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Model of Electrical Energy Consumption in Cotton Ginning Industries

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ABSTRACT: This article presents the energy regimes and the consumption of electricity and gas, the quality indicators of raw cotton processed at the ginnery. A schedule of daily, monthly and annual consumption of electricity and gas consumption modes has been determined. The energy characteristics of the object and a histogram of the distribution of electricity and gas consumption per ton of processed raw cotton have been constructed. Also presented are summarized analytical results of the plant, based on empirical studies obtained for each day.

KEY WORDS: cotton-cleaning enterprises, energy modes of operation, distribution of electricity and gas consumption rates, energy saving.

I.INTRODUCTION

Energy modes of cotton ginning enterprises, electricity and gas consumption depend on the quality indicators of raw materials (cotton fiber). Electricity and gas consumption mode is usually characterized by daily, monthly and annual consumption. In accordance with this, experimental studies on the mode of operation and consumption of energy resources were carried out in "Okkorgon Cotton Industry" LLC, which belongs to "AVS Okkorgon Agro Cluster" LLC (during 2019-2020) [1-3].

II. LITERATURE SURVEY

It is known that the main indicator describing the unevenness of the daily load schedules is the inequality coefficient a, where the ratio of the minimum and maximum loads is equal. According to the analysis of the obtained data, the greatest inequality of the graphs is observed in the autumn and winter months. Electricity consumption by months of the year is affected by seasonality and composition of consumers. The description of electricity and gas consumption for a month (for May 2020) in "Okkorgon Paxta Sanoat" LLC, which belongs to AVS Aqqorgon Agro Cluster" LLC, is presented in Figure 1 [1].

III. METHODOLOGY

The results show that the consumption of energy resources is affected by the following factors: moisture content of the cotton raw material coming out of the bundle (*a*, g/m^3); contamination of cotton raw materials coming out of the bundle (*b*, g/m^3); moisture content of raw cotton coming out of the gin (*c*, g/m^3); pollution of cotton raw materials coming out of gin (*g*, g/m^3); seed moisture (*r*, g/m^3); fiber moisture content (*f*, g/m^3).

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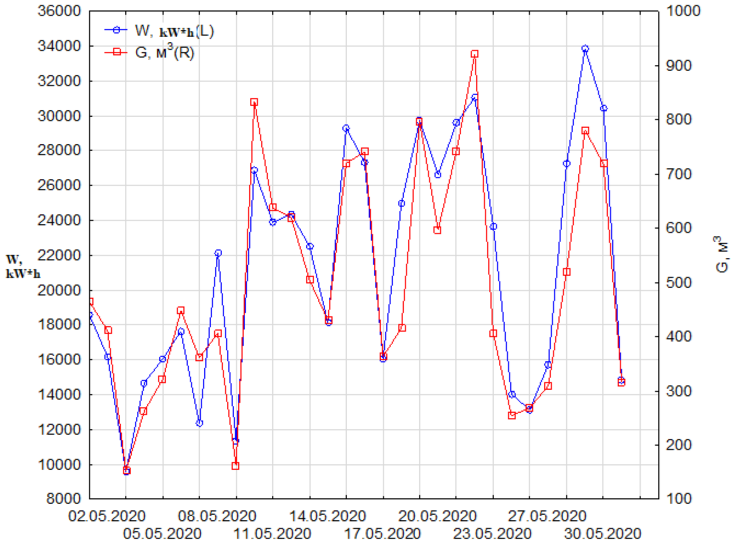

Fig. 1 Monthly consumption of energy resources (electricity and gas).

Table 1 summarizes the analytical results obtained from the empirical studies, and Figure 2 presents the matrix line.

