronous motor is an AC motor working at a fixed speed at a certain frequency system. This motor requires direct current (DC) for power generation and has low initial torque, and therefore synchronous motors are suitable for low-load initial use, such as air compressors, frequency changes and motor generators. Synchronous motors can improve the system power factor, so it is often used on systems that use a lot of electricity.

An induction motor is an AC power motor that works based on induction magnetic media between rotor and stator.

Induction motor(Non synchronous)

- Singe phase.
- Three phases.

Synchronous motor.

- Reluctance.
- Hysteresis.

Linear motor.

DC MOTOR:

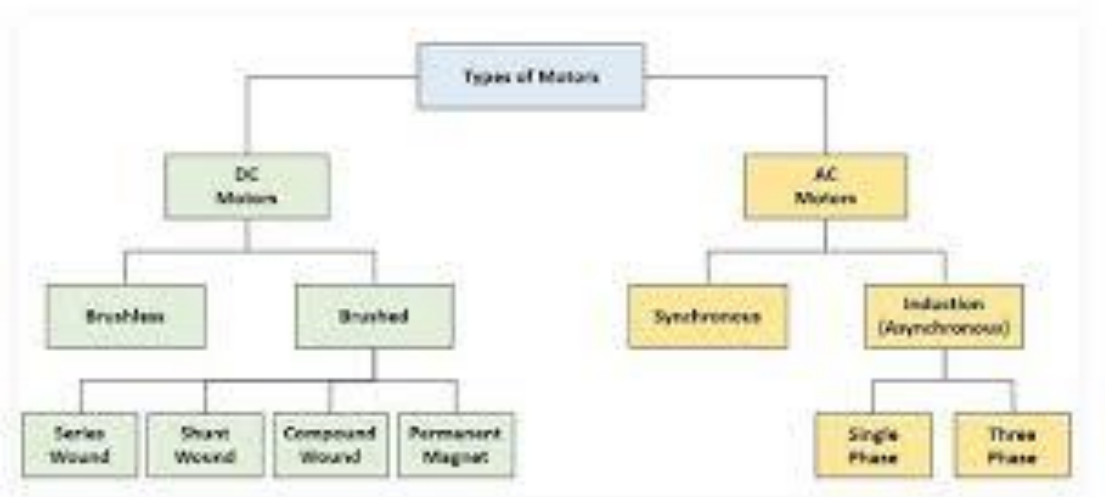
An AC electric motor is a type of electric motor operating with an alternating current (AC, Alternating Current) voltage source. This AC electric motor can be distinguished by its resources as follows.

Asynchronous motor is an AC motor working at a fixed speed at a certain frequency system. This motor requires direct current (DC)

for power generation and has low initial torque, and therefore synchronous motors are suitable for low-load initial use, such as air compressors, frequency changes and motor generators. Synchronous motors can improve the system power factor, so it is often used on systems that use a lot of electricity.

An induction motor is an AC power motor that works based on induction magnetic media between rotor and stator.

- Self-excited
    1. Series.
    2. Compound.
        - Short- shunt.
        - Long-shunt.
    3. Shunt.
- Separately excited.

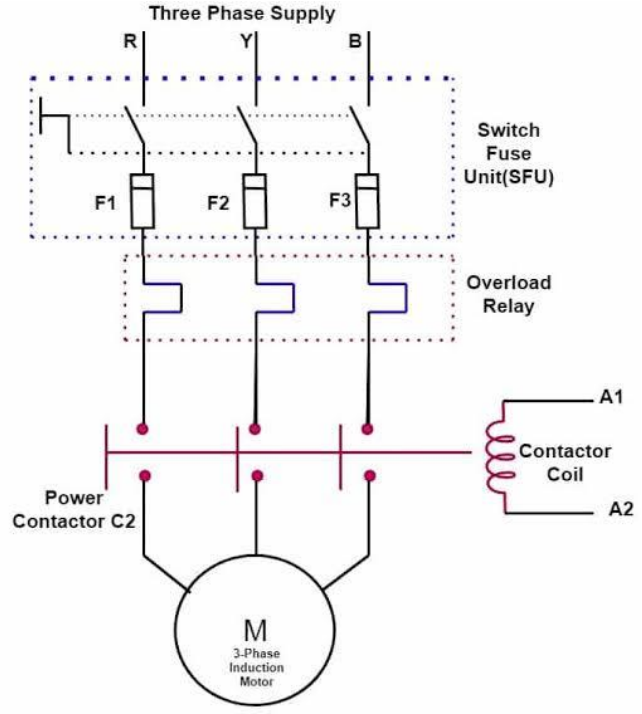


MOTOR STARTER:

