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Comparison and Selection of Three-Core Cable and Single-Core Cable

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Comparison and Selection of Three-Core Cable and Single-Core Cable

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Abstract. The selection of three-core and single-core power cables generally follows the following rules: three-core cables are selected under the condition of 6-10 kV voltage, and single-core cables are selected when the voltage level is 66 kV or above. However, 35 kV voltage grade cable has both three cores and single core. How to choose the right one is a difficult problem for engineers and technicians. Through the analysis and comparison of 35 kV three-core cable and single-core cable, the applicable environment and conditions of each cable are defined, which can provide reference and help for the majority of electric power technicians in choosing cable in engineering practice.

1. Introduction

With the acceleration of urbanization, the proportion of cable application in power lines is getting higher and higher. Power cables are generally divided into two categories: 66 kV and above are high voltage cables; 6 kV to 35 kV are called medium voltage cables. In order to solve the problem of phase insulation, high voltage power cables usually adopt single core type. Because of the low voltage of medium voltage cable, the insulation between phases is no longer a bottleneck problem, so the three-core type is generally adopted in this case. However, there is a special case, if the load capacity is large, the required cable section is particularly large. For example, if the section of 35 kV cable reaches 630 mm² or more, and if it is made into a three-core cable type, there are various difficulties in manufacturing, transportation and laying facilities. At this time, the cable should be made into a single core.

The problem studied in this paper is how to select single-core and three-core cables when the cross-section of cables is 400 mm² or 500 mm², which are often used in 35 kV cable engineering. Because by inquiring the catalogue of cable products, 35 kV cables with these two cross-sections can be manufactured, regardless of the three-core or single-core, without any difficulty in processing.

2. Comparison of Three-core and Single-core Cables of the Same Section

2.1. Comparison of structural parameters between three-core cable and single-core cable.

A comparison is made between 35 kV three-core XLPE armored cable with 400 mm² and single-core XLPE cable. Fig. 1 and Fig. 2 are the structure diagrams of three-core cable and single-core cable respectively.



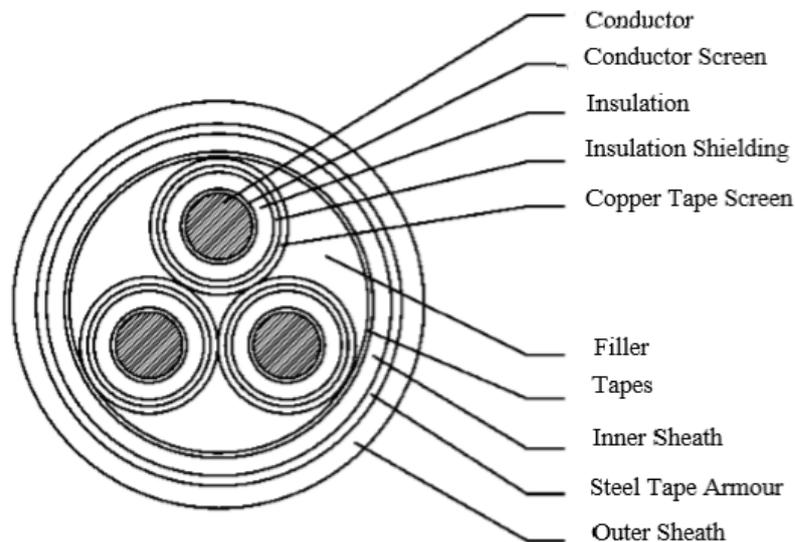


Fig.1 Structural diagram of three-core cable

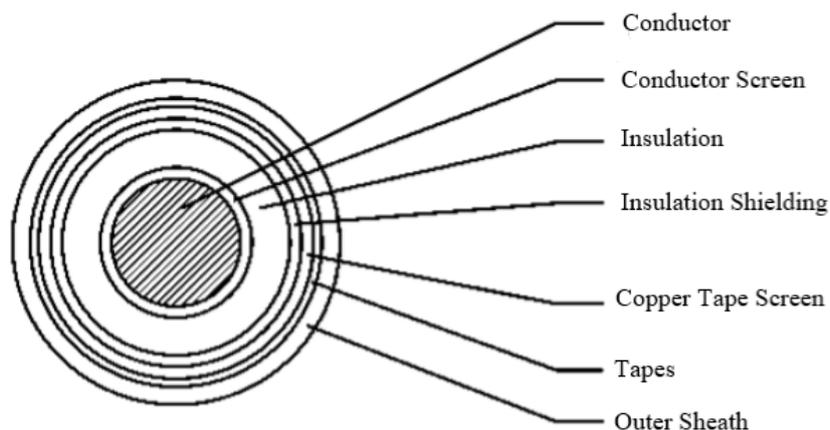


Fig.2 Structural diagram of single-core cable

Table 1 is a comparison table of structural parameters of two types of cables.

Table 1. Comparison Table of Structural Parameters of two types of Cables

Nominal Cross Section [mm ²]	Diameter [mm]	Insulation Thickness [mm]	Outer Sheath Thickness [mm]	Approximate External Diameter of Cable [mm]	Cable's Weight [kg/km]
Three-core	23.5	10.5	5.0	125.1	23390
Single-core	23.5	10.5	2.9	60.5	6340

From table 1, it can be seen that the conductor cross-sectional area and insulation thickness of a single-core cable of 400 mm² are consistent with those of a three-core cable. The difference lies in the thickness of outer sheath, approximate outer diameter of cable and cable's weight. The outer diameter

of the three-core cable is about twice that of the single-core cable, and its weight is 3.7 times that of the single-core cable.