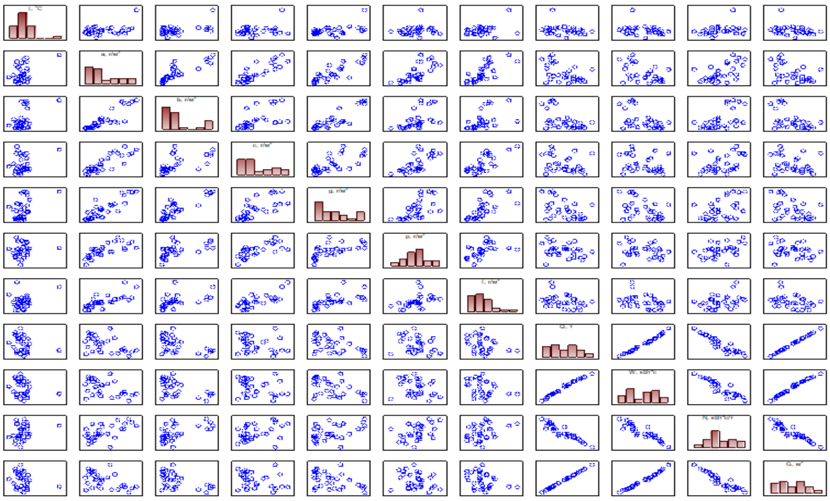

Fig. 2 Matrix line

Figure 3 shows the description of energy (electricity and gas) LLC "Okkorgon Paxta sanoat". Figure 4 shows the distribution histogram of the electricity consumption rate (N, kW·h/t) per processed ton of cotton.

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Table 1
Generalized analytical results obtained on the basis of empirical studies

Day, month, year	Temperature, t, ^{0}C	Moisture content of raw cotton coming out of the bundle, *a, g/m³*	Contamination of raw cotton coming out of the bundle, *b, g/m³*	Moisture content of raw cotton coming out of gin, *c, g/m³*	Contamination of raw cotton from gin, *g, g/m³*	Seed moisture, *r, g/m³*	Electricity consumption, W, kW·h	Comparative energy consumption, N_e, kW·h /t
01.05.2022y	86	9.4	8.2	9	2	8	18600	600
02.05.2022y	76	13.8	31	11.4	4.8	9.9	16191	630
03.05.2022y	80	14.7	28.9	11.6	5	9.5	9591	690
04.05.2022y	85	15.1	30.9	11.8	4.9	9.7	14673	670
05.05.2022y	142	15.7	32.1	12.5	5	8.9	16055	650
06.05.2022y	86	14.1	29.3	9.9	4.5	8.9	17640	630
07.05.2022y	86	12.5	25	8.9	3	8.4	12350	650
08.05.2022y	90	10.4	11.3	9	3.8	8.8	22140	600
09.05.2022y	74	9.2	7	8	1	6.7	11340	630
10.05.2022y	80	9.5	7.3	8.9	1	7.6	26854	580
11.05.2022y	75	11.2	16.5	10.6	2.4	8.7	23880	600
12.05.2022y	70	9.1	7.5	8.6	1	7.4	24367	590
13.05.2022y	54	10.5	9.7	9.4	2.8	8.8	22504	580
14.05.2022y	62	11	15.2	9.9	2.4	8.2	18113	590
15.05.2022y	70	9.9	7.5	9.4	1.2	8.8	29298	570

