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Development of Measures to Save Electricity in the Extraction of Oil from Cotton Seeds

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ABSTRACT
The article examines the development of energy characteristics of electric drives of technological equipment and regulation of power consumption of a fat-and-oil enterprise.

KEYWORDS: *power supply system, oil extraction unit, efficient operation mode, specific power consumption.*

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INTRODUCTION

One of the possible ways to solve the problem of increasing the reliability and accuracy of forecasts of energy and energy-economic indicators in power supply systems of industrial enterprises is their forecasting taking into account the relationship with other indicators characterizing the production process. The implementation of this method uses the fundamentals of probability theory and mathematical statistics.

At the operational stage, the problem under consideration is closely related to the tasks of standardization of specific energy consumption (SEC) in industry. These tasks cannot be considered solved, although much attention is paid to them in the literature. The article presents the results of the studies conducted by the authors on the example of RIZQU-TOJIR LLC, on the development of energy-saving measures for the purpose of selecting the most energy-efficient modes of equipment operation, assessment, analysis and control of power consumption modes, as well as standardization of absolute and specific energy consumption at oil and fat enterprises.

RIZQU-TOJIR LLC operates continuously around the clock. Analysis of power consumption graphs for 2022-2023 shows uniform power consumption by months of the year, except for the enterprise's repair period (Table 1). In 2022, due to the irregular receipt of cotton seeds for processing, monthly power consumption fluctuated between 240 thousand kW h and 310 thousand kW h, i.e. deviations amount to 77%.

Table 1 shows the electricity and gas consumption by month in 2023 at the enterprise.

Report on electricity and gas consumption for 2023

Table 1

№	Date	Wa, kWh	Wr, kvar·h	tanφ
1	January	618415	218532	0,35
2	February	821341	291754	0,36
3	March	843424	318336	0,38
4	April	504316	214391	0,43
5	May	412174	161293	0,39
6	June	158776	84534	0,53
7	July	456002	214176	0,47
8	August	107862	77304	0,72
9	September	66215	61848	0,93
10	October	1335439	512352	0,38
11	November	1236973	154080	0,12
12	December	985602	360300	0,37

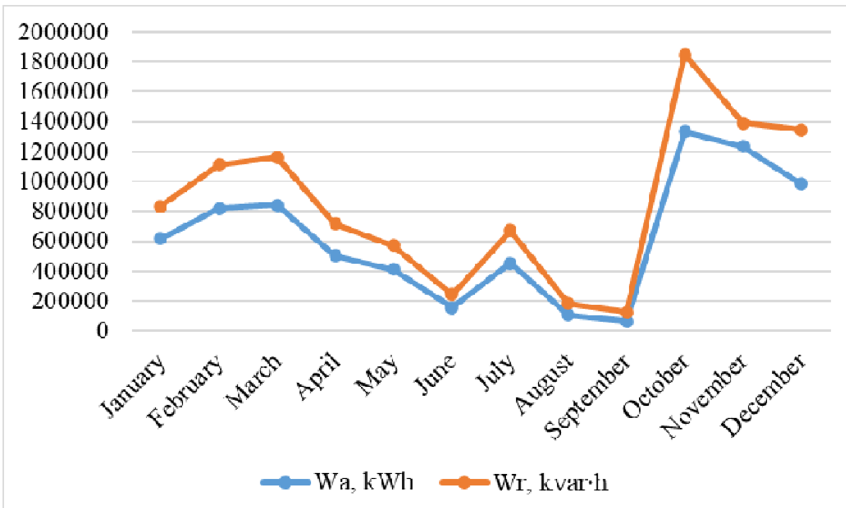


Fig. 1. Electricity consumption in 2023

The main initial data for forecasting and determining the standards for electric energy consumption are:

- primary technical and technological documentation;
- restored power supply schemes of the enterprise;
- measurement results;
- standard characteristics of power and technological equipment and raw materials, passport data of equipment, standard indicators;
- data on planned and actual specific energy consumption for past years;
- working time fund (month, year);
- plan of organizational and technical measures to save electric energy, introduction of new equipment and technologies;
- forecast data on the volumes of manufactured products.