DIRECT ON LINE STARTER:

DOL Starter (Direct Online Starter) is also known as “across the line starter”. DOL starter is a device consist of main contactor, protective devices and overload relay which is used for motor starting operations. It is used for low rating usually below 5HP motors.

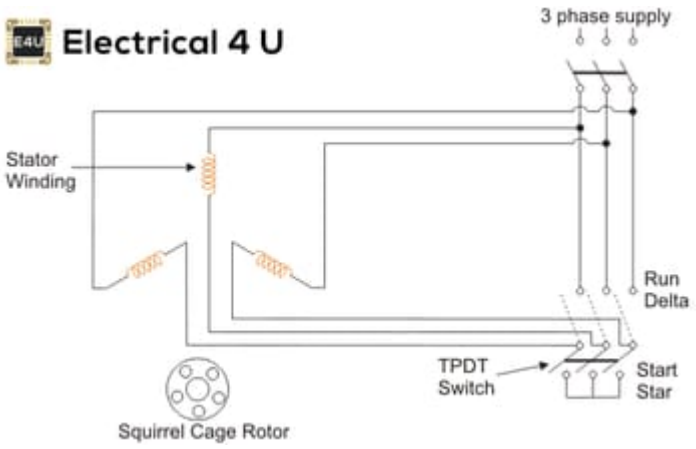
In direct online starter method of motor starting, the motor stator windings are directly connected to the main supply where the DOL protect the motor circuit from high inrush current which may damage the overall circuit as the initial current is much higher than the full rated current.



DOL Starter Power Circuit Diagram

STAR DELTA STARTER:

A star delta starter is the most commonly used method for the starting of a 3-phase induction motor. In star delta starting an induction motor is connected in through a star connection throughout the starting period. Then once the motor reaches the required speed, the motor is connected in through a delta connection.



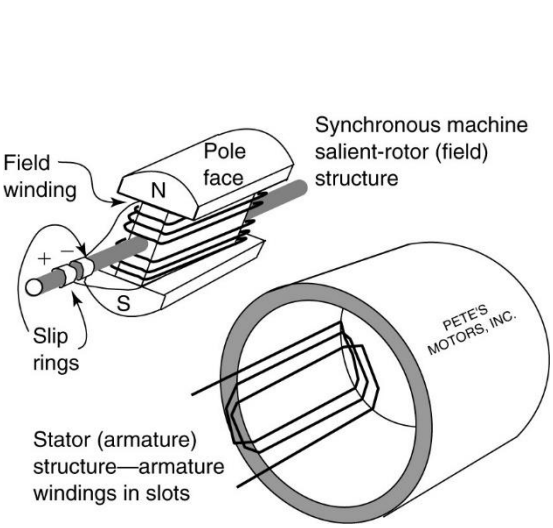
AC MOTORS:

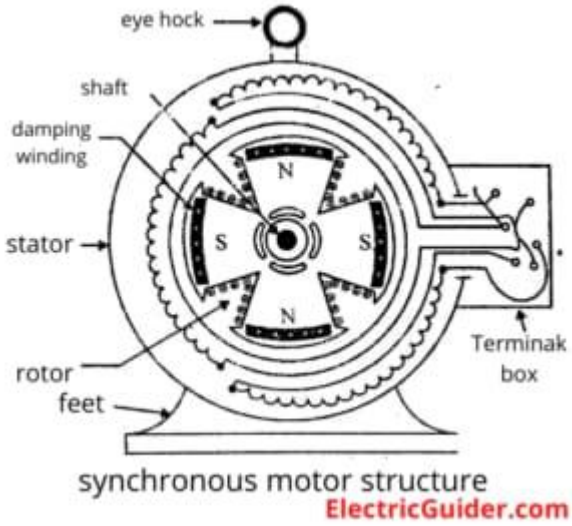
The types of ac motors mainly include synchronous, asynchronous, induction motor.