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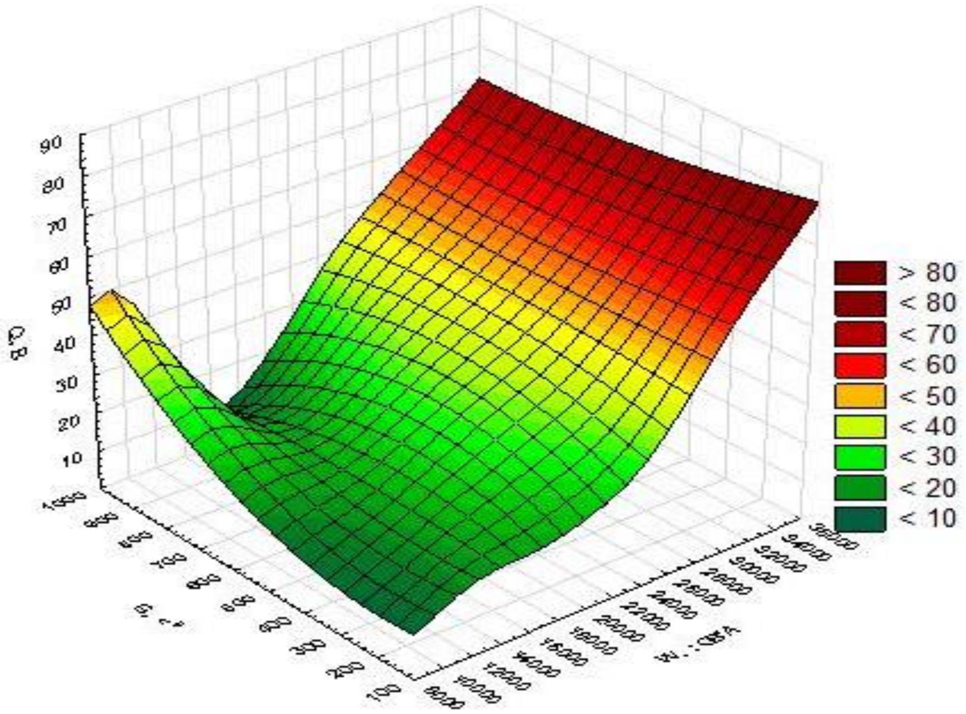

Fig. 3 Energy description of "Okkorgon Paxta Sanoat" LLC

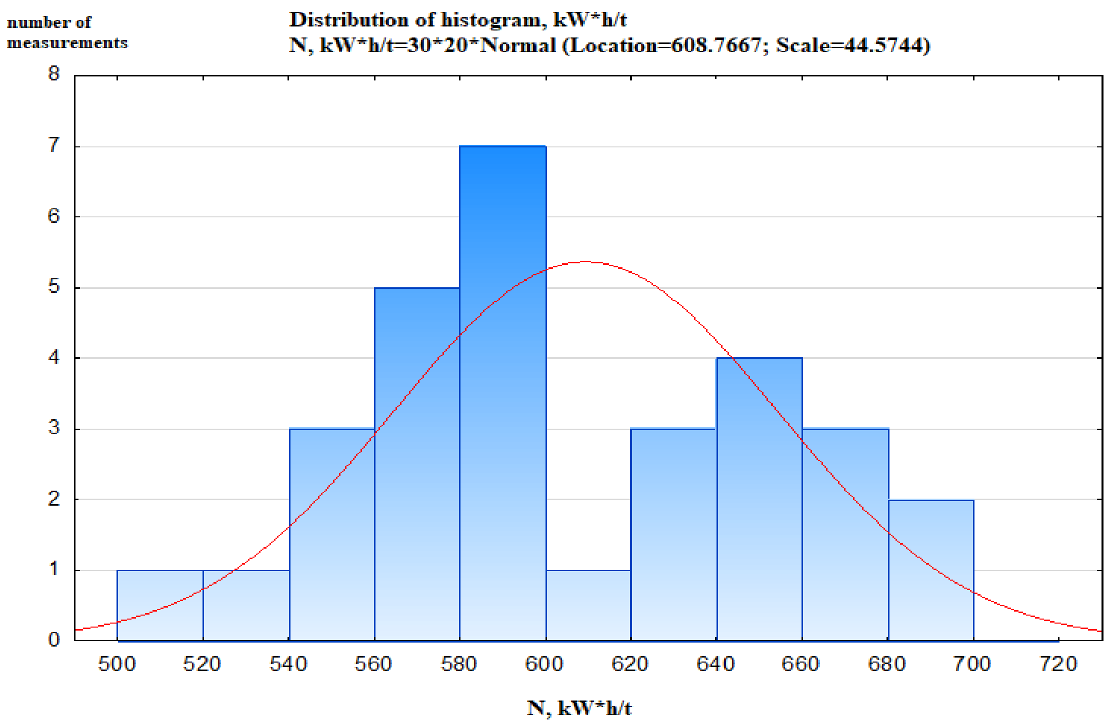

Fig. 4 Histogram of the distribution of the rate of electricity consumption (N, kW h/t) per processed ton of cotton

