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RESEARCH OF PROCESS OF THERMAL TREATMENT OF COTTONSEED JAM

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Abstract: The article covers the main factors influencing the process of thermal treatment of cottonseed jam, which are the heat flow density, length of radiation wave, thickness of the layer of the material being processed and duration of processing, ad which are were studied on experimental installation.

Keywords: Thermal treatment, influencing factor, heat flow, extraction, intensity, duration, oil content.

Introduction

The process