ANALYSIS OF LOSSES REDUCTION METHODS FOR LOW-VOLTAGE OVERHEAD POWER NETWORKS

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Annotatsiya: Odatdagi taqsimlash tizimida energiya yo'qotishlari 6% dan 10% gacha bo'lishi mumkin va tizim xususiyatlariga, o'rnatilgan uskunalarga va taqsimlash tarmog'ining ishlash strategiyalariga bog'liq. Eng yuqori yuklanish davrlarida yo'qotishlarni kamaytirishga alohida e'tibor qaratish kerak, chunki yo'qotishlar va tizim yo'qotishlarining qiymati bu davrlarda eng yuqori bo'ladi. Ushbu maqola texnik yo'qotishlarni, quvvat omillarini va kuchlanish profillarini miqdoriy jihatdan aniqlaydi va tahlil qiladi. Ushbu maqolada shuningdek, 0,4 va 6–10 kV liniyalar uchun o'tkazgichlar va kabellarni optimal tanlash va tizim yo'qotishlarini va natijada tizimning ishlash xarajatlarini kamaytirish uchun transformator yo'qotishlarini kapitallashtirish qiymatlari ko'rib chiqiladi.

Kalit so'zlar: Elektr taqsimlash tarmog'i, elektr toki, taqsimlash transformatorlari, optimal o'tkazgich, quvvat koeffitsienti, yuqori kuchlanish, kommutatsiya, kondensator banki.

Аннотация: В типичной распределительной системе потери энергии могут составлять от 6 до 10% и зависят от характеристик системы, установленного оборудования и стратегий эксплуатации распределительной сети. Особое внимание следует уделять снижению потерь в периоды пиковой нагрузки, поскольку стоимость потерь и потерь в системе в эти периоды достигает максимальной величины. В работе количественно оцениваются и анализируются технические потери, коэффициенты мощности и профили напряжения. В данной работе также рассматривается оптимальный выбор проводников и кабелей для линий 0,4 и 6–10 кВ, значения капитализации потерь в трансформаторах для снижения потерь в системе и, следовательно, эксплуатационных расходов системы.

Ключевые слова: Электрическая распределительная сеть, электрический ток, распределительные трансформаторы, оптимальный проводник, коэффициент мощности, высокое напряжение, коммутация, конденсаторная батарея.

Annotation: In a typical distribution system, energy losses can range from 6 to 10% and depend on the system characteristics, installed equipment and distribution

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network operating strategies. Special attention should be paid to reducing losses during peak periods, since the cost of losses and losses in the system is highest during these peak periods. Technical losses, power factors and voltage profiles are quantified and analyzed. This paper also studies the optimal conductor and cable selection for 0.4 and 6-10 kV lines, the capitalization values of transformer losses to reduce system losses and, therefore, the operating costs of the system.

Keywords: Electrical distribution network, current flow, distribution transformers, optimal conductor, power factor, high voltage, switching, capacitor bank.

Introduction.

With the continuous growth in the size and complexity of the electricity distribution network, reducing losses can lead to significant savings for the Distribution System Owner (DSO). A loss reduction strategy provides other advantages, such as reducing system power and allowing the DSO to expand capital expenditures for system upgrades and expansion (Emmanuel Metal.). In order to meet the demand for load, distribution companies must reduce system losses and improve the quality of power supply to achieve social and economic development. Losses associated with the distribution network are classified as technical and non-technical losses. Fixed losses in distribution networks range from 1/4 to 1/3 of the technical losses. Such fixed losses are caused by leakage current, dielectric losses, no-load losses, and current flow through measurement and control elements and are realized as heat and noise. Variable losses represent 2/3 to 3/4 of the distribution losses and depend on the magnitude of the current flow. Such variable losses include copper losses in distribution lines and transformers. An increase in load demand leads to an increase in the current flow through the lines and distribution transformer windings and, therefore, to an increase in losses. Such losses are significantly higher in distribution networks, since a large number of distribution transformers are involved. In addition, system unbalance due to unbalanced load on the consumer side increases the losses in the transformer. However, high-frequency harmonic voltages contribute significantly to the magnetic losses of the transformer [1-2].

When purchasing efficient distribution transformers, it is not an economic choice to rely solely on the initial cost of the transformers. Losses in distribution transformers, especially load losses, occur depending on the loading pattern, which varies during its operating life. Therefore, the transformer purchaser should estimate the capitalization values of no-load and load losses for the transformers required over the life of the transformer. The capitalization values of the transformer depend on the system capacity cost, the graded cost of energy, the load profile, and economic considerations. A detailed model for calculating capitalization values for distribution transformer losses is presented and the model

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is applied to capitalization values for distribution transformers. In addition, losses in the distribution system can be reduced by increasing the conductor size. However, from an engineering perspective, increasing the conductor size can increase costs and losses. Therefore, the economically optimal conductor size should be selected. In this study, the differences in losses are not compared with the total material and labor costs for building and rebuilding the line; instead, the differences in the cost of losses for different conductors are compared only with the higher construction costs than would be required to build the line with the smallest suitable conductor [3-5].

