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AUTOMATION OF REACTIVE POWER COMPENSATION IN ELECTRICAL NETWORKS

Abstract: *This article analyses the existing problems of automation of reactive power compensation in electrical networks, automates circuits of reactive power sources in the power supply system using analytical and experimental methods, as well as provides recommendations for their optimization.*

Key words: *Reactive power, rectifier, synchronous machine, network, load, automatic control, coefficient, electrical device.*
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Introduction

The energy sector is the main core of production, and today it is entrusted with the task of providing high-quality electric power to production technologies that meet the world standards, and therefore it is subject to responsible requirements.

It is known that reactive power compensation is used to save energy. [1, p. 88]

At large industrial enterprises, this issue is considered more relevant. The use of reactive power compensating devices is the most effective and efficient way to reduce power consumption from the network.

The work aims to analyze automated schemes of reactive power sources in the power supply system and develop recommendations for their reasonable implementation based on optimization.

The practical importance of work: Since electricity consumers have reactive power consumption, it is necessary to control the power of reactive power sources.

This problem manifests itself in the automation of reactive power sources.

To solve this problem, it is important to improve the automatic control schemes of jet sources and optimize their modes.

MATERIALS AND METHODS

In the course of research on automation of reactive power compensation in electrical networks, analytical and experimental methods were applied: Study of electrical and magnetic circuits and systems, graphic models, control theory, the theory of measuring transducers, modelling, probabilities, the study of errors and methods of reliability calculation. [[2, p. 73]

Algorithms and methods have been developed to calculate in real-time the determinants, static and dynamic classifications of electromagnetic converters that can work together with semiconductor elements in the control of the reactive power of the power system, providing high accuracy, linear output classification, economic cheapness, simplicity in structure, high sensitivity, low power consumption, informativeness, reliability;

The method and principle of adequate change of sizes, angles and irregularities of single- and three-phase currents, angles and irregularities of the energy system to the secondary voltage, providing combined control of reactive power sources, implementing the principles of building energy-efficient and resource-saving energy systems, was created. [3, p. 145]

The main consumers of reactive power are:

1. Asynchronous motors (AM) -they consume 60% of the total reactive power.

2. Power transformers consume about 20% reactive power.

3. Adjustable rectifiers, induction furnaces, etc. consume about 15-20%.

High-voltage synchronous motors (SM), synchronous compensators and static sources of reactive power with voltage up to 1000 V and above 1000 V, capacitor batteries (CB), high-voltage synchronous motors (SM) are used to reduce consumption of reactive power received from the system at enterprises and in workshops. Also, it is possible to reduce the consumption of reactive power, affecting the process and structure of the operation of technological mechanisms and electrical installations. [4]

In the design and operation of ETS, various measures 2 are used to replace reactive power:

1. Coating using a special jet power supply;

2. Compensation measures affecting the process, design and parameters of the electrical installation without using a special source.

We will look at these events:

1. Limit the salt stroke time of an asynchronous motor in a mechanism or machine. Because the asynchronous motor consumes mainly reactive power when the salt is going, and the power factor cos, Therefore, the motor circuit breaker from the network is installed, Salt walking time is more than 10 seconds.

2. If the design of the mechanism allows, replacing ad with a more powerful engine with a smaller load factor. At the same time, if the load ratio of the engine $K_{ю} < 0.45$, the high-power engine can be replaced by a low-power engine without performing economic calculations. If $0.45 < K_{ю} < 0.7$, it is possible to replace based on technical and economic calculations.

3. Reducing reactive power consumption by reducing the voltage by reconnecting the blades from the triangle to the star, which allows low-loaded asynchronous motors and synchronous machines to the stator cams. It can be used for 4A series engines where the blades are triangularly connected at rated voltage.

4. If possible, replace asynchronous motors with synchronous machines (pumps, compressors, fans) installed on mechanisms with the constant mode of operation. Because the synchronous machine can independently produce and transmit to the network without consuming reactive power.

5. For mechanisms with variable operation mode (for large-size pumps, compressors, fans) it is planned to install a synchronous machine during its new design.

Capital investments will be less costly to perform the above actions. Therefore, they can be performed first, and then special reactive power sources can be used if necessary.

In the capacitor, it is allowed to increase overload currents up to 30%, and voltage up to 10%. [5] in practice, the load current due to resonance can reach 400% -500%. When selecting the power supply location and installation of capacitor batteries, it will be necessary to take into account the voltage and current generated by the load. When considering the operation of capacitor batteries under nonsinusoidal voltage conditions, it is necessary to take into account the interdependence of the capacitor battery with the high harmonics of the power supply circuit. Figure 1 shows a distribution network of capacitor batteries in which a thyristor converter is provided and installed to compensate for reactive power.

