GROUP CONNECTION OF TRANSFORMERS

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Abstract: For a three-phase electric transformer, the connection group refers to the specific arrangement of the primary and secondary windings of the transformer. This determines how the windings are connected to form a particular configuration and is necessary to ensure the correct voltage and phase ratios between the input and output.

Key words: Y-Y and Star connection, Y-D connection, harmonic reduction, Z-connection group, electric micromachines, single operation mode, short circuit mode, load operation mode.

Introduction: A transformer is a static (non-rotating) electromagnetic converter that converts alternating current voltage (frequency f = const in this process). However, since the working principle of the transformer is based on the phenomenon of electromagnetic induction, like that of electric machines, and the physical processes in alternating current machines are similar to those of transformers in many ways, studying the basics of the theory of transformers in this course allows for a deeper understanding of the theory of alternating current machines.

Electric machines are classified as.

By power:

1) up to 500 W - electric micromachines;
2) 0.5< P<10 kW — low power;
3) 10<P< 200 kW — medium power;
4) power P>200 kW — high power;

according to the rotation frequency:

a) n = 300 rpm. to - low speed;
b) n = 300 + 1500 rpm - medium speed;
d) 1500 < n < 6000 rpm - high speed;

e) n > 6000 rpm - high-speed electric machines.

In the process of using transformers, there are mainly three types of operating modes.

1. Normal operation mode. The mode in which the primary winding of the transformer is supplied with rated voltage and the secondary winding is unloaded is called its pure operation mode.

2. Short circuit mode. If the secondary winding of the transformer operating at nominal load is accidentally short-circuited, then this mode is called short-circuit mode. In this case, a current 10-20 times larger than the rated current can pass through the circuit breaker. In this case, the relay protectors will be activated and disconnect it from the electrical network at once, otherwise, major malfunctions may occur in the transformer.

3. Download mode. In this mode, loads of its characteristic sizes are connected to the transformer, and it works in the nominal state. To determine the parameters of a short-circuit transformer, a short-circuit experiment is used. If a Zn load is connected to the secondary winding of a transformer in a single-mode operation, the load current (I) 2 is generated. In this case, it is not necessary to take into account the voltage drop in the primary coil chain, since it is small. This mode of operation is a load mode. A transformer whose secondary parameters are equal to the primary can be replaced by an equivalent circuit. Therefore, the electrical circuit equivalent to the given transformer is called the equivalent circuit of the transformer. On the basis of the equivalent scheme, the analysis of the electromagnetic processes in it and the calculation of the power network connected to the transformer are much easier. The main factor in the distribution of electricity from long distances to consumers, measurement works and the creation of a general energy system is the use of transformers.

Let's take a closer look at the simple operation mode of the transformer. In salt mode, the current in the secondary circuit is zero, but the current in the primary circuit is not zero. When the secondary circuit is disconnected, the current in the primary circuit is called the operating current and is denoted by λ s. In the technical description of the transformer, the value of the primary circuit voltage equal to the nominal value is given as the operating current. The operating current is 2-10% of the nominal current In. Power loss in salt mode means loss in the steel core. This waste is the residual currents in the core and the power lost in the process of remagnetization. This is denoted by the letter israf and is referred to as steel israfl. The parameters necessary for the operation of the transformer are calculated only by the operating current and steel consumption. Therefore, these two quantities are necessarily given in the technical description of the transformer. The power loss of the transformer is only 0.2-0.8% of the rated power.

Primary Section: For a three-phase electrical transformer, the connection group refers to the specific arrangement of the primary and secondary windings of the transformer. It determines how the windings are connected to form a specific configuration and is necessary to ensure the correct voltage and phase ratios between the input and output. The choice depends on the specific application, voltage requirements and electrical system design. Different countries and regions may have their own standards and preferences for transformer connection groups, so local practices should also be considered.

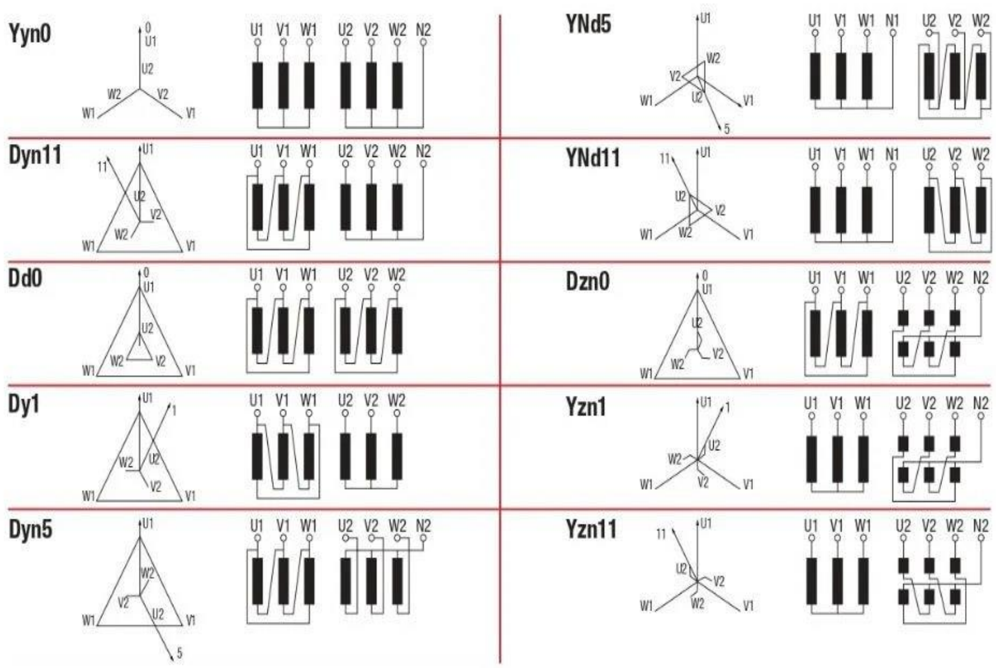
Common applications and connection groups are as follows: The phase windings of three-phase transformers are interconnected to provide a three-phase, three- or four-wire supply through three different connection modes.

