«Сейфуллин оқулары – 18: « Жастар және ғылым – болашаққа көзқарас» халықаралық ғылыми -практикалық конференция материалдары = Материалы международной научно-практической конференции «Сейфуллинские чтения – 18: « Молодежь и наука – взгляд в будущее» - 2022.- Т.I, Ч.V. - P. 205-207

APPLICATION OF NEW INSULATING STRUCTURES AND NEW MODES OF TRANSPORT FOR CABLE POWER LINES

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Almost any company operating electric networks at a voltage of 6, 10 kV and 35 kV deals with power cable lines. In general, cable lines have many advantages over overhead lines: they are smaller, safer, more reliable and convenient to operate. And these are one of the main reasons why most of the electric networks of cities and large industrial enterprises consist of cable power lines [1].

In cable production, various materials are used to insulate wired elements. The main condition for the insulation of cables and wires is that it should not conduct current, therefore, rubber, PVC, polyethylene, fluoroplast or paper are traditionally used as materials here. In some cases, magnesium oxide, varnish, silk or polystyrene are also used as insulation materials [1].

Modern types of insulation of high-voltage cables, comparison and prospects of development

The most widespread are cable lines of low (up to 1 kV inclusive) and medium (up to 35 kV inclusive) voltage. At the same time, new lines for a voltage of 20 kV are mainly built only with the use of cables with cross-linked polyethylene (PE) insulation, for a voltage of 6 and 10 kV, the main insulation materials are PE and paper impregnated insulation [2].

Cross-linked polyethylene insulation is a modern type of solid insulation. The base is an ethylene polymer, a material that has good mechanical properties and dielectric properties. However, these properties are not enough to be used as insulation. However, there is a weak link in the ethylene polymer chain, which, under certain conditions, can be used to connect (stitch) several polyethylene molecules together [2]. The result is a substance whose parts are connected by additional more rigid bonds. It turns out a material that was called cross-linked polyethylene [2].

Cables with cross-linked polyethylene insulation do not have many disadvantages characteristic of cables with paper insulation, therefore, their use allows solving many urgent problems in the reliability of power supply,

simplifying and optimizing the network scheme, reducing the cost of reconstruction and operation of cable lines [3].

Cables with cross-linked polyethylene insulation owe their unique characteristics to the insulating material used in them. At modern enterprises producing cables, the process of crosslinking or vulcanization is carried out in a neutral gas environment at high pressure and temperature [3].

The main advantage of cables with cross-linked polyethylene insulation over paper cables is their low damage. According to foreign data, the percentage of electrical breakdowns of cables with cross-linked polyethylene insulation is tens or even hundreds of times lower than on cables with paper insulation [1].

Cables with cross-linked polyethylene insulation are preferred and have great prospects in the construction and reconstruction of cable lines with a voltage of 6, 10, 35 kV. Due to the unique characteristics, high electrical resistance of insulation, low damage, long service life of insulation made of cross-linked polyethylene cables, their use becomes not only technically sound, but also economically profitable [4]:

- the use of cross-linked polyethylene as insulation allows to increase the capacity of the cable by increasing the permissible core temperature to 90 ℃ (65-70 ℃ for cable with paper-impregnated insulation insulation);

-cables made of cross-linked polyethylene are the most flexible, unlike paper-impregnated insulation, both cables have a low weight, smaller diameter and bending radius;

- one of the most important characteristics of insulation materials is the permissible heating temperature. The higher this indicator, the higher the permissible load currents that can be passed through the power cable for a long time. (the permissible current of cross-linked polyethylene is 250 degrees, which is much higher than the performance of a cable with paper-impregnated insulation);

- high resistance to the formation of water triings (the effect of water on polymer materials (insulation from paper) leads to the formation of water trees (triings) in the thickness of the insulation, which accelerates the subsequent processes of its aging);

- cables with cross-linked polyethylene insulation are more resistant to thermal deformation and have less thermal expansion than cables with paper insulation. Also, one of the negative features of paper insulation cables is the prohibition of their placement in explosive zones, which makes it difficult to use them.