In the process of standardization of SEC, it is advisable to distinguish two stages: the study of SEC as random variables and their standardization. The presentation of SEC as random variables puts forward special requirements for the sequence of their formation by production levels. The task of developing scientifically based SEC standards should be solved in a comprehensive manner with the tasks of organizing control and accounting of electricity consumption [1,2].

In industry, among the numerous methods of assessing, analyzing and monitoring power consumption modes, as well as standardizing the energy consumption efficiency, the most effective is the construction of energy characteristics (EC) of units, workshops and the enterprise as a whole, expressing the dependence of the consumed power or energy consumption efficiency on a number of factors, in particular, on the volume of manufactured products (productivity), quality indicators of processed raw materials, etc. [2].

As a arguing value for constructing energy characteristics, which are the basis for analyzing and calculating electric power indicators at enterprises in the oil-producing industry, it is advisable to take a unit of processed raw materials with subsequent recalculation per unit of final product (oil). Electricity consumption is mainly related to the number of seeds processed. Oil production is not directly associated with electric power consumption and depends on the oil content of seeds and oil losses during the production process [2].

In the production of cottonseed oil, the most energy-intensive units are the preliminary oil extraction units, forepresses, which, together with the roasters, consume more than 20% of the plant's overall electricity consumption.

The authors have carried out experimental studies of the power consumption characteristics P and SEC d depending on the hourly productivity A of MPSh-type oil pressing units, which are widely used in the industry at the RIZQU-TOJIR LLC enterprise. The units have some design differences, different productivity and relatively high technical and economic indicators compared to other units of domestic and foreign production. The operating principle of these presses is similar to the operating principles of forepresses described in [2].

The experiments were conducted as follows. The press productivity was measured by collecting the cake shell into a special box (the sampling interval was 60 sec), weighing it on a centesimal scale and recalculating it for 60 min (minus the tare). At the same time, the power was measured using an active energy meter and measuring clamps.

Based on the fact that the conversion of the press productivity to the seed indicator can be done using simplified formulas (1, 2), the energy characteristics of the press are considered as a function of the produced cake, i.e. P=f (Ac) and d=f (Ac) [2].

To obtain these characteristics, the Chebyshev method [3] is used, which makes it possible to determine the order of the correlation equation and its error.

We experimentally measured the power consumption of the above-listed types of forepress units depending on their productivity, which was regulated by opening the feeder.

For each point, sampling was carried out 3 times. The data volume was 12 for each type of unit with one thickness of the cake shell.

As a result of experimental measurements for productivity levels of 0; 25; 50; 75 and 100% and the implementation of the compiled algorithm, equations for the energy characteristics of the consumed power and specific energy consumption for oil-pressing units of the MPSh type were obtained:

$$P_P = 6,3 - 2,26 \cdot A_c + 16,76 \cdot A_c^2 , \quad (1)$$

$$d_P = -2,26 + 16,76 \cdot A_c + 6,3 \cdot \frac{1}{A_c} . \quad (2)$$

The mathematical model of energy characteristics is obtained in the CI+ language, the algorithm is shown in Fig.2.

