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INCREASING THE RELIABILITY OF 10 KV POWER SUPPLY NETWORKS WITH INSULATED NEUTRAL IN MINING MINING

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Annotation
The article considers the increase in the reliability of 10 kV power supply networks with an isolated neutral during mining

Keywords: power supply, consumers, electrical networks, isolated neutral, inductance, pollution, overhead lines, short circuit, resistance

Introduction

Improving the reliability of power supply to consumers is a priority for the development of the modern electric power system of Uzbekistan as a whole. The sustainable functioning of the unified grid electric power complex of the Republic of Uzbekistan is largely determined by the reliable and high-quality work of the final link in the system for providing consumers with electrical energy - 6-35 kV electrical networks, operating, as a rule, in isolated neutral mode.

Reliable operation of the electrical network, capable of providing uninterrupted supply of energy to consumers of the required quality and safety of power supply, essentially depends on the solution of the issues of preventing failures of overhead line elements operating in conditions of pollution, moisture, dynamic and thermal overloads.

According to operating experience, it is known that up to 80% of all consumer power supply disruptions occur precisely in electrical networks of 6-35 kV with isolated neutral, and the main cause of damage to electrical equipment is single-phase ground faults, including arc faults [1].

The burning of grounding arcs both in rural electrical networks of 6-35 kV, supplying consumers mainly via overhead power lines, and in urban electrical networks, incorporating mixed air-cable lines, can be accompanied by dangerous thermal and mechanical effects on the electrical equipment of power lines [3].

Under operating conditions, due to the thermal action of the arc on the wire of overhead lines, melting or complete burnout of the wire is possible, which increases the likelihood of an arc fault turning into a multi-phase short circuit with a network disconnection or leads to multi-site insulation breakdowns on the damaged phase [2].

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A break in one or more wires of the upper layer, visible from the ground, is a defect that must be eliminated during repair. A burn and subsequent fall of the wire of overhead lines to the ground leads to interruptions in the power supply, accompanied by material damage, creates a dangerous situation for the life of people or animals that are near the place of the circuit, as well as a fire hazard.

To date, about 40% of overhead lines in Uzbekistan have developed a regulatory resource and more than 80% are in need of technical re-equipment. The duration of consumer outages is about 70 hours per year. The average number of faults causing outages of overhead lines with voltage up to 35 kV is ~25 per 100 km of lines per year. Overhead power lines 10 kV are built on a radial principle of a tree configuration. The cross-sections of the wires decrease in steps from the head sections to the end of the line, there is a large number of redundant connections made using manually operated disconnectors. Protective devices are installed in power centers. The average length of lines along the highway is 16 km, the length of branches is 5-6 km. There is a significant inhomogeneity of the load density.

The traditional power supply scheme for linear pipeline facilities is made according to the main principle, often with a single network redundancy along the main. The features of these schemes are associated with a uniformly distributed nature of the loads, the length along the highway is 50-60 km.

The negative consequences of the impact of an electric arc on the phase wire of overhead lines, as well as the need to limit emergency effects on the electrical network, lead to the task of increasing the speed of detection, elimination, and, if possible, preventing the occurrence of a single-phase arc fault mode, which can be achieved by changing the neutral mode of electrical networks.

In Uzbekistan, on the territory of the South-Western Gissar substations Zharkuduk and Adamtash, 10 kV networks operate either with an isolated neutral or with compensation for the capacitive earth fault current. Moreover, they work in conditions where there are practically no means of limiting currents and voltages in case of single-phase ground faults, so a high accident rate is typical for both those and other networks. The negative consequences of single-phase earth faults in electrical networks with an isolated neutral are the more significant, the longer the network and, accordingly, the greater the values of capacitive currents flowing through the network and at the fault site. Therefore, one of the means of preventing or at least reducing these consequences is the compensation of capacitive fault currents. The compensation inductance is connected to the neutral of the additional transformer, and when the reactor inductance is tuned to resonance with the network capacitance,

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capacitive currents are compensated. However, the effect of the practical implementation of this seemingly simple solution to the problem is, as evidenced by publications, not always positive.

In the research work, the means of limiting the currents of single-phase earth faults and overvoltage's of a 10 kV network are considered, how to choose their parameters, their decisions are based, as a rule, on the results of studies of ongoing transient processes using simplified equivalent equivalent circuits of networks, the use of which leads to the fact that the results of theoretical studies give a certain result.

The experience of the practical use of the proposed means shows that, depending on the specific conditions of implementation, the effect of the use of each of them is either positive or negative. This situation should be considered as evidence that there is a fundamental possibility of using the appropriate means (if there are positive results), but work is needed to identify and clarify the conditions under which the use of one method or another can have a positive effect.

And the negative experience of using certain means can also be considered as a result of their improper use.

To determine ways to improve the efficiency of overvoltage and current limiting devices in case of single-phase ground faults in 10 kV cable networks, it is necessary to find out the reasons for the low efficiency of those means that are used. Simplified models based on single-phase equivalents that do not reflect a number of features, both of the networks themselves and of the transient processes occurring in them, do not solve this problem. The basic model, based on the representation of network elements not by single-phase equivalents, but by three-phase multipoles and equations in phase coordinates, allows taking into account the real network configuration, network element parameters (active resistances, intrinsic and mutual inductances and phase capacitances) and its mode parameters (currents, voltages , phase power), a method of grounding the neutral and reproduce electromagnetic transients in case of symmetrical and asymmetric damage in electrical networks of arbitrary configuration. Therefore, in order to identify factors that reduce the effectiveness of the means used to limit capacitive currents and overvoltages, studies of the operating modes of 10 kV cable networks were carried out using this model.

Networks with an isolated neutral have been studied and, with their short length up to 10-20 km, the single-phase fault current is only a few amperes, the phase-to-earth fault at one point is not an emergency mode, does not require immediate shutdown, and with capacitive currents up to 10-30A, PUE is allowed for some time, sufficient to take measures to eliminate it. However, with the development of electrical networks, their length increases and the historical situation is that networks with an isolated neutral continue to operate with a total length of up to 20-30 km.

Therefore, to identify the operating conditions of equipment during single-phase ground faults in studies of electromagnetic transients in networks with an isolated neutral, a range of lengths from 20 to 30 km is adopted. In order to determine the main influencing factors, the degree of influence of these factors and to assess the possibility of improving the efficiency of the tools used, as well as to illustrate the capabilities of the developed software tools, four characteristic schemes are considered as calculated, differing in the total length of cable lines. For each of the circuits, taking into account its real configuration, using the developed mathematical model, calculations of electromagnetic transients were performed for single-phase earth faults.

Based on the indicators of the rationality of the operation of power supply systems, the neutral modes for overhead and air-cable field networks of 10 kV containing high-voltage electric motors are determined.

Regularities have been identified that allow determining the damaged phase in a 10 kV medium voltage network with a variation in transient resistance at the site of a single-phase short circuit and phase conductivities relative to the ground; it was found that the parameter that unambiguously indicates the damaged phase of the network is the initial phase of the zero-sequence voltage vector.

References

1. Evdokunin G. A., Gudilin S. V., Korepanov A. A. Choice of neutral grounding method in 6-10 kV networks. Electricity, 1998, N 12
2. Opoleva G.N. Schemes and substations of power supply. Directory. M., 2006, p.480
3. Radkevich V.N. Design of power supply systems. Minsk, 2001, p.293.