Ministry of Higher Education

and Scientific Research

Al- Mustaqbal University College

Department of Medical Instrumentation Techniques Engineering

تكنولوجيا الكهرباء

Electrical Technology

Lecture 1

Lecture Name: TRANSFORMER

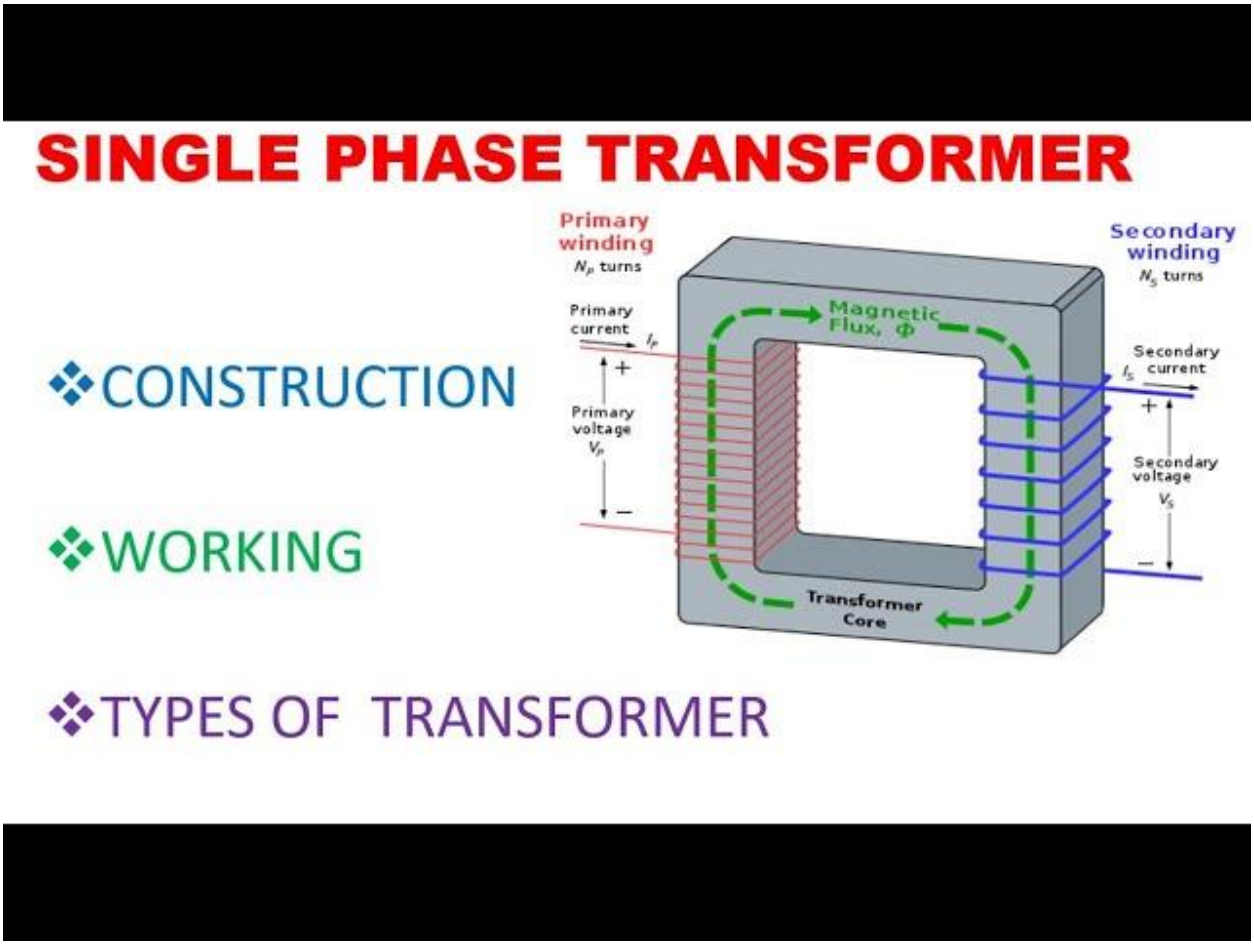
By

Dr. Jaber Ghaib Talib

TRANSFORMER

Single-phase transformers

A transformer a static electrical device that changes ac electric power at one voltage level to ac electric power at another voltage level through the action of a magnetic field.



