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SECTION 4.

ENGINEERING

ASSESSMENT OF THE TECHNICAL CONDITION OF 6-35 KV CABLE LINES AT ENTERPRISES: METHODS AND PERSPECTIVES

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ABSTRACT

In modern conditions, ensuring reliable operation of elements of power supply systems at enterprises of various industries is a priority task. Special attention is paid to high-voltage cable lines (CL) of 6-35 kV, which play a key role in the smooth operation of industrial facilities.

Wear and degradation of cable insulation are the most common causes of emergency shutdowns, which lead to significant economic losses. Modern methods of assessing the technical condition of CL are often based on the identification of damage that has already developed, or are indirect and destructive of insulation.

This article examines the main factors affecting the technical condition of 6-35 kV overhead lines in industrial enterprises, and also presents promising methods for assessing the condition of cables that ensure increased reliability, safety and economic efficiency.

Keywords: short circuit, cable, coupling, insulation.

The main task in the design of the electrical network and the choice of operating voltage is to ensure economic efficiency. This is achieved by balancing the cost of the necessary equipment, such as generators, transformers, transmission lines, switching equipment, and the increase in cost with increasing voltage. Optimal network voltage and minimization of equipment are key to economic feasibility. The cable is a factory product consisting of insulated conductors enclosed in a protective shell, which can be reinforced with armor to protect against mechanical damage [3, c 21]. Power cables are manufactured for voltages up to 110 kV. Cables for voltages up to 35 kV can have from one to four copper or aluminum cores with a cross section from 1 to 2000 mm^2.

The veins of the smaller section are single-wire, the larger ones are multi-wire. Single-core cables have round cores, and multi-core cables have segment or sector cores. Cables with aluminum cores are most often used, and copper ones are used in special cases, for example, for moving mechanisms or in explosive zones. The insulation of the cores can be made of various materials, including cable paper impregnated with an oil-based composition, rubber, polyvinyl chloride and polyethylene.

Ensuring reliable operation of elements of power supply systems is a priority task at enterprises of various industries, it largely determines the safety of technological processes. Substances and elements involved in these technological processes have a high fire and explosion hazard, and serious damage to elements of power supply systems can lead to emergency situations, which subsequently lead to material losses and harm the environment, and sometimes even lead to deaths [1-3]. It is only because of 6-35 kV cable lines that downtime and emergency failures often occur at industrial enterprises, this is due to their moral and physical wear and tear. [4]. Special attention is paid to high-voltage lines.

To date, methods for assessing the technical condition of 6-35 kV cable lines are either based on identifying the parameters of previously developed damage, or are methods that indirectly destroy insulation. For example, due to the threat of insulation breakdown, the high rectified voltage test used today leads to a decrease in the operating time of cable lines.

Therefore, determining the technical condition with the exception of breakdowns and burning of cable insulation, as well as with the greatest accuracy and minimum time is considered a priority and economically justified task. Further, considering how these cable lines (CL) are arranged at enterprises, the following main points can be distinguished: branches of the network [5; 6], which is characterized by a large number of transitions, bends; a considerable number of connections in the form of couplings (Figure 1); height differences, different heights, such a location complicates the maintenance of the object [7].

Figure 1. Connection of cable lines with couplings

In addition, the method of laying CL is also of significant importance, for example, whether in a pipe or in a trench, or underground, or another method [7]. However, any method sets different cooling conditions for the CL, as a result, different throughput, which directly depends on the gasket environment. Therefore, high heat dissipation is quite possible, which entails a change in the operating temperature of the CL, and this is not always acceptable [8].

At oil and gas enterprises, 6-35 kV cable lines are operated in conditions characteristic of this production [9], which strongly affect insulation. This environment is characterized as fire–hazardous and explosive, having large temperature fluctuations, vibration and other mechanical effects, but the most dangerous is the chemical effect on insulation due to the presence of substances in the technological process, which also lead to a change in its quality, and, consequently, to defects entailing failure. That is why the electrical insulating material used in the CL deteriorates, and electrically conductive zones arise.

In order to avoid all this and not allow further bad consequences, timely special maintenance and measures are necessary, but in order to eliminate the problems that have already arisen, repair [10]. The nature of the destruction and the extent of the damaged cable length often depends on the effect of vibrations or concussions on it, which leads to intercrystalline destruction. It is characterized by the growth of crystals in the shell material from which it is made, as well as the loss of the relationship between them, thereby creating grids of small cracks on the shell. This is fraught with the fact that in the future the cracks increase and, as a result, the shell layer cracks. Such sections of the CL are more susceptible to this. in industrial enterprises that are connected to units with high vibration. In addition, those sections of the CL where there are fractures are subject to frequent accidents, this is due to cable laying. Figure 2 shows a photo of a breakdown of a medium-voltage power cable at the place of its bend, which caused a fire in the workshop of the enterprise [5; 8].

