

The principles of the Electrical Transformers operation

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The transformer is the electric device that transforms electric energy between two or more circuits through the means of electromagnetic induction. The varying current is induced in the primary coil of a transformer which produces the varying electromotive voltage in the secondary coil of the transformer.

The power induced in the transformer's primary coil can be transferred between two coils by a magnetic field. It is done without any metallic connection between the coils. The principle of the transformer operation was discovered in 1831 by Faraday, who developed Faraday's law of induction, which explains the effect of electromagnetic induction. Based on the Faraday law of induction, transformers are used to decrease and increase the alternating voltage in the electric power application. Since the invention of the transformer, it has been important in the distribution, transmission, and utilization of the alternating current of electrical energy. There is a wide range of electrical transformer designs seen in electric power and electric applications. It has a different size, ranging from an RF transformer that is less than a cubic centimeter in volume capacity to a power grid transformer that weighs hundreds of tons (Allan, 1991; Mack & Shoemaker, 2006).

The varying current in the primary coil or winding creates the varying magnetic flux in the transformer's core and the varying field of the magnetic impinging on the secondary coil or winding. The magnetic field at a secondary coil normally induces the varying voltage of EMF in the secondary coil because of the electromagnetic induction. Both secondary and primary coils are wound around the core of endless magnetic permeability. Therefore, all the magnetic flux passes through the secondary coil and primary coil. Transformer current flows in the indicated direction depending on the polarity. The transformer coil voltage ratio is directly proportional to the number of coils that are wound on the core. Therefore, if the number of coils in the primary winding is less than that of the secondary, the current induced in the primary coil will be less than that produced by the secondary coil. Otherwise, if the secondary coil turns less than the primary coil turns. The current induced in the primary coil will be more than that produced in the secondary coil. This is according to the law of the conservation of energy (Hameyer, 2001; Khanchandani, 2008).

Types of the Transformers

Electric transformers are of different types depending on the purpose of the design. Despite the different transformer designs, all transformers employ basic principles similar to those discovered in 1831 by the scientist Michael Faraday, and they share several main functional parts. *The following are the types of the transformers:*

Laminated core transformers: This is the common type of transformer that is widely used in the transmission of electric power. It is applied to convert the primary voltage to lower voltage to that power that is efficient for an electronic device. This transformer is available in power that ranges from mW to MW. The insulator in the lamination reduces eddy current from being lost in the iron core. The transformer can be used in the split bobbin.

Toroidal transformer: This is a ring-shaped transformer wound on a ring-shaped core. It takes up minimal space in the device and has a low magnetic field compared to the rectangular transformer.

Autotransformer: A transformer is tapped at various points in the windings. The voltage produced in the transformer varies depending on the point connected to the coil. The voltage produced increases with an increase in the turns of the winding at that particular point.

Polyphaser transformer: It is a single-build transformer with multiple windings inside it. For example, the three-phase transformer has three windings of the primary coil that induce its electromagnetic field to three windings of the secondary coil, which is connected. Connection examples of the transformer are wye-wye, delta-delta, delta-wye, and wye-delta.

Grounding transformer: It is the transformer connected to the delta form in the more polyphase system with supply accommodate phase to the neutral load by giving the return path of the currents to neutral. This transformer incorporates the single coiling transformer with the zigzag coiling configuration but can also be created through a wye-delta isolated coiling transformer connection.

Resonant transformer: This transformer has a capacitor on both windings or a single winding across the coil that functions as a tuned circuit. It is used at radio frequencies and electronic ballasts.

However, other types of transformers include ferrite core transformers, planar transformers, constant voltage transformers, stray field transformers, oil-cooled transformers, isolated transformers, and many others that are designed for different purposes (Mack & Shoemaker, 2006).

How the transformer works

Transformers is based on the simple fact of electricity. When an alternating electric current travels through the wire, it normally generates magnetic fields, which are also known as magnetic fluxes (the invisible pattern of magnetism). The strength of the magnetic flux density is always directly proportional to the number of electric currents. Therefore, the stronger the magnetic field is, the bigger the current size. Also, when the magnetic field alternates around the piece of the wire, it normally generates an electric current to the wire. Therefore, if we put the secondary winding next to the primary coil, the current in the secondary wire will automatically be induced. The current in the primary winding is known as the primary current, and that in the secondary winding is known as the secondary current. The current from the primary coil is induced in the second coil through space, which is known as electromagnetic induction. The current in the primary coil induces a magnetic field,

and then the magnetic field induces the current in the secondary coil. Electric energy can pass efficiently from the primary coil to the secondary coil by wrapping the wire on the soft iron bar or core. The number of turns on both coils determines the amount of current that can be produced. It turns on the secondary and primary, which are the same number, and the current in the primary coil will be the same size as the current in the secondary coils; this is the same as connecting the direct secondary coil with the primary coil. If the secondary coil turns more than the primary coil, there will be an increase in the current produced in the secondary coil. The application is used in the step-up transformers where the current that enters the transformer (primary coil) will be less than currently produced by the transformer (secondary coil). On the other hand, when the secondary coil turns less than the primary coil, it leads to a decrease in the current produced by the transformer as compared to the current taken in. It is the basic application of the step-down transformers where the current taken by the transformer (primary coil) is more than the current produced by the transformer (secondary coil). This is applied to the induction charger, where the current absorbed by the charger from the main is more than the size of the current produced by the charger. At some time, the charger becomes the worm because of the difference in the current input and current output. The electric energy produced by the transformer is less than the electric energy feed. Therefore, it produces waste heat to equalize the energy difference (Khanchandani, 2008).

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