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Analysis of reactive power consumption "Denav oil extraction plant"

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Abstract. The article deals with the study of non-contact devices, the analysis of reactive power consumption of the "Denav Oil Extraction Plant" and the graphs of reactive power consumption of enterprises. And also, the purpose of the article is from a review of materials on contactless devices for automatic control of the power of capacitor banks and the study of graphs for the consumption of reactive power of enterprises.

1 Introduction

Improving the reliability of power supply systems, developing and implementing energy-saving technologies and ways to reduce power losses is one of the topical issues of today. The reliability of the power supply system is associated with the safe implementation of switching in the system by turning on, off, transferring power to electrical consumers. The efficiency of the power supply system is influenced by many factors, one of the main among them is the optimal start-up and power control of capacitor units [1-5, 15].

Implementation of regulation using non-contact devices improves the reliability of the electrical system and the rational use of electricity [1-5, 15-17].

Ensuring the economical operation of capacitor units is possible by regulating their power when the magnitude and nature of the loads change depending on the voltage at the point of connection of the capacitors [1-5, 16].

Non-contact devices for switching and power control of capacitor units are distinguished by their speed, long service life, quiet operation and other advantages [1-5].

However, existing non-contact devices have a complex system for controlling the operation of thyristors or other semiconductor elements, which creates difficulties in the installation, commissioning and maintenance of such devices and prevents their widespread use [1-5, 17-20].

In addition, devices for power regulation, capacitor banks and switching of electrical equipment are imported from other countries and for the purchase of which foreign currency is required [1-5, 18-19].

Based on the foregoing, it is relevant to develop and implement inexpensive contactless starters with a simplified design for controlling the power of capacitor banks and switching various consumers, including various motors operating in a stressful mode with frequent starts and stops [1-5, 15-20].

2 Analysis of reactive power consumption Denav oil extraction plant

"Denav oil extraction plant" is an oil and fat industry enterprise producing vegetable refined cottonseed and soybean oil, as well as consumer goods, soap, husks, meal, etc. [1, 6-9].

By the nature of consumption of raw materials, the enterprise "Denav Oil Extraction Plant" belongs to the manufacturing industries, that is, it processes raw materials of plant origin [2, 10-12].

According to the purpose of the finished product, the enterprise belongs to a group that sends its products for direct consumption by the population, and sends waste as raw materials to other enterprises [1, 13-15].

According to the duration of work, the enterprise belongs to the group of year-round (permanent) operation. Duration of work during the day - continuity of action [2, 16].

The method of obtaining finished products is the extraction of vegetable oil from oilseeds (cotton, soybeans, sunflower, safflower) [1, 17-19].

According to the level of mechanization and automation of production processes, the enterprise is considered to be complex-automated, that is, all processes of the main and auxiliary production are automated [2, 20-21].

The efficiency of production largely depends on the quality of raw materials supplied for processing (seed oil content), weediness, spoilage, as well as on the degree of

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provision of the enterprise with the necessary raw materials in the right amount [1, 22-25].

The production capacity of the Denav Oil Extraction Plant under the project is 1360 tons per day of processed seeds [2, 26-27].

3 Analysis of the consumption of electric energy

The enterprise is supplied with electricity from the main power grids through the Denov substation with a voltage of 110/10 kV through the feeders GCP-1 (Gas Control Point), GCP-2, GCP-2, Boiler-1, Boiler-2, Water intake-1, Water intake-2, through the Complete Cells Outdoor Switchgear (CCOS) 10 kV [2, 28-31].

The 110/10 kV substation is a deep input substation, i.e. higher voltage (110 kV) is as close as possible to electrical installations of consumers with a minimum number of stages of intermediate transformation and devices. The total installed capacity of 10/0.4 kV transformers is 14300 kVA. The substation is located on the territory of the enterprise, and the connection is made via cable and overhead power transmission lines [32-33].

Commercial metering devices (Automated Electricity Control and Accounting System - AECAS) are installed at the outlets of the Denov substation with a voltage of 110/10 kV along the feeders GCP-1, GCP-2, GCP-3, Boiler-1, Boiler-2, Vodozabor-1 and Vodozabor-2 [34].

To analyze the dynamics of changes in electricity consumption, a summary table was prepared based on the report provided by the department of the chief power engineer [1, 35-38].

Based on the data from the reporting of the enterprise, the total electricity consumption amounted to (see table 1): active energy – 5497990 kWh, reactive energy – 1497220 kVAr·h. The weighted average power factor is cosφ=0.98 [2, 39-41].

For detailing, a separate analysis of power consumption was performed for feeders GCP-3 and Boiler-1. Power consumption data are summarized in Tables 1 and 3. The dynamics of changes in active, reactive energy and power factor are also indicated there. When analyzing the graphs (see figure 2) of the change in power factor, it can be seen that at GCP-3 and Boiler-1 there is a sharp fluctuation of reactive power [42-44].

The main reason for this is the manual control of reactive power compensation. To solve this problem, it is required to install a microprocessor controller for automatic control of reactive power compensation [45].