1.Synchronous Motor

The working of the synchronous motor mainly depends on the 3-phase supply. The stator in the electric motor generates the field current which rotates in a stable speed based on the AC frequency. As well as the rotor depends on the similar speed of

the stator current. There is no air gap among the speed of stator current and rotor. When the rotation accuracy level is high, then these motors are applicable in automation, robotics, etc.





2.**INDUCTION MOTOR:**

The electric motor which runs asynchronous speed is known as induction motor, and an alternate name of this motor is the asynchronous motor. Induction motor mainly uses electromagnetic induction for changing the energy from electric to mechanical. Based on the rotor construction, these motors are classified into two types namely squirrel cage & phase wound.

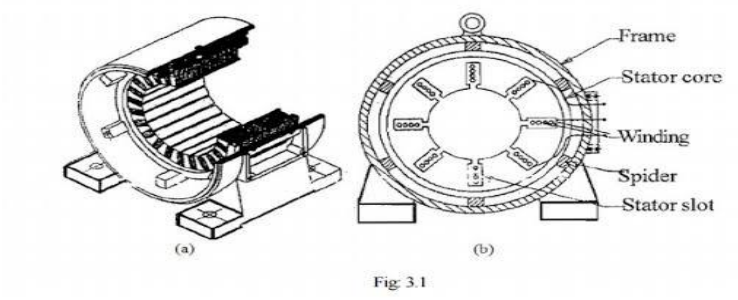


Fig: 3.1

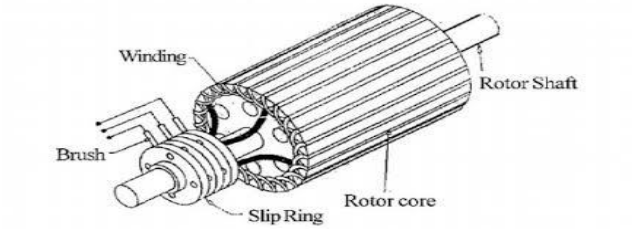


Fig: 3.2

SLIP RING INDUCTION MOTOR

Alternating current (AC) Induction motors, otherwise known as asynchronous motors, are the workhorses of the mining industry. These motors comprise two main components, a fixed stator with windings that function as electromagnets, and a rotor that spins inside the stator. The electric current in the rotor that causes it to rotate is produced by electromagnetic induction from the magnetic field of the stator windings. This design is known as an asynchronous motor because the electrical fields in the rotor and stator are rotating at different speeds they are out of phase with each other.The high starting torque, high inertia starting capabilities and low starting current of slip-ring motors can help minimise mechanical stress when starting heavy mining equipment and increase its working lifetime. A further benefit of large slip-ring motors is their high-power density. This means that they can deliver the required power in smaller frame size. Less spaceis

needed to install the motor and it is easier to lift and handle on-site, lowering installation costs.There are two main designs for large industrial induction motors. The key difference is the rotor, which can be either a squirrel-cage or a wound type used with slip-rings. The main advantage of squirrel-cage induction motors is that they are self-starting, reliable and cost-effective. However, for equipment where a high starting torque is essential to overcome the initial inertia, slip-ring motors can offer more than double their normal full-load torque on start-up. A slip-ring is simply a device intended to transmit electrical power, signals or data between rotating and fixed parts. It comprises a rotating ring made of a suitable conducting material such as copper, copper alloy or steel and fixed brushes. In a wound-rotor AC induction motor, the slip-rings are not used to carry electrical current. Instead, they are used to insert an increased resistance into the rotor windings. In a three-phase motor, three slip-rings are used – one connected to each winding phase. They are mounted on the motor shaft so that they rotate as it rotates. But they are insulated electrically from the shaft**.**

SLIP RINGS :

This brush is attached to a small rotor located at the end of the main rotor. The friction that occurs will flow the current in the same direction even though the rotor rotates. So that the rotation can be synchronous and continuous. This friction will be supported by a spring located behind the copper brush. This spring will always hit the brush so that this brush will always stick to the rotor despite spinning at high RPM.