Why Transformers are Important

• The first power distribution system in U.S. was 120V dc

system invented by Thomas A. Edison to supply power for

incandescent light bulbs.

• Edison’s first central power station went into operation in New

York city in 1882.

• The power was transmitted at very low voltage level, thus

requiring a very large current to supply significant amount of

power resulting in high power losses.

• To avoid this problem central power stations were located

every few blocks of the city.

• The invention of transformer and concurrent development of

ac power sources eliminated these restrictions foreverA transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. The

principal purpose of a transformer is to convert ac power at one voltage level to ac power of the same frequency at another voltage level.

I. Construction

• There are two types of cores;

1. One type consists of a simple rectangular laminated piece of steel with the

Transformer windings wrapped around two sides of the rectangle. This type of

Construction is known as core form.

2. The other type consists of a three-legged laminated core with the windings

Wrapped around the center leg. This type of construction is known as shell form

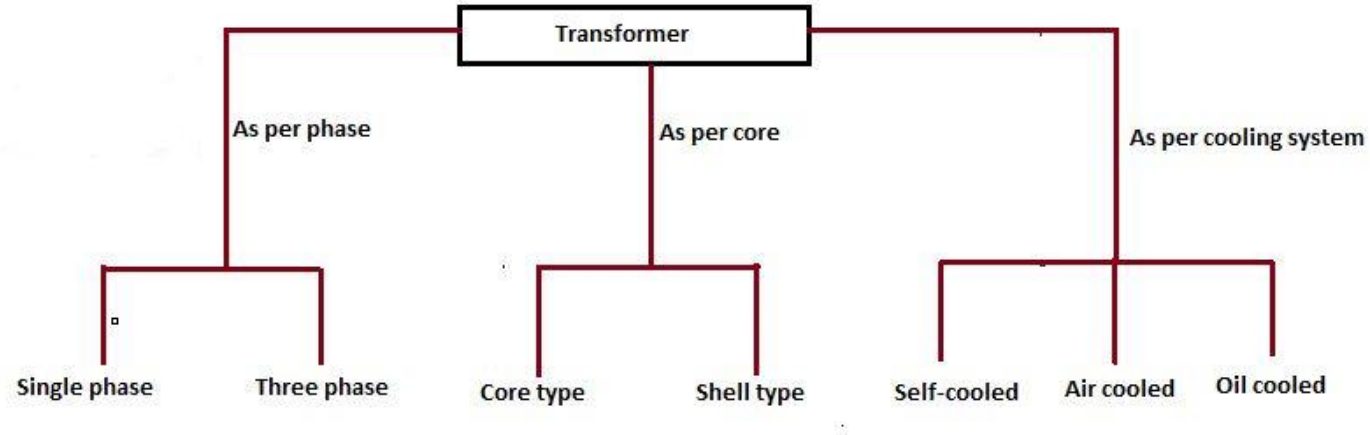
STRUCTURE OF TRANSFORMER

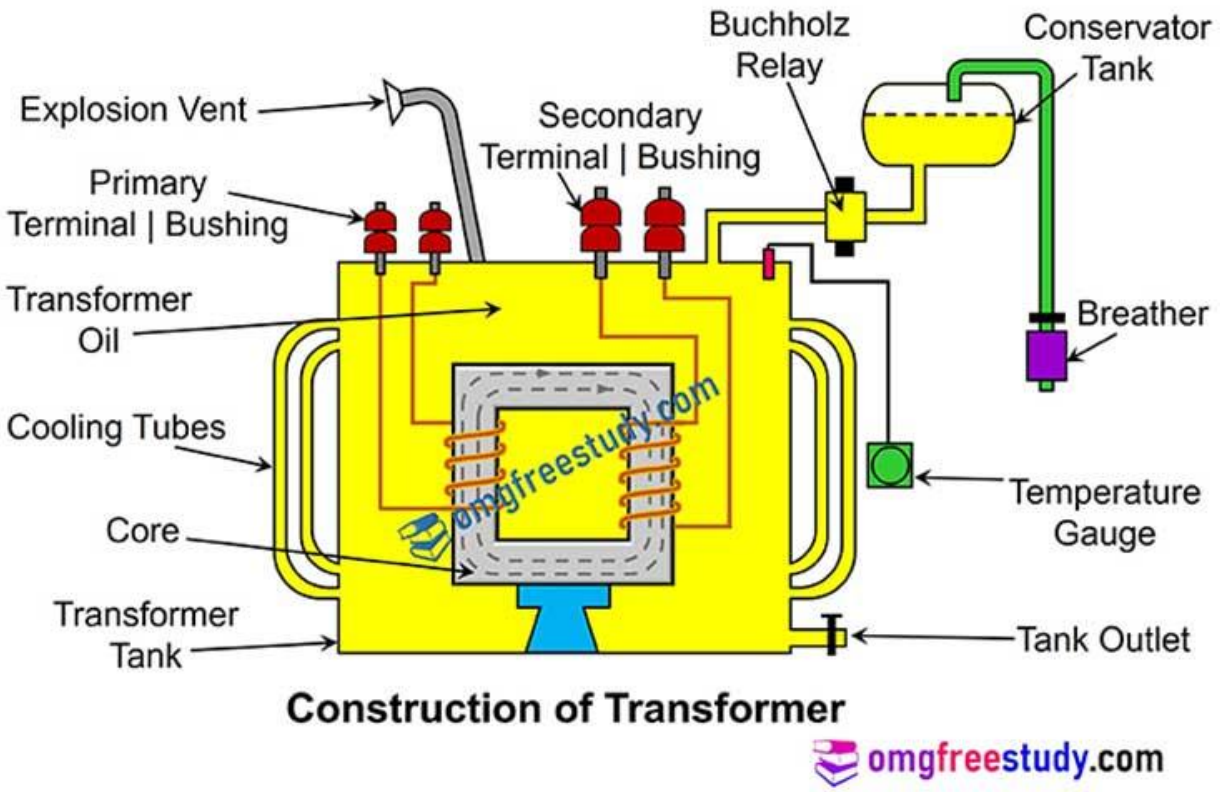
The transformer two inductive coils, these are electrical separated but linked through a common magnetic current circuit.

• These two coils have a high mutual induction.

• One of the two coils is connected of to alternating voltage. this coil in which electrical energy is fed with the help of a source called primary winding (P) shown in fig.

• The other winding is connected to a load the electrical energy is transformed to this winding drawn out to the load. This winding is called secondary winding(S) shown in fig.





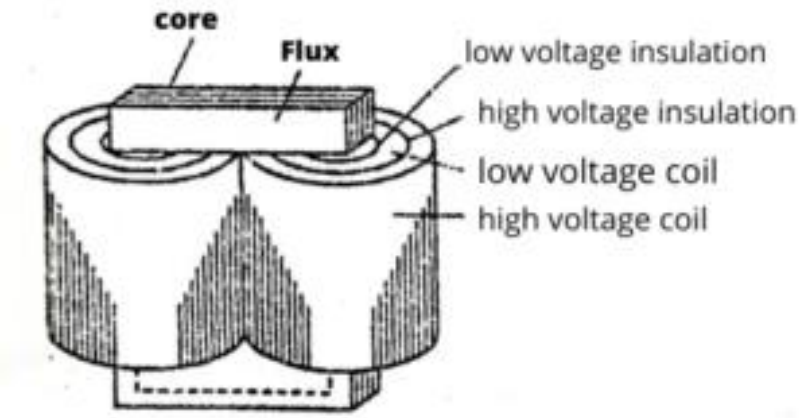
Construction of Transformer

There are two types of a single-phase transformer-

(a) core format

(b) shell format

(a) core format transformer- In this transformer, L-shaped leaves are applied and the coil is almost around the iron core. A single magnetic path is formed in this type of transformer. The general arrangement of a phase-type transformer is shown in the figure below. There are two types of a single-phase transformer

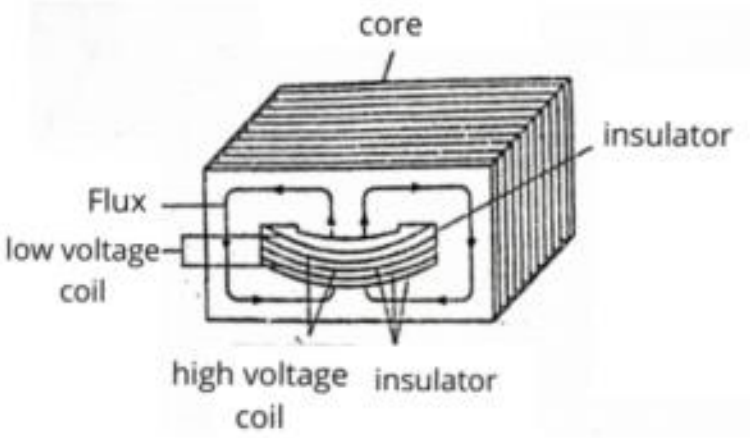


Core format trasnformer

What is a Single Phase Transformer?