2.2. *Applicability comparison of three-core cable and single-core cable*

Now let's compare the application of three-core cable and single-core cable in engineering.

From the perspective of application scope and laying environment: Three-core cables are generally laid indoors, tunnels and cable trenches, which can withstand certain mechanical external forces and tensions; they can be directly buried with armour; they can also be laid in various pipes containing magnetic pipes. Single-core cables are generally laid indoors, tunnels and cable trenches, which can not withstand external mechanical forces; they are not armoured and are not allowed to be laid directly; cables are not allowed to be laid in magnetic pipes such as steel pipes.

From the aspects of manufacturing and transportation: During the manufacture and transportation of three-core cable, due to the weight limitation of cable disc and cable itself, each cable cannot be made too long. The length of 400 mm² cable generally does not exceed 500 m. For single-core cable, because of its smaller outer diameter and lighter weight, the manufacturing length of single-core cable can not be limited by cable disc and weight, and the length of 400 mm² single-core cable can be up to 1000 m.

From the perspective of floor area: Three-core cable is laid in a pipeline, which can effectively reduce the area occupied. It is especially suitable for multi-circuit line engineering of substation's inbound and outbound lines. Single-core cables need to be laid in three non-magnetic pipes, and the number of pipes needs more; multi-return incoming and outgoing lines in substations are inconvenient to arrange.

Consideration from aspects of construction and installation:

For three-core cables: (1) Three-core cable is not easy to lay, but the laying length is one third of the single-core cable, and the overall construction time is shorter. (2) When three-core cable climbs the multi-loop cable terminal tower, it is easy to arrange the cable. (3) When the three-core cable connects the distribution device in the house, the three-core cable terminal is easy to arrange.

For single-core cables: (1) Single-core cables are easy to lay, but the laying length is three times as long as three-core cables. The overall construction time is longer. (2) When single-core cables climb the multi-loop cable terminal tower, it is not convenient to lay cables. (3) When single-core cables are connected to indoor distribution devices, because of the narrow space, single-core cables are easy to collide with each other, and cable terminals are not easy to arrange.

From the point of view of running condition:

For three-core cables: (1) Three-core cables are protected by armoured steel strips, which have relatively loose requirements for laying environment and have certain protective effect on general external force damage. (2) Three-core cables are covered by three phases and insulated by insulating materials. If the insulating materials are damped and deteriorated, it is easy to cause inter-phase short circuit. (3) If the sheath is damaged locally in long-term operation, it will lead to metal damage. When the shield layer is grounded in many places, the cable can still operate safely, because the metal shield layer of the three-core cable needs to be grounded normally.

For single-core cables: (1) Single-core cables are not allowed to be armoured with magnetic steel strips, so the laying environment is more stringent. Generally, external force damage may cause damage to the cables. (2) Single-core cables are separated by three independent cables, which are far apart from each other. Even if the insulating materials of the cables are damped and deteriorated, the grounding short-circuit of the cables generally occurs, and the inter-phase short-circuit rarely occurs. (3) In the long-term operation, if the local damage of the outer sheath occurs, the cable can not keep safe operation after Multiple Earthing of the metal shield; because the metal shield layer of the single-core cable needs to be grounded unilaterally or cross-connected under normal conditions; if grounded directly, the metal shield layer will produce a large circulation, thus burning the cable.

In addition, the current carrying capacity of three-core cable is 675A and that of single-core cable is 720A. The unit price of three-core cable is \$137 and that of single-core cable is \$157.

3. Comprehensive Analysis

According to the analysis in Table 2, we can draw the following conclusions: Three-core cable and single-core cable have their own advantages and disadvantages in practical engineering application. The advantages of the three-core cable are: the cable itself can be made with steel belt armour, which has a strong ability to prevent external forces from destroying; it covers a small area; it can be laid in various pipes; although construction is more difficult, the overall construction time is short; it is more convenient to climb the tower or enter the substation during installation; even if several local metal shield layers are grounded during long-term operation, it will not affect the safety of line operation. The disadvantages are as follows: due to the limitation of cable disc and its own weight, ordinary cables can not be made too long and transport is inconvenient; too thick cables are difficult to lay and not easy to bend; the carrying capacity of three-core cables is also smaller than that of single-core cables with the same cross-section.

Advantages of single-core cable: easy insulation between phases, not easy to occur short-circuit between phases; convenient cable transportation, easy laying; a long cable can be done, single-core cable with the same cross-section carrying capacity. Disadvantages: Cable itself can not be protected by armour, and its ability to resist external force damage is poor; Cable roots are large, occupying a large area; Cables in and out of substations, outdoor tower climbing is not easy to arrange; Unit cost is higher than three-core cable; Especially in the long-term operation of single-core cable, if the metal shield layer is grounded at multiple points, it is easy to cause circulation, leading to cable heating and eventually burning out the cable.

4. Conclusion

Based on the above analysis, for 35 kV voltage class cables, unless the load capacity is particularly large and the cross-section current of three-core cables can not meet the requirements, it is necessary to select single-core large-section cables. Generally speaking, it is better to choose three-core cable for 500 mm² and below section cables. Because three-core cable has many advantages over single-core cable in terms of circuit safety, unit cost, area and so on, it is in line with the main direction of cable line development.

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