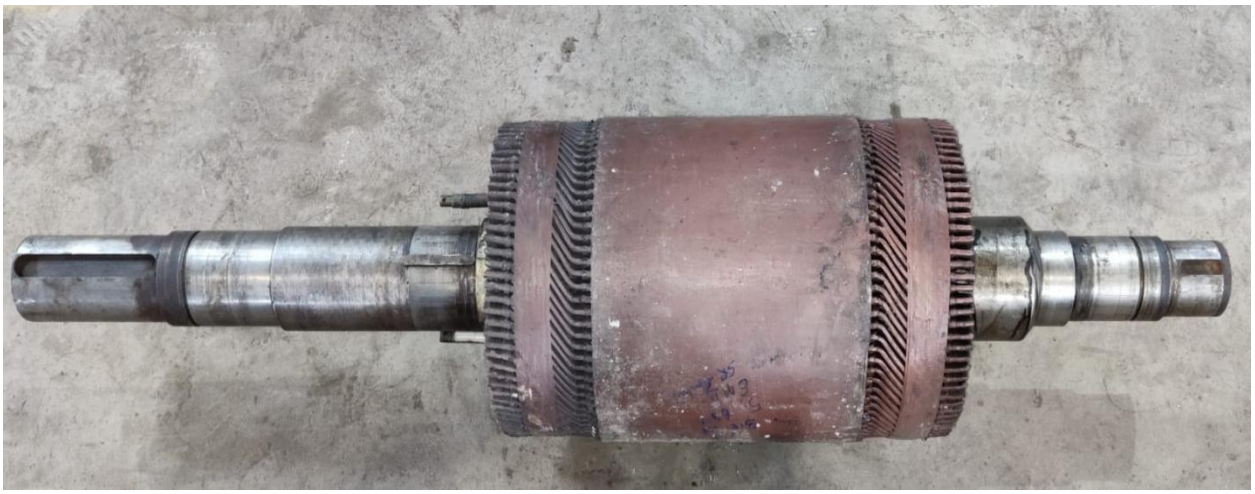
A simple electric motor should be equipped with two brushes. This brush will supply the current and time for the coil rotor. In addition, this component is a popular cause that causes the electric motor to die. The crust attached to the surface of the brush will cause the flow of the current to be inhibited. In addition, the condition of the

brush being worn because it continues to be rubbed can also inhibit the flow of obstructed flow.

SQUIRREL CAGE MOTOR

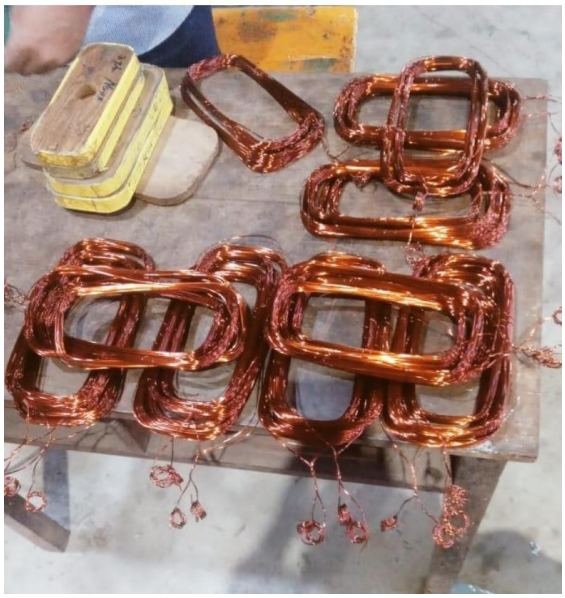
A squirrel-cage rotor is the rotating part of the common squirrel-cage induction motor. It consists of a cylinder of steel laminations, with aluminum or copper conductors embedded in its surface. In operation, the non-rotating stator winding is connected to an alternating current power source; the alternating current in the stator produces a rotating magnetic field. The rotor winding has current induced in it by the stator field, like a transformer except that the current in the rotor is varying at the stator field rotation rate minus the physical rotation rate. The interaction of the magnetic fields of currents in the stator and rotor produce a torque on the rotor. By adjusting the shape of the bars in the rotor, the speed-torque characteristics of the motor can be changed, to minimize starting current or to maximize low-speed torque, for example.Squirrel-cage induction motors are very prevalent in industry, in sizes from below 1 kilowatt (1.3 hp) up to tens of megawatts (tens-of-thousand horsepower). They are simple, rugged, and self-starting, and maintain a reasonably constant speed from light load to full load, set by the frequency of the power supply and the number of poles of the stator winding. Commonly used motors in industry are usually IEC or NEMA standard frame sizes, which are interchangeable between manufacturers. This simplifies application and replacement of these motors. Squirrel induction motor working is based on the principle of electromagnetism. When the stator winding is supplied with a three-phase AC, it produces a rotating magnetic field (RMF) which has a speed called synchronous speed. This RMF causes voltage induced in the rotor bars. So, that short-circuit current