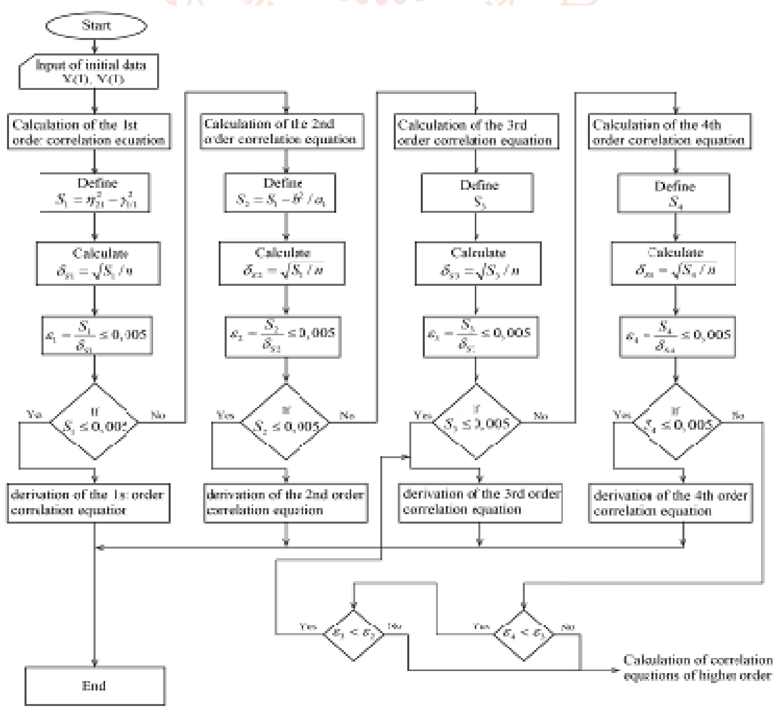
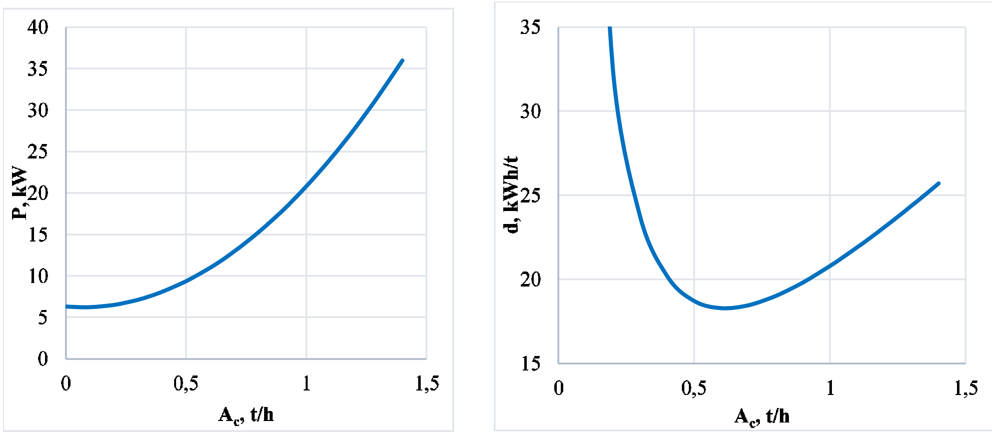


Fig. 2. Block diagram of the algorithm for developing a mathematical model of energy characteristics using the Chebyshev method

Fig. 3 shows the energy characteristics of the MPSh oil pressing unit.

The total EC of departments, workshops and production facilities as a whole have been constructed, limiting the zone of possible operating modes for a given specific type of equipment and level of operation.



a) b)

Fig. 3. Energy characteristics a) *$P=f(A_c)$* and b) *$d=f(A_c)$* of the oil press unit with cake thickness δ = 9 mm.

This makes it possible to determine the minimum levels of power consumption and SEC for different volumes of processed products. Depending on how much higher the actual level is from the minimum possible, it is possible to determine the reserves for energy savings.

Conclusions

1. The minimum specific power consumption of the MPSh unit with uniform loading is obtained at 60 percent productivity (18 (kW·h)/t).
2. The compiled algorithm is universal and allows to obtain mathematical models of the energy characteristics of oil pressing units of other types with a sufficient degree of adequacy.
3. A method for quantitatively assessing the reserves of energy savings associated with the irrational mode of the electric drive of the process equipment is proposed.

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