Analysis of compensating devices with adjustable capacity in the railway power supply system

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ABSTRACT

Powers of compensating devices for electrified railway power supply systems can be provided with certain technical conditions. In this case, optimal distribution of reactive power within the system is required. This problem can be solved, for example, by the Lagrangian method. In the power supply scheme, compensating devices with a certain value of power should be distributed among the nodes of the electric network in such a way that it is necessary to achieve a minimum wastage of active power

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The relevance of the topic: the ways of introducing the methods of saving and increasing the efficiency of electricity in the railway power supply system are highlighted. The layout of compensation equipment (CU) in different parts of the railway power supply system is presented. KU voltage jump is proportional to the current passing through it. If one load current is passing through KU, then the voltage jump in KU will depend on this load current. It should be taken into account that the voltage after KU should not be higher than the permitted voltage for the electrical equipment connected to this point [2].

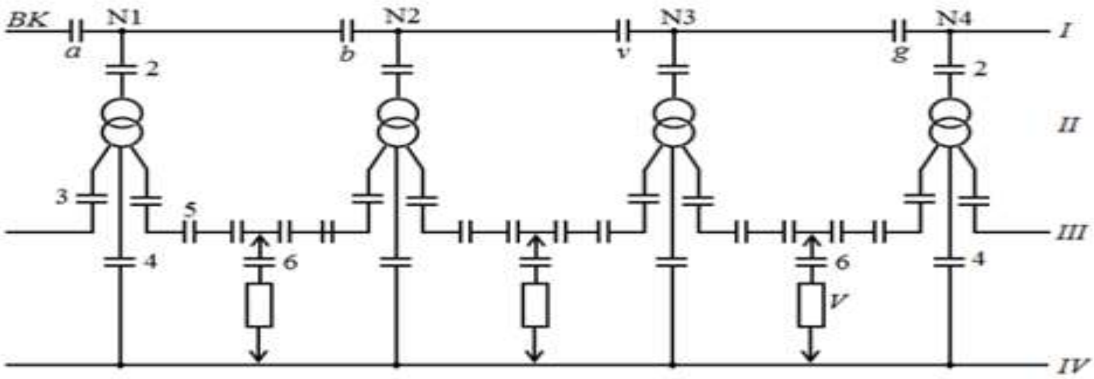


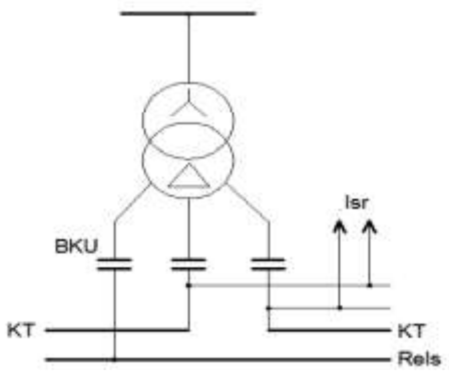
Figure 1. The arrangement scheme of the compensating device in different parts of the railway power supply system: I - high voltage transmission line; II - traction substations; III - contact network; IV- rails V - electric locomotives.

When designing electricity supply schemes, the costs of this scheme are minimized. The reduction of power loss due to compensating devices makes the scheme cheaper, because each kilowatt of wasted power must be produced in power plants, which means it costs money. But money is also spent on compensating devices. In this regard, the problem of determining the optimal capacity of compensating devices that minimizes total costs arises. Such a problem should be solved by gradient methods.

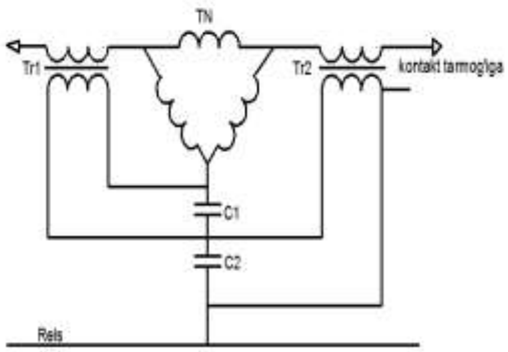
In order to regulate and balance the voltage in traction substations, it is possible to connect one, two or three phases of the secondary circuit of the KU traction transformer. There are four schemes for connecting electric vehicles according to their technical and economic indicators.

