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USING DEVICES TO ELIMINATE UNSYMMETRY IN ELECTRICAL NETWORKS AND ACHIEVE ENERGY SAVING

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Abstract:

The abstract explores the intricate challenges and potential solutions related to asymmetry in Uzbekistan's contemporary industrial landscape, encompassing diverse sectors such as cotton processing, textiles, and ceramics. With a focus on the rural industrial landscape, where water pumps drive electricity needs, the text delves into the resulting issues like line imbalance and transformer overloads. Various methods for mitigating asymmetry in 0.4 kV distribution networks are discussed, emphasizing the complexity, cost, and efficiency considerations. The text concludes by highlighting the imperative role of automatic correction systems in achieving symmetry, optimizing operational efficiency, and ensuring uninterrupted production in light industry complexes. The discussed technical methods prove effective in neutralizing asymmetry in electrical energy networks, contributing to enhanced consumer potential and operational continuity.

Keywords: voltage, voltage symmetry, network, industry, agriculture, consumption, quality indicators.

In the contemporary era, Uzbekistan's versatile industrial conglomerate encompasses a myriad of sectors, comprising cotton refining plants, textile manufacturing, knitting, carpet weaving, silk production, embroidery, multi-disciplinary weaving, carpet-making, chinaware and porcelain factories, and textile mills, with over 150 enterprises operating in the domestic landscape. The seamless and high-quality production output of these enterprises relies significantly on a robust electrical supply. In this context, the actionable directives of our President Shavkat Mirziyoyev are being effectively implemented. Specifically, the provision of high-quality electrical energy to consumers, especially residents and rural industries, is being facilitated [1-6].

It is well-established that 15-20% of the electricity generated annually in our country caters to rural industrial sectors. A substantial portion of this electricity is primarily utilized by water pumps in this domain. Particularly, this situation becomes conspicuous during the irrigation season in summer and winter cropping periods. Consequently, the extension of power through electrical networks, the operational conditions of certain lines and transformers under overload, power reliability, and asymmetric conditions are closely monitored. To mitigate such situations, the deployment of machinery and mechanisms working on renewable (non-depletable) energy sources in rural industrial areas proves to be an effective solution. In essence, the future will witness the adaptation of electrically powered tractors, mechanisms operating on the power of the tractor's engine, and others to the renewable energy sources in order to alleviate the burdens of this sector [7-15].

Unifacial electrical consumers are predominantly employed in light industry plants. In sectors of manufacturing plants, asymmetry in the power network arises due to the asymmetrical loading of electrical consumers to the power grid [16-19]. Similarly, in rural industries, the absence of prompt loading of water pumps at specific times, i.e., connecting to the network at any time, also introduces asymmetric behavior. As a result, the asymmetry of loading leads to the premature wear and tear or shortening of the service life of unifacial electrical consumers, thereby escalating energy costs and inefficiencies.

Various sophisticated methods and technical tools have been developed to reduce asymmetry in 0.4 kV power networks, differing in complexity, cost, efficiency, operational principles, and suitability for various types of consumers. Figure 1 illustrates the methods for mitigating asymmetry in power networks [20-26].

Upon examination, the enhancement of asymmetry levels in 0.4 kV powered networks can be accomplished through the following avenues: leveraging open loops of 0.4 kV distribution networks, redistributing loads across network phases, mitigating zero-sequence reactance of the network, and eliminating the zero and negative components of three-phase network asymmetry in power consumption.

Scientific investigations [27-31] have revealed that the utilization of fully or partially open schemes in electrical networks (such as lines powered by two-sided electrical supply) facilitates the optimization of their operational regimes.

This is articulated as follows: reducing power losses and asymmetry in network loading. The adjustment of the asymmetry level in such networks occurs due to the compatibility of the loading of different phases with distinct components.

Research indicates that in the connection regime of two network lines, the mathematical expectation of the deviation of asymmetrical loading in radial lines is at most 33% less than that observed in interconnected lines [32-33].

It is imperative to emphasize that when multiple transformer-connected networks with various types of loading are interconnected in bidirectional branches, resonant loops may emerge, leading to power losses. The magnitude of resonant loops diminishes when the impedance of connecting lines is large, and the difference in the arrangement phases during the stages of transformer switching is comparatively small. Although their assistance is beneficial in aligning the operational loading of transformer-connected branches and enhancing the nature of network asymmetry, their contribution extends to amplifying the characteristics of network loading.