In a phase core type transformer, the core is collected in a rectangular form.

(b) shell format transformer- E-shaped cores are used in this transformer. The central limb of the E core is made twice the width of the edge foot.



On this central foot, the primary and secondary coils are separated and placed or wrapped in a sandwich method. And in a typical transformer, the core surrounds the coil and the core is in the form of the English letter 8. There are two magnetic circuits in this type of transformer since in this transformer the core is applied in the form of a shell on the coil, **so it is called a shell type transformer**. In this

type of transformer, the flux erosion is less, but this transformer is slightly heavier than the core type transformer.

The main parts of a single-phase transformer are:

(i) Core- The core in the transformer forms a magnetic path for the flux. Mainly in transformers 'E', 'I', 'L' and 'U' shaped laminated cores are used.

(ii) Winding- There are two types of windings in a transformer.

(1) primary winding And **(2) secondary winding**

Both windings are made of super enameled copper or aluminum wires. The number of turns in these coils depends on the transformer's transform ratio and the cross-sectional area of the wire used in the coils, the current carrying capacity of the transformer. The side of the transformer where the supply is provided is called the primary side and the side where the load is applied is called the **secondary side**.

(iii) Insulation- To insulate both the coils from each other and between the different layers of each coil a special type of insulated paper is used, such as Prasfan paper, Ladoride paper, special pressboard, fiber sheet, varnished paper, kraft paper, etc.

(iv) Tank- The part in which the transformer is kept is called the tank. This M.S. is Made of the sheet. For natural cooling, ventilation ducts are left in the tank for air circulation, while for oil cooling, hollow tubes are made on the outer surface of the tank. Transformer oil is filled in these tanks for cooling.

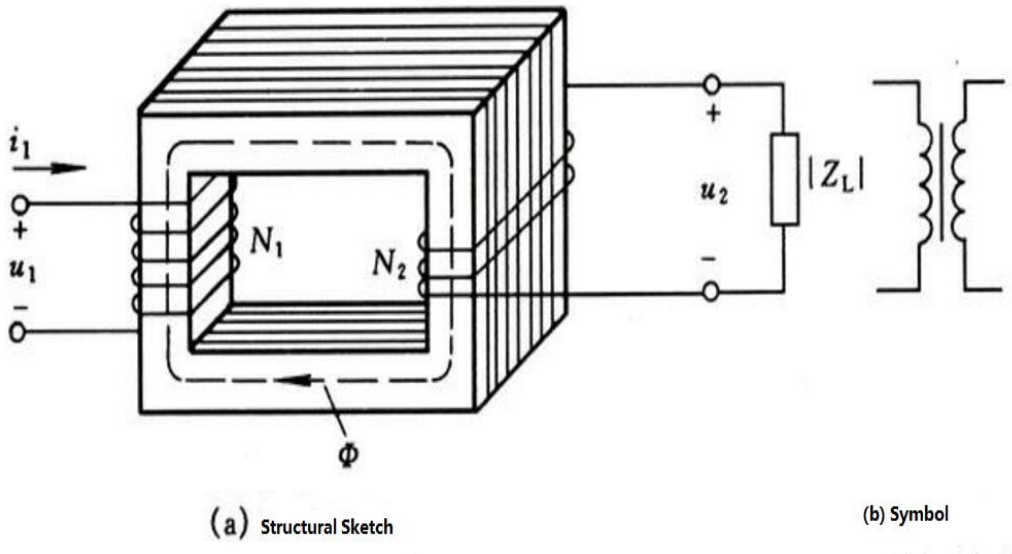
(v) Terminal box- The terminal ends of the primary and secondary coils are mounted on the terminals of the terminal box, the terminals are usually made of

brass and the terminal plate is made of Bakelite sheet or some other insulating material. The terminal box is mounted on top of one of the sides of the tank.

(vi) Other goods- Apart from the above, some other accessories are also used for the proper operation of large power transformers, such as a breather, book hole relay conservator tank, vent pipe and diaphragm, tape changer, etc.