A) mesh or delta connection

B) star connection

C) zigzag connection

Each of them can be reached in two ways. Primary and secondary can be treated in two ways, so at least twelve ways of connection are possible. Twelve methods are shown in Fig



They are divided into the following four main groups according to the phase shift that exists between the line voltages on the two sides of the transformer.

Group 1: zero phase shift (Yy 0, Dd 0, Dz 0)

Group 2: 180° phase shift (Yy 6, Dd 6, Dz 6)

Group 3: 30° delay phase shift (Dy 1, Yd 1, Yz 1)

Group 4: 30° lead phase shift (D y11, Y d11, Y z11)

It was observed in group 4 that if the voltage of the HV line is maximum, the voltage of the lv line is increased by 30°. With group no. 1 has no phase shift, but group 2 gives a 180° phase shift. Group 3 leads to a delay of lv line voltage by 30 °. The main requirement for parallel operation of transformers is that the transformer connections belong to the same basic group.

A Zig-Zag connection is an example of a partial winding, and its effect is to reduce third harmonics in the line-to-neutral voltage as well as in the line voltage.

Ezoic: Compared to a normal phase connection, each phase requires 15% more turns for a given total voltage, which may require an increase in the size of the frame typically used for a given rating. Nevertheless, the advantages of the zig-zag arrangement may offset the costs; unbalanced loads on the secondary side are better distributed on the primary side. Zig-zag-star connection is used in HV transformers in cases where delta connections are mechanically weak (due to the large number of turns and small copper pieces); also for rectifiers.

Yy or Y-Y: This configuration connects the primary and secondary windings in a "Y" or "star" configuration. It is characterized by a neutral point in the primary and secondary windings.

Distribution Transformers: Yy is commonly used in distribution transformers that supply power to residential, commercial and industrial areas. The yy configuration allows for a grounded neutral point, which is important for safety and handling unbalanced phase loads.

Grounding: The Yy configuration provides a neutral point that can be connected to ground for safety and protection against fault currents.

Low Voltage Systems: Yy connections are often used in low voltage systems where a neutral point is required for practical and safety purposes.

Dd or D-D: In this configuration, the primary and secondary windings are connected in a "delta" configuration. There is no neutral point in this arrangement. Isolation transformers: in situations where electrical isolation is critical, such as in sensitive electronics or where there are strict safety requirements, the Dd configuration is used to provide electrical isolation without a grounded neutral point.

Industrial Applications: Dd transformers can be found in industrial settings, especially where it is important to maintain a constant voltage ratio between the primary and secondary sides. This is often found in manufacturing processes and heavy industry.

Special voltage ratios: In cases where a specific voltage ratio must be maintained without neutral connections, the Dd configuration is a suitable option.

Yd or Y-D: This arrangement connects the primary winding in a "Y" configuration and the secondary winding in a "delta" configuration.

Phase Splitting: The Yd configuration can be useful when a three-phase supply needs to be split into two-phase sources. This can be useful in certain industrial processes or loads that require such adjustment.

Neutral Current Reduction: In cases where the load on the secondary side is unbalanced and produces significant neutral current, using a Yd setting on the primary side can help reduce this neutral current.

Transformer Taps: Some transformers have multiple taps on the primary winding, which allows the turns ratio to be adjusted. Yd connection can be one option that offers versatility in transformer application.

Dy or D-Y: Connects the primary winding in a "delta" configuration and the secondary winding in a "Y" configuration.

Voltage step-down: Dy settings are often used when it is necessary to step down the voltage from the primary side to the secondary side of a transformer while providing a neutral point on the secondary side.

Load balancing: It helps in balancing unbalanced loads on the secondary side and limits the flow of zero sequence current in case of earth fault, which can be useful in certain industrial applications.

Harmonic Reduction: A D-Y connection helps to smooth out harmonics in the electrical system. A delta winding can suppress some of the harmonics that may be present in the load.

Conclusion: Why is a three-phase system preferable to higher phases? The three-phase system is universally used for the generation, transmission and distribution of electricity.

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