Table 1. Summary table of active energy consumption

Months	Active Energy, kWh
January	389210
February	1283810
March	391110
April	424110
May	247310
June	251000
July	274810
August	276910
September	232610
October	1727110
Total	5497990

Table 2. Electricity consumption at GCP-3

Months	Active Energy, kWh	Reactive Energy, kVAr·h	Power factor, *cosφ*
January	156000	36000	0,97
February	697200	302400	0,92
March	176400	34800	0,98
April	168000	96000	0,87
May	60000	24000	0,93
June	60000	4800	1,00
July	78000	7200	1,00
August	62400	26400	0,92
September	38400	14400	0,94
October	945600	472800	0,89
Total	2442000	1018800	0.92

Table 3. Electricity consumption at Boiler-1

Months	Active Energy, kWh	Reactive Energy, kVAr·h	Power factor, *cosφ*
January	31400	20000	0,84
February	95800	65400	0,83
March	31000	16600	0,88
April	36000	22000	0,85
May	10400	10200	0,71
June	5500	2440	0,91
July	5800	200	1,00
August	8200	2200	0,97
Total	224100	139040	0,85

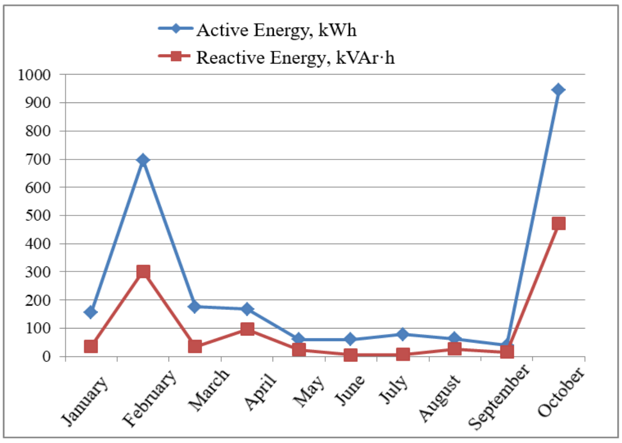

Fig.1. Dynamics of electricity consumption at GCP-3

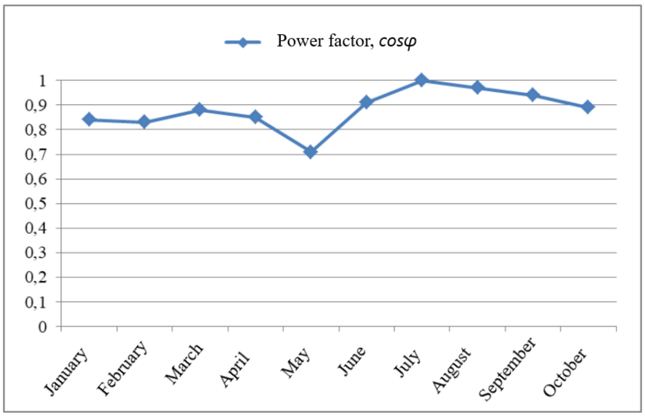

Fig.2. Power factor GCP-3

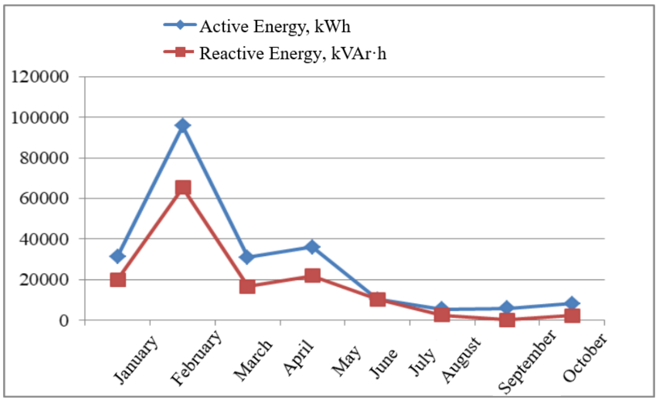

Fig.3. Dynamics of electricity consumption at Boiler-1

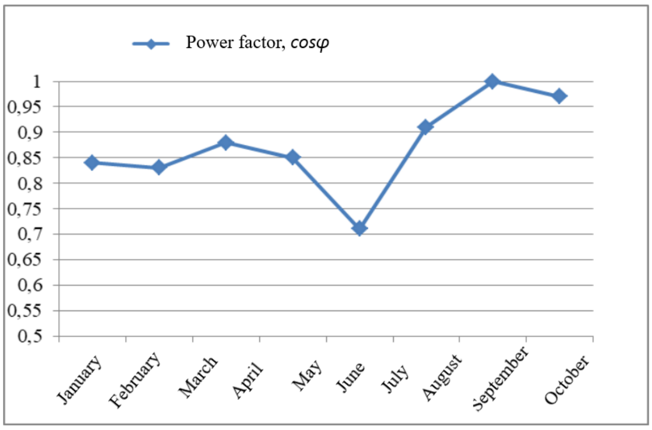

Fig.4. Power factor of Boiler-1

4 Conclusion

As part of the implementation of the article on the topic "Analysis of the consumption of reactive power "Denav Oil Extraction Plant"" for 2021, the following results were obtained:

The study and analysis of graphs of reactive power consumption at the "Denav Oil Extraction Plant" makes it possible to have an idea of the magnitude of the consumed power and understand the importance of constantly maintaining the power factor within the required limits, because undercompensation and overcompensation of reactive power takes place.

In general, for automatic control of the power of capacitor banks without arc formation, it is necessary to develop non-contact devices based on semiconductor elements. Now contactless devices are purchased for currency, i.e. are among the goods imported from abroad, therefore, the solution of the problem of development and implementation of such devices with a simple design and reasonable prices, along with a technical problem, would solve the problem of import substitution, which justifies the relevance of the purpose of this study and the need to continue research in this direction.

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