Single-phase KU installed on the suction wire, two-phase KU installed on the suction wire and the lagging phase, KU installed on the suction wire and the advancing phase. non-connected circuits are described [3].

The connection of three-phase symmetrical KU allows voltage loss and symmetrization, compensating the inductive resistance of the feeder air transmission lines and traction substations. A single-phase phase-to-phase transformer connected KU installed on the suction wire also has the same effect (Fig. 2).



1-rasm.Tortuvchi nimstansiyada KU sxemasi



2-rasm. Transformatorli bog'langan KU sxemasi

It is known that two transformers are connected in traction substations with large loads, as a result of which the inductive resistance of feeder lines and transformers is reduced by 1.4÷1.9 times. Therefore, when two transformers are connected, the parameters of the compensation equipment, that is, the capacitance resistance and the rated current, also change. This requires correcting them. The scheme shown in Fig. 3 is used for the use of adjustable KU in a substation with two transformers. The disadvantage of this scheme is that the power of the capacitor C_2 is not used. In this case, the power of the capacitor is effectively used in the circuit in Fig. 3b.

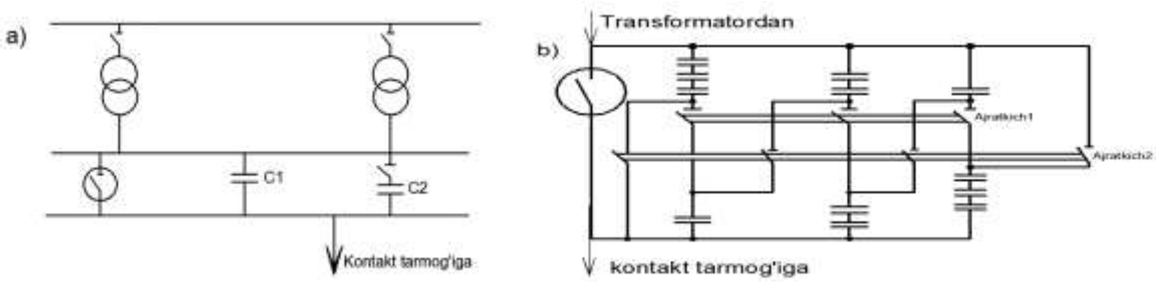


Figure 3. The scheme of disconnecting and reconnecting capacitors in an adjustable KU.

If one transformer is connected, disconnector 1 is connected and disconnector 2 is disconnected. When two transformers are connected, separator 1 is disconnected, and 2 is connected. In such KU, the nominal current changes 1.33 times, and the capacitive resistance changes 1.77 times. KU is formed by a large number of branches and groups in it. When losses in the traction network are large, such a situation occurs in feeder zones with one-way feeding, KU is directly connected to the traction network and the inductive resistance is compensated. The easiest way to connect the KU is to connect it to the sectioning point of the contact network. For example, at the sectionalizing posts shown in Fig. 4 a, but in this case, an electric arc may appear in the current receiver of the electric locomotive in the air gaps of the contact network. As the KU power increases, the arc speed increases. Known protection methods are used to increase the reliability of the air gap. At the same time, air-gap shunting with a circuit breaker is used, in which the current is added before the receiver passes when the voltage at KU is zero.