flows through that. Due to these rotor currents, a self magnetic field is generated which interacts with the stator field. Now, as per the principle, the rotor field starts opposing its cause. when the RMF catches the rotor moment, the rotor current drops to zero. Then there would be no relative moment between the rotor and RMF.



WINDING SECTION:

Motor windings are made up of a series of conductive wires that have been produced in a loop pattern that can carry an electrical current. The loop is wrapped around a magnetic core. When electrical current flows through the windings it will create a magnetic field which in turn makes the rotor spin.



Types of winding:

1. Stator Winding
2. Rotor Winding
3. Lap Winding

4.Wave winding

STATOR WINDING:

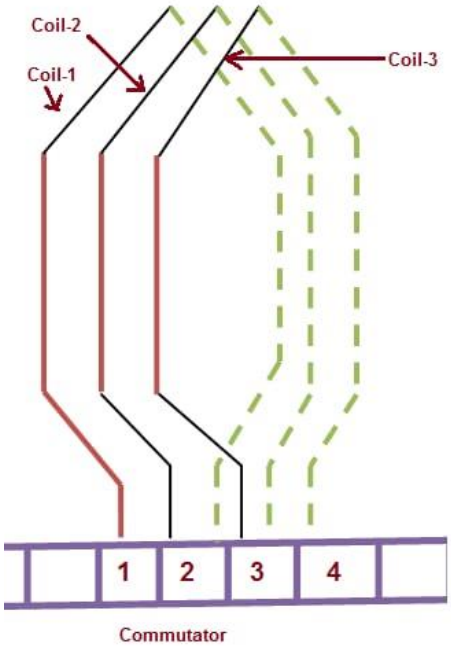
Stator winding is made up of former wound coils of high conductivity copper of diamond shape. These windings must be properly arranged such that the induced emf in all the phases of the coils must have the same magnitude and frequency. These emfs must have same wave shape and be displaced by 1200 to each other.

ROTAR WINDING:

In a motor, the rotating part is known as the rotor. The rotor includes the rotor winding as well as rotor core. The rotor winding is energized by the DC supply. The rotor can be classified into two types namely the phase wound and the squirrel cage. The squirrel cage rotor's core is made up of cylindrical iron core which has a curved slot over the external surface on which the aluminium or copper conductors are located. These are shortcircuited at the endings using the copper or aluminium ring. The electromagnetic induction is the occurrence wherein the electromagnetic force is induced within the conductor which carries the conductor due to the variable magnetic field. When the current stimulates in the rotor then it causes the rotor to move.

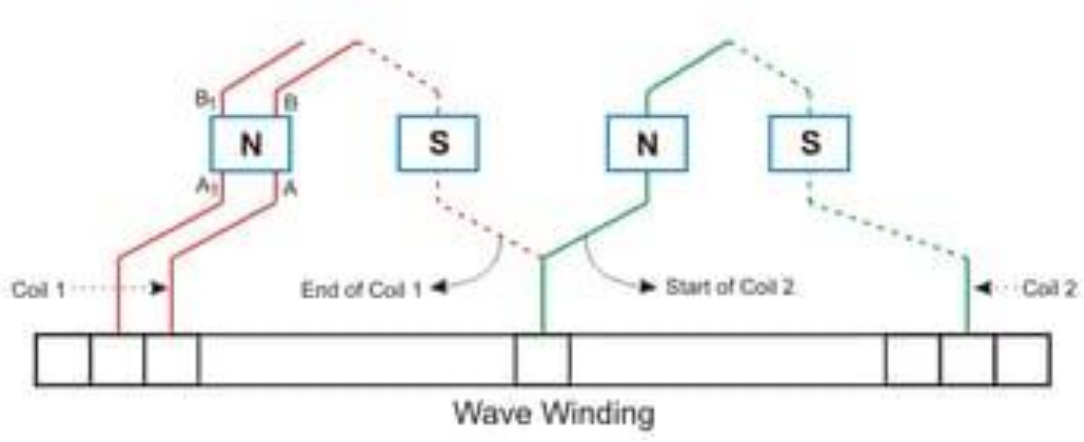
LAP WINDING:

Lap winding is the one kind of armature winding. The conductor connection can be done where the lanes and poles are similarly connected. The final part of each armature coil is associated with the commutator. The number of brushes within winding is the same as the number of parallel lanes. These are divided equally into two polarity windings like positive & negative. The lap winding applications mainly involve in high current and low voltage machines. These windings are categorized into three type's namely simplex, duplex and triplex type winding.



WAVE WINDING:

This type of winding is used in dc generators employed in high-voltage applications. Notice that the two ends of each coil are connected to commutator segments separated by the distance between poles. This configuration allows the series addition of the voltages in all the windings between brushes. This type of winding only requires one pair of brushes. In practice, a practical generator may have several pairs to improve commutation. When the end connections of the coils are spread apart as shown in Figure a wave or series winding is formed. In a wave winding there are only two paths regardless of the number of poles. Therefore, this type winding requires only two brushes but can use as many brushes as poles. Because the winding progresses in one direction round the armature in a series of 'waves' it is know as wave winding.If, after passing once round the armature,the winding falls in a slot to the left of its starting point then winding is said to be retrogressive.If, however, it falls one slot to the right, then it is progressive.



Wave Winding

Name plate of a Motor:

Name plate is normally located on all produced electric motors. Understanding nameplate information can be hard sometimes, but is essential. In most countries it is a requirement for manufacturers to display all information on the motor's nameplate, but often this is not the case.

The above name plate is a 3 Phase BHEL 1250KW Motor ,RPM-988,Stator volt-6600,Rotar volt- 1490,Insulation class - F(155c),Stator Amp- 132 A,Rotar Amp-500,Rotar type -Round,DE Bearing – NU234,NDE Bearing -NU234.

BEARING

- Ball-bearing
- Roller bearing
- Rolling element bearing
- Sealed bearing

- Shielded bearing
- Open bearing
- Sleeve bearing
- Vertical motor bearing

BALL BEARING:

In ball bearings, the rolling motion is provided by balls held in position by a race and cage. Ball bearings support high speeds and very low friction and they can handle light to medium loads. Electric motor ball bearings are typically used in direct-coupled applications and can handle both radial and axial loads.

ROLLER BEARING:

As the name implies, roller bearings depend on cylindrical rolling elements. These bearings don’t require a cage and race in the same way that ball bearings do. Electric motor roller bearings are used for belted applications with motors 150 HP and above. The surface

of the cylindrical shape rolling elements helps to account for the high level of radial load that the belts put onto the bearings.

CONCLUSION

In this Internship, we have gained a lot of knowledge in Transformers and Motors confidence on Electrical applications.

We worked on high voltage sections which increased our Electrical applications.

We observed the dismantling and assembling procedure of transformers and motors.

We Witnessed to Test the Transformers and Motors to ensure the Healthiness of the same with which we gained the ability to test the Transformers and motors.

We also learned to Identify the Faults occurred in Transformers and Motors and the ways to Rectify the Faults.

Our Guide and his Team helped us a lot in this Internship to gain more Practical and Theoretical Knowledge of Transformers and Motors.

We Thank NLC India Limited, Neyveli for giving us this Opportunity to Practically work with Transformers and Motors

REFERENCE

WEBSITES:

ELECTRICAL ENGINEERING PORTAL -https://electrical-engineering-portal.com/

ELECTRICLAS4U-https://www.electrical4u.com/

BOOKS:

PS BIMBRA (Reference books)- best book for building concepts.