Impact Factor:

ISRA (India)	= 4.971	SIS (USA)	= 0.912	ICV (Poland)	= 6.630
ISI (Dubai, UAE)	= 0.829	РИНЦ (Russia)	= 0.126	PIF (India)	= 1.940
GIF (Australia)	= 0.564	ESJI (KZ)	= 8.997	IBI (India)	= 4.260
JIF	= 1.500	SJIF (Morocco)	= 5.667	OAJI (USA)	= 0.350

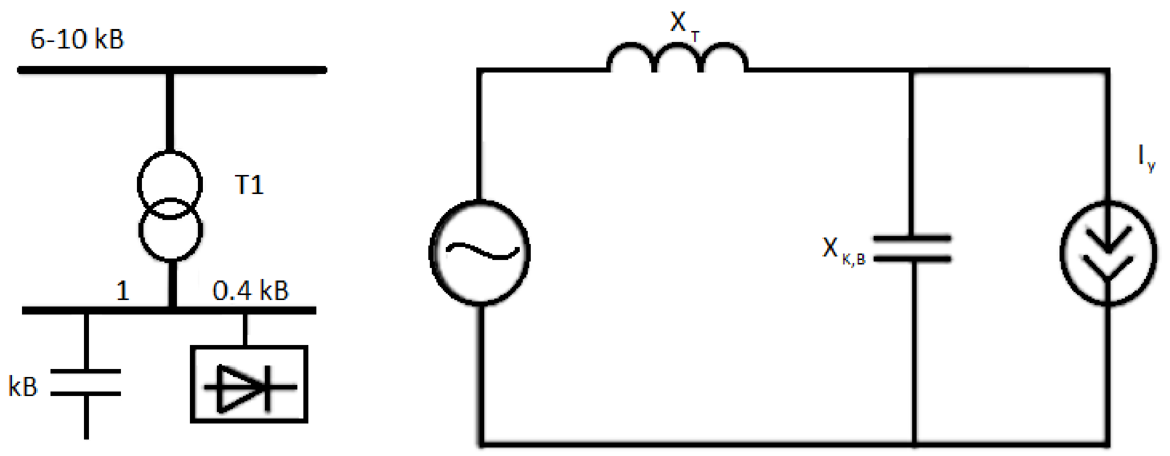

Figure 1. Capacitor (a) connected to the AC transformer and its exchange circuit (D)

УКРМ (КРМ, УКМ, АКУ) - Automatic equipment for reactive power compensation. This device makes it possible to cover the reactive power with capacitor banks. The device can be automatically controlled or manually operated.

– The device supports the set CoC coefficient φ, which monitors the change in reactive power in the network and compensates for the reactive power when loaded.

– Eliminates the generation of reactive power in the network.

– Prevents voltage drop in the mains.

– Prevents overheating of wires distributed in the enterprise.

– The company pays less, reducing the consumption of active and reactive energy.

– The equipment covering the reactive power will consist of:

– Disconnector (disconnector), network connection and disconnection for construction with eyes.

– Circuit breaker type D, each capacitor separately for the battery.

– Contactor with a capacitor, contactor with special two-stage switching. The contactor capacitance with a capacitor is designed for consumers. The capacitor switches off when the charge is assembled in the short-circuit mode. [6] The installation of conventional contactors may cause equipment to fail and operate incorrectly.

– The thyristor contactor is also used instead of the contactor for a fast connection.

– The condenser battery, dry, oil, other types of liquid static condensers are available, they get out depending on climate and operating modes.

– controllers for automatic control; Controllers can be flat or power. [7; 8] The same flat stage capacitor battery may be turned off while the power stage controller may be turned on and off by different power batteries according to the power included in the program.

– A board with the cooling system depending on the capacity and arrangement

– The surge protectors compensating jet power should be added to high-capacity power supply systems and poor quality.

The reactive power to be coated is determined by the following formula:

$$K_{крм} = P_{актив} *[(тг(\varphi_1)) - (тг(\varphi_2))] = P_{актив} * K(кВАр) \quad (1)$$

Here

тг(φ1) - Current indicator

тг(φ2) - The indicator we need to achieve the K ratio is determined from the table above.

$$КРМ \ (кВАр) \quad (2)$$

The capacitor, consisting of R and L connected in parallel to the load, is selected so that the current flowing through the capacitor is selected at a value close to the absolute value of the current I magnetic L flowing through the capacitor. It can be seen from the vector diagram that when the capacitor C is connected with the value from φ1 to φ2, the angle of phase shift of current and voltage in the load value and, accordingly, the increase in the load power factor increases the amplitude.[9;10].

By increasing the capacitance in which φ2=0 is located, the entire load can be compensated by the reactive power. Reactive power compensation is an important technical event and can be used for several purposes.

At industrial enterprises, including due to very high energy consumption, a lot of research and development work on energy saving is currently being carried out. In research works, it is important to organize the energy balance at the enterprise, to analyze energy indicators in production, to determine the degree of loading of reserve sources of energy efficiency of power transformers, reactors and other electrical appliances.

CONCLUSION

Electrical balance is the balance of reactive power with an active power in consumption, t. e. the sum of all network losses is taken into account. How much energy is used in different parts of the plant can be estimated by analyzing the data collected during the energy audit. The identified energy consumption can be compared with the target and standard indicators set for the enterprise. In order to compensate for reactive power and to solve related problems related to the increase of power consumption and power quality at various elements of the power supply system, a reactive power balance is made. To increase the efficiency of energy resources use and reduce heat losses, it is necessary to improve the condition of heat networks at the enterprise, as well as to organize a constant control over the correctness of measurements on the devices at the enterprise, the rational use of energy resources in the heat source and places of its consumption.

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