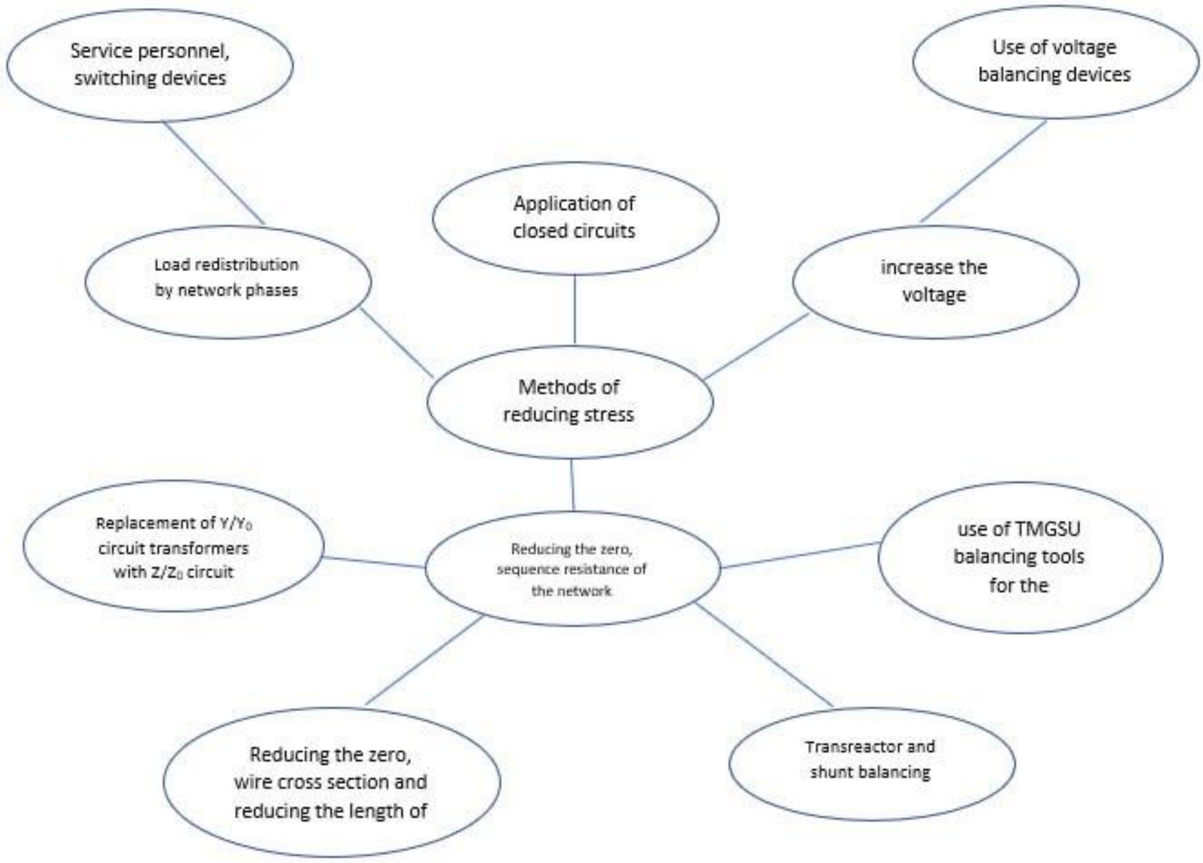

Fig.1. Methods for reducing voltage irregularities

The limitations of the designated approach lie in its execution, as its implementation in distribution networks catering to communal and residential loads proves highly intricate and demanding. These networks, characterized by substantial lengths, numerous subsidiaries, and incomplete segments, invariably necessitate extensive capital investments. Furthermore, safeguarding network lines from the transients of short-circuiting in open loops intensifies in complexity, requiring specialized interventions and technological instruments.

In the realm of light industry production facilities, predominantly featuring unifacial, i.e., 0.4 kV low-voltage consumers, the challenge arises in the intricate distribution of these consumers across three phases. The objective is to establish symmetry in loading concerning phases by implementing a symmetrical redistribution structure at the forefront of the network. This mechanism ensures the automatic transition of consumer loading from one phase to another when the loading on a particular phase becomes disproportionate, ensuring a seamless operation.

One fundamental tactic in mitigating asymmetry lies in the accurate equalization of unifacial loads across phases, preventing the asymmetry coefficient from surpassing permissible limits. However, this approach does not consistently lead to the desired outcomes. In instances where asymmetry persists, specific symmetrical devices are employed to rectify the situation.

IN CONCLUSION, it is noteworthy that in light industry facilities, primarily featuring unifacial consumers supplied from a 0.4 kV network, the automatic deployment of corrective and managerial mechanisms facilitates the attainment of a symmetrical state within the network. This proves crucial for enhancing the operational duration of unifacial consumers and ensuring uninterrupted workflow even when one of the three phases experiences a lack of loading. These technical methods are instrumental in effectively neutralizing asymmetrical states in electrical energy networks, contributing significantly to optimizing consumer potential and elevating operational efficiency.

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