Structure of Transformer

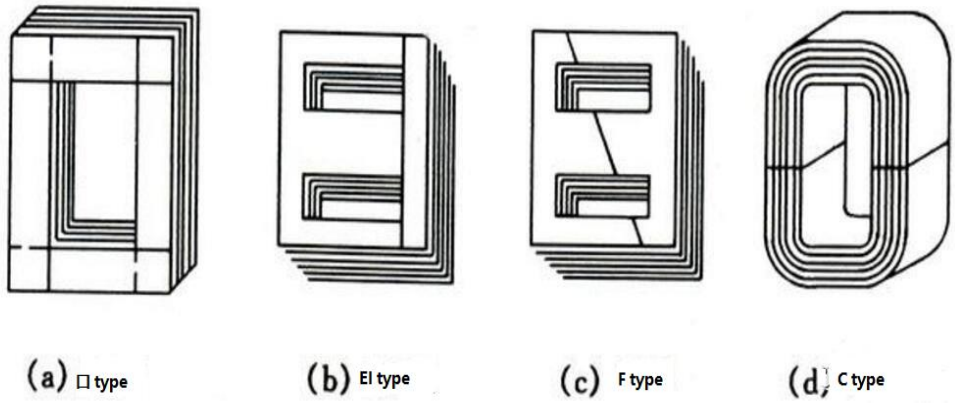
The transformer consists of two basic parts, the core and the winding, as shown in the figure below, which is its schematic diagram and symbol.



structure diagram and symbol of transformer

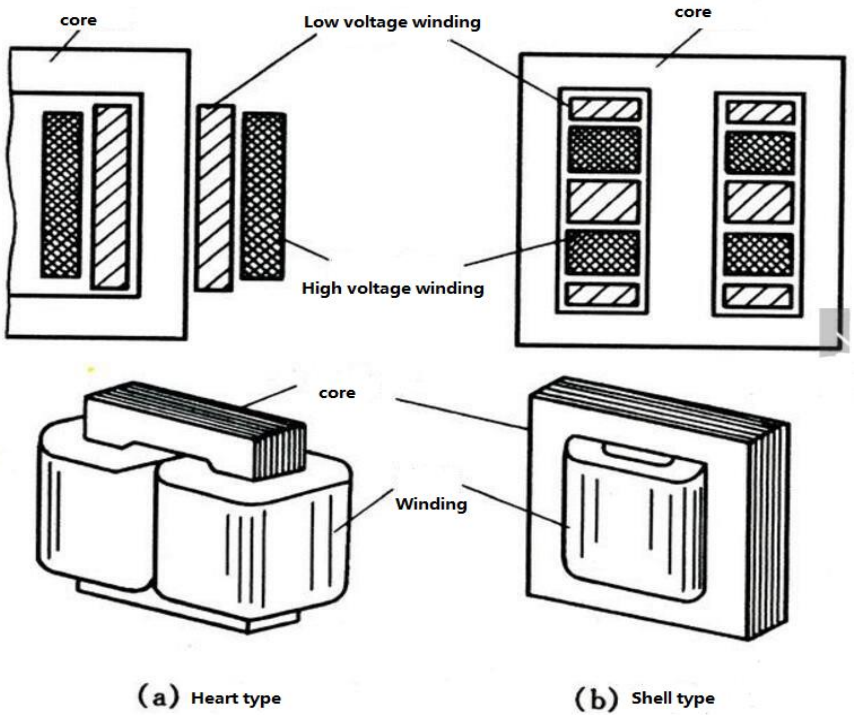
This is a simple two-winding transformer with two windings on a closed core, insulated between the windings and the windings and between the windings and the core.
The windings are usually wound with insulated copper or aluminum wires. One of the windings is connected to the power supply and is called the primary winding. The other winding is connected to the load and is called the secondary winding.

In order to reduce the hysteresis loss and eddy current loss in the iron core, the iron core of the transformer is mostly laminated with a silicon steel sheet of 0.35-0.5 mm thick. In order to reduce the magnetic resistance of the magnetic circuit, a staggered stacking method is generally adopted, that is, each layer of silicon steel sheet is used. The seams are staggered. The following figures show several common core shapes.



several common core shapes

The transformer can be divided into two types, a core type and a shell type, according to the combination of the iron core and the winding, as shown in the following figure.



The core of the core transformer is surrounded by windings, which use less iron and are used for large-capacity transformers, such as power transformers.