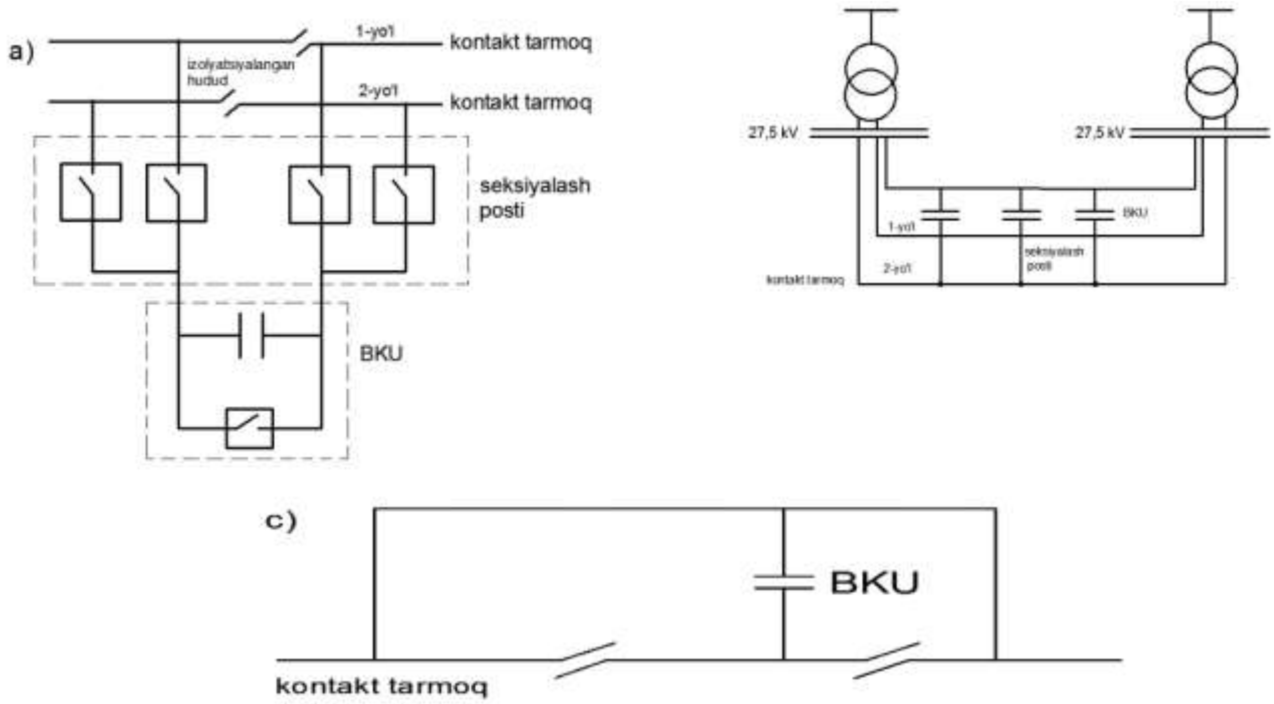


Figure 4. Schemes of connecting KU to the contact network. The use of a-section post with an additional resistor b-to the separator. in the limited section of the c-contact network.

KU connected to the contact network with an additional wire short circuit does not affect the air gap and the balance currents between the substations (Fig. 4 b). When the electric locomotive is close to KU, the voltage loss depends on the compensated additional wire.

KU connected with an additional wire is suitable for use in recuperative braking sections. In this case, the section of the contact network with intensive recuperation is shunted with an additional wire, this section of the contact network is sectioned and the additional wire is connected through the KU. Such a scheme allows to increase the power factor of the recuperative electric locomotive.

As a disadvantage of KU, it can be mentioned that there is a need to use large-capacity capacitors and their high price. The capacity resistance of capacitor batteries are the main parameters of BK. They are selected on the basis of the following conditions: it is desirable to select the voltage according to the minimum value or the given value of the asymmetry coefficient, the condition that the voltage does not depend on the load current, the given values of the phase voltages, and the minimum of the specified costs.

Conclusion

Technical and economic calculations showed that the longitudinal compensation equipment will pay off its costs in an average of 10 years [4]. At present, the demand for electricity in the Republic of Uzbekistan is increasing by the hour, and taking into account the fact that the sources of electricity production, i.e., the natural resources of gas in our country will decrease after certain years, the most important problem of the present time is the more efficient use of electricity. is considered Installation of compensatory equipment provides an opportunity to increase the quality indicators of electricity and maintain symmetry in the external power supply system.

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