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IV. EXPERIMENTAL RESULTS

Empirical results were evaluated based on formulas (1) - (5) and calculations were performed using the "Statistica" software package version 10.0. Accordingly, the variance estimate is determined by the following formula:

$$SS = \frac{\sum_{i=1}^{m}\left(Y_{1g} - \bar{Y}_g\right)^2}{m-1}, \tag{1}$$

all variances are drawn from samples of the same size m, then the degrees of freedom for all variances are the same and equal

$$df = m - 1, \tag{2}$$

the average square of the effect is determined according to the following formula

$$MS = \frac{SS}{df}, \tag{3}$$

Student's test is used to test the hypothesis of equality of mathematical expectations given normal distributions with equal distributions in two samples [4-8].

$$t = \left(Y_{1g} - \bar{Y}_g\right) \Big/ \left(SS \cdot N\right)^{\frac{1}{2}}, \tag{4}$$

where N is the sample size.

The test of the hypothesis about the adequacy of the model was carried out using the F-Fisher test. Fisher's criterion allows testing the null hypothesis that two common variances and are equal.

The ratio of variances is used as a control value.

$$F = \frac{D_x}{D_y}, \tag{5}$$

where $D_x = \frac{1}{N-d}\sum_{g=1}^{N}\left(Y_{1g} - \bar{Y}_g\right)^2$; $D_y = \frac{1}{N}\sum_{g=1}^{N} SS$; N - sample size; d - the number of terms of the approximation polynomial.

It is known that when determining the value according to expression (5), the indicator of the criterion F is smaller than the table obtained by the level of significance q%, that is, the null hypothesis is accepted and the mathematical model of electricity consumption is considered sufficient at a certain level of reliability. Otherwise, it is rejected and the description (model) is recognized as not appropriate for the object.

According to the expressions (1) - (5), Table 2 shows the results of the regression analysis, evaluating the effect of the mathematical model of electricity consumption.

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Table 2

Regression analysis results

N=30	Regression summary of electricity consumption: W, kW*h R= .55618283 R?= .30933934 Adjusted R?= .12916700 F(6.23)=1.7169 p< .16210 Standard error: 6417.4					
	b*	Std.Err. of b*	b	Std.Err. of b	t(23)	p-value
Indicator			29407,46	19271,13	1,525985	0,140649
a, g/m3	-0,545277	0,765778	-1934,51	2716,79	-0,712057	0,483590
b, g/m3	-0,260336	0,588472	-217,92	492,59	-0,442394	0,662337
c, g/m3	0,314957	0,421989	1442,01	1932,04	0,746364	0,463009
g, g/m3	0,002335	0,460315	11,97	2360,54	0,005073	0,995996
r, g/m3	0,141355	0,267545	1158,06	2191,88	0,528341	0,602324
f, g/m3	-0,100414	0,304884	-846,50	2570,18	-0,329353	0,744869

In this case, Effect is the impact value of the contribution of each factor to the consumed electricity; Std. Error – standard error of effect evaluation; t (df) and p-value – t-criterion and level r value; t-test is used to test the hypothesis that the free term is equal to zero; F –F-criterion value; df –F- criterion is the number of degrees of freedom; p - level of significance; Coeff. - equation coefficients; Std. Err. Coeff. – standard error of coefficients (equation).

V. CONCLUSION AND FUTURE WORK

Thus, as a result of the performed regression analysis, the moisture content of the cotton raw materials coming out of the bundle (a, g/m^3), the contamination of the cotton raw materials coming out of the bundle (b, g/m3), the moisture content of the cotton raw materials coming out of the gin (c, g/ m^3), a model of electricity consumption (W, kW·h) was obtained as a function of contamination of cotton raw materials coming out of gin (g, g/m^3), seed moisture (r, g/m^3) and fiber moisture (f, g/m^3):

$$\boldsymbol{W = 29407,46 - 1934,51a - 217,92b + 1442,01c + 11,97g + 1159,06p - 846,5f},$$

that is, the model of electricity consumption is determined, which is compared with the initial data set obtained during the experiment with Eq. The analysis of the compatibility of the model with the initial data is explained by the sufficient accuracy of the obtained results.

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