Methodology Part. There are several methods to reduce losses in the distribution network. However, some mechanisms require the installation of additional equipment in the system, which can increase the financial burden on the companies. Several devices such as fluorescent lamps, distribution transformers in no-load, lighting in distribution networks or induction motors without load can cause deterioration of the power factor in the system. Improving the power factor using capacitors is an effective method that helps to reduce losses in the distribution system and maximize revenue. Improving the power factor can lead to a reduction in the phase angle difference between voltage and current. A large part of the loads in the distribution system are inductive type loads, which require reactive power for their operation. Installing a capacitor bank in parallel with the loads provides them with the necessary reactive power, which reduces the phase angle difference between voltage and current. Installing a capacitor bank can reduce the high current flow through the distribution lines, thereby reducing losses in the system. Another advantage of installing a capacitor bank is that it reduces voltage drop during heavy load periods. To install such a capacitor bank, the location of the capacitor bank, along with their types and correct sizes, must be determined.

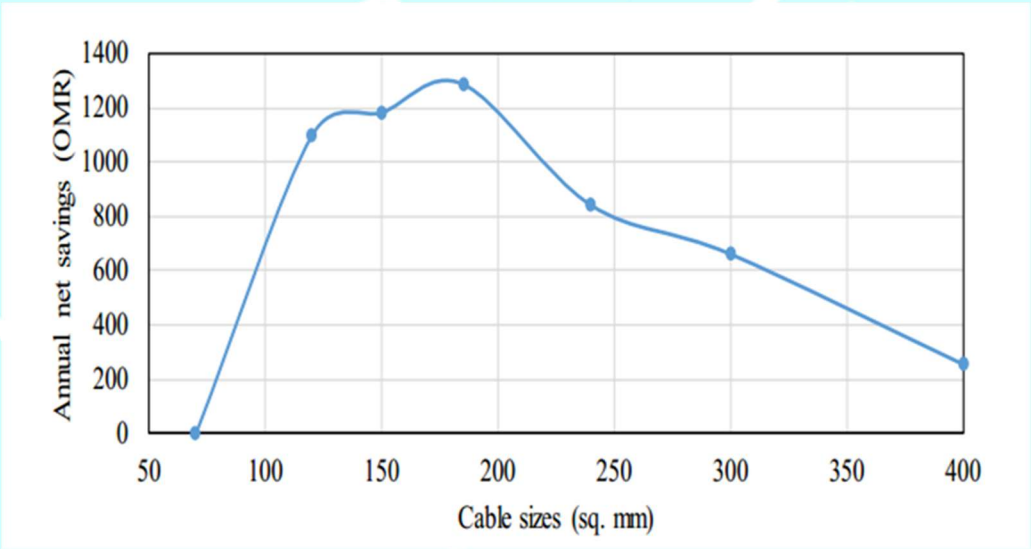
Switching optimization is also known as “reconfiguration”. It is a method of moving existing switching devices or inserting new devices in the appropriate location based on the size of the loads, length and size of the conductors. An effective method, switching optimization helps in reducing technical losses in distribution networks and increases its safety. Compared to the method of installing new re-conductors or feeders, switching optimization has been identified as one of the most cost-effective methods of reducing technical losses. Although the switching optimization method requires several new devices, the low cost of switching devices makes this method cost-effective compared to the “re-conductors or new feeder installation method”. Selecting the appropriate conductor size can reduce losses. Losses in conductors depend on the quality of the connections at each end of the conductor, the size of the conductor relative to the amount of current it carries, and the operating voltage of the conductor. Linear loss is inversely

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proportional to the conductor size and directly proportional to the square of the current flowing through the conductor. Smaller conductor size can result in higher losses and higher voltage drops, which results in credit losses for the DSO [6-8].



1-picture: Network diagram of total losses in distribution (kW and kVAR) for different loading conditions.



2-picture: Annual net savings variation for different cable sizes with an annual peak load current of 120 A, load factor of 0.5, where the optimal size is 185 mm^2.

The recommended practice is to ensure that the conductor can meet the peak demand of the consumers at standard voltages. In other words, the voltage drop should be kept within the standard range. A short length of distribution network can reduce the distribution losses, which has been studied. An approximate optimal solution based on current density and heuristic index for selecting the conductor size for a radial distribution system is presented.

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Distribution companies consider power losses in distribution lines as a serious problem due to the waste of energy and money. This paper presents various methods to minimize such losses.

Losses in a distribution system cannot be eliminated step by step. However, it can be reduced by proper system planning to ensure that power losses remain within an acceptable range. This paper presents the following conclusions and recommendations to reduce losses in a distribution system and thereby improve system efficiency:

Distribution system losses can be identified through network modeling and simulation. Such a study reveals the components or subsystems that contribute to high losses in the system. By modeling and simulating a representative distribution network, it has been found that transformers and cables, lines, among all other components in the system, cause high losses [9-10].

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