Figure 2. Breakdown of the medium voltage power cable at the bend point

As practice shows, testing with increased rectified voltage does not provide further trouble-free service of cables due to the real danger of its breakdown, which naturally leads to a reduction in operating time. This is demonstrated in practice by the fact that if there was no breakdown during the test, then later during operation it may fail.

In addition, one of the disadvantages of this method is the fact that it does not in any way provide reliable information about the real state of the object, but only indicates that the cable is suitable if it has passed the test, and if not, it is not suitable. Such checks are usually considered as indirectly destructive. Among other things, these tests must be performed at the first admission of the CL to work. Comparing cables with cross-linked polyethylene insulation with cables where paper-oil insulation is used, as a rule, the following advantages of cross-linked polyethylene are mentioned: higher permissible temperature in normal operation and short circuits (longer permissible current and thermal resistance); no restriction on the height difference along the cable line route; Easy installation (especially single-phase cables) and operation; lower dielectric constant of insulation (lower "no-load" current); less tangent of the dielectric loss angle (lower insulation loss); Environmental safety due to the lack of oil. The competition in the market of power cables with cross-linked polyethylene insulation is very tough.

Figure 3. 10 kV cable after removing parts of the damaged coupling from it

There are cables with a large cross-section, however, the transportation and costs of such cables are associated with significant difficulties caused by their heavy weight and rigidity, in order to avoid this, cables of smaller cross-sections are used. Cable breakage can occur anywhere along its route and can be caused by various reasons.

However, to determine the location of the damaged area, all types of damage can be divided into two groups: visible and invisible damage. Visible damage is usually caused by mechanical impacts on the cable, such as digging, gouging, sinkholes, bumps, etc.

At the site of damage, it is possible to detect visible traces of cable integrity violations, such as ruptures, cracks, fractures of shells and wires. In addition, changes in the surrounding soil may be visible, indicating the presence of a problem. Invisible damages, on the contrary, are caused by the action of hidden factors such as moisture, corrosion, electrical problems, etc.

Damage can be caused by changes in cable insulation properties, changes in electrical parameters, and other causes that cannot be visibly detected. Special measurements and diagnostic procedures are required to determine the location of invisible damage. Determining the location of a breakage or damage on a cable line can be achieved by various methods. Some of them include the use of special equipment and tools such as cable search, listening, thermal imaging diagnostics and others. In addition, special mathematical models and algorithms can be used to more accurately determine the location of the damage.

However, each method has its own limitations and can only be applied in certain conditions. Therefore, to determine the location of a damaged section of a cable line, an integrated approach is usually used, including the use of several methods and tools simultaneously or sequentially. This allows you to increase the accuracy of determining the location of damage and reduce the time for its detection and elimination.

Diagnostics and prevention of defects in cable insulation play an important role in ensuring the safety and reliability of electrical networks. Various methods and technologies, such as high-voltage testing, measurement of partial discharges and dielectric losses, thermal imaging and others, are used for this purpose. Some methods require the cable to be decommissioned, while others allow you to monitor the status of the line online and in operation.

Due to the design features of 6-10kV cables, their laying methods and the considered effects, the main types of electrical damage to the cable are single-phase earth fault and phase-to-phase short circuit (short circuit), which account for up to 70-90% and 10-30% of the total number of electrical damage [6]. At the same time, it should be noted that a significant part of the single-phase earth fault either self-destructs one second after its appearance, or goes into phase-to-phase closure within the first minute. Such cases account for about 20% of all electrical damage to cable lines.

Conclusions: The assessment of the technical condition of 6-35 kV cable lines in industrial enterprises is an important factor ensuring the safety, reliability and smooth operation of the facility. The use of modern methods that take into account the specifics of the operation of CL in aggressive environments makes it possible to identify damage at an early stage, preventing accidents and reducing risks. Further development of diagnostic and monitoring methods will ensure the necessary level of reliability of power supply at oil and gas enterprises, contributing to staff safety and improving the environmental situation.

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REVOLUTIONISING BUSINESS ANALYSIS USING BIG DATA: AN EFFECTIVE APPROACH FOR INFORMED DECISION-MAKING

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ABSTRACT

In a dynamic and fast-paced business environment, how can organizations make strategic decisions that ensure long-term success and competitiveness? This question is at the heart of leveraging Big Data Analytics for strategic business analysis. Companies can drive informed decision-making and