However, the use of cross-linked polyethylene has a number of disadvantages. The experience of using cross-linked polyethylene has shown that electrical breakdown of insulation during single-phase earth faults (OZZ) in 60-70% of cases is self-eliminated and the operating personnel does not fix these emergency modes. The high "durability" of cables with paper-impregnated insulation is due to the specifics of the dielectric medium [4].

One of the main disadvantages of a cable with paper-impregnated insulation is the limited possibility of laying this cable on routes with a significant difference in levels, because the oil-and-vanilla composition tends to drain, while the paper insulation is depleted and has a tendency to premature aging. Insulation made of cross-linked polyethylene does not have such disadvantages. When installing the cable, it must be taken into account that for paper-impregnated cable insulation, the minimum laying temperature without preheating is 0 ℃. For a cable in solid insulation, laying at - 35 (SPE) is possible [4].

However, a significant reason for the introduction of cables with a modern type of insulation is their high cost, as well as the fact that raw materials and production facilities can be found mainly in the West. To solve this problem, it is necessary [4]: creation of an alternative type of cable insulation, which would combine modern technologies and an acceptable price; placement of production facilities in the country, allowing to produce modern types of cables on their own.

TEVOX is an alternative to cables with paper-impregnated insulation and insulation made of cross-linked polyethylene at a voltage of 6, 10 and 20 kV

TEVOX cables can be used in DC electrical networks at values 2.4 times higher than the corresponding AC voltage. It is known that until 2004, in St. Petersburg, cables with paper-impregnated insulation were used to transmit and distribute electrical energy in networks with a nominal alternating voltage of 10 kV with a frequency of 50 V. Cables with cross-linked polyethylene insulation were superior in their characteristics to cables with paper-impregnated insulation. The main disadvantage of cables with cross-linked polyethylene insulation remains their cost. For example, the cost of three meters of APvPu2g-10 1x124/70 cable is more expensive than one meter of ASB2l-10 3x240 on average 60-70% [5].

Power cables of the TAVOX brand with heat-resistant insulation are widely represented by various designs for laying in the ground and in the air, including fire-safe ones that do not spread gorenje when laying in group category A with the index "ng(A)-LS" and "ng(A)-HF" [5].

A feature of the new design of the TEVOX cable is the possibility of operation at a long-term permissible temperature of the conductive cores up to 90 ℃. Cable designs with heat-resistant insulation of a new generation solve the problems of repair and reconstruction of existing cable lines [5].

The cost of cables with heat-resistant paper is 10-15% lower than the cost of cables with polymer insulation, new cables with heat-resistant insulation have a number of advantages over cables with polymer insulation in their performance characteristics [5]:

- the service life is ensured by a high level of insulation protection due to the presence of a metal shell and 2 steel armor bands in the cable structure. Heat-resistant insulation impregnated with a non-flowing synthetic compound has a drop-off temperature of at least 105 ° C. Resistance to single-phase short circuits - "the effect of self-healing of the damage site";

- the cables are stable when exposed to sinusoidal vibrations with a frequency from 1 to 10000 Hz;

- reducing the cost of installing cable lines and reducing the number of connecting fittings by almost two times is achieved due to the increased construction length of the cable on drum No. 22 (by 40%.) Such an increase compared to similar cables with cross-linked polyethylene insulation is achieved due to the presence of a sector-shaped TPJ. Thus, the cost of installing a TEWOX cable is at least 30% lower than analogues due to a longer construction length and fewer couplings;

- the cost of TEVOX cables is comparable to the cost of a cable with paper-impregnated insulation.

Conclusion.This article discusses the existing types of insulation designs for a power cable. Their number of advantages and disadvantages are considered. This topic in the selection of insulation designs is necessary in order to reduce the aging of insulation, limit problems, and also improve the quality of transmitted electricity.

Based on the above, it follows that a cable with SPE insulation has a number of advantages compared to a cable with paper insulation and is almost as good as cables with ethylene propylene rubber insulation. According to the key parameters, modern types of cable insulation are winning, and they are an advantageous prospect for the further development of cable networks.

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