The winding of the shell-type transformer is surrounded by a core lock. It uses a lot of iron, but does not require a special transformer casing. It is often used in small-capacity transformers, such as transformers in various electronic equipment and instruments.

1.1 Dry-type Transformer Structure

The dry type transformer is mainly composed of a core composed of silicon steel sheets and a coil made of epoxy resin. An insulating cylinder is placed between the high and low voltage coils to increase electrical insulation, and the coil is supported and restrained by the spacer, and the fasteners of the parts are overlapped. Both have anti-loosening properties.

Construction performance: (1) solid insulation enveloping winding (2) does not enclose winding.

Winding: Among the two windings, the higher voltage is the high voltage winding and the lower is the low voltage winding. From the relative positions of the high and low voltage windings, the high voltage can be divided into concentric and overlapping types. Concentric windings are simple and easy to manufacture, all using this structure. The overlapping type is mainly used for special transformers.

1.2 Oil-immersed Transformer Structure

The main structure of the oil-immersed transformer is composed of a body, a fuel tank, a cooling device, a protection device and an outlet device. The body includes a core, a winding (winding), insulation, a lead and a tap changer; the fuel tank includes a fuel tank body and a fuel tank accessory (a drain valve, a ground screw, a trolley, a nameplate, etc.); the cooling device includes a radiator and a cooler; The protection device comprises an oil storage cabinet, an oil standard, a safety air passage, a moisture absorber, a temperature measuring element and a gas relay; the outlet device comprises a high and low-pressure sleeve.

1.3 The Main Components and Functions of the Transformer

(1) Iron core: The iron core of the transformer is the path of the magnetic flux line, which concentrates and strengthens the magnetic flux and is used to support the winding.

(2) Winding: The winding of the transformer is the path of current, the current is passed through the winding, and the induced electromotive force is generated by electromagnetic induction.

(3) Fuel tank: The fuel tank is the outer casing of the oil-immersed transformer. The main body of the transformer is placed in the fuel tank, and the tank is filled with transformer oil.

(4) Oil pillow: The oil pillow is also called an auxiliary oil tank. It is a round barrel container made of steel plate. It is horizontally installed on the transformer fuel tank cap. It is connected with the fuel tank by a curved connecting pipe. The oil pillow is equipped with an oil level

indication at one end. The volume of the oil pillow is generally 8% to 10% of the volume of the oil contained in the transformer tank.

Its function is that the inside of the transformer is full of oil, and because the oil level in the oil pillow is within a certain limit, there is room for manoeuvre when the oil expands and contracts at different temperatures, and the position of the air pillow is small so that the oil and air are in contact with each other. The possibility of oil moisture and oxidation is reduced. In addition, the oil in the oil conservator is much lower than the oil in the upper part of the tank and hardly convects the oil in the tank. A gas relay is installed on the connecting pipe of the oil pillow and the fuel tank to reflect the internal fault of the transformer.

(5) Respirator: The respirator contains a desiccant, silica gel, to absorb moisture from the air.

(6) Explosion-proof pipe: The explosion-proof pipe is installed on the fuel tank cap of the transformer. The top end of the explosion-proof tube is equipped with a piece of glass. When a fault occurs inside the transformer, high pressure is generated, and the gas inside the oil breaks through the glass sheet and is discharged to the outside of the tank to release the pressure, thereby protecting the transformer tank from being damaged.

(7) Thermometer: The thermometer is installed in the side temperature cylinder on the fuel tank cap to measure the temperature of the upper oil in the fuel tank.

(8) Bushing: The bushing is an insulating device that leads the leads of the high and low voltage windings of the transformer to the outside of the tank. It is both the insulation of the lead to the ground (the outer casing) and the role of the fixed lead.

(9) Cooling device: The cooling device is a device that dissipates the heat generated by the transformer during operation.

(10) Oil purifier: also known as temperature difference filter. Its main part is a cylindrical net oil tank welded by steel plate, which is installed on one side of the transformer tank. The tank is filled with adsorbents such as silica gel and activated alumina. In operation, due to the temperature difference between the upper oil and the lower oil, the transformer oil flows from top to bottom through the oil purifier to form convection, and the oil is in contact with the adsorbent, wherein the water, acid and oxide are absorbed so that the oil Get purified.

Extend the life of the oil. The oil purifier of the strong oil circulation transformer relies on the oil flow pressure difference to make the transformer oil flow through the net oil pump to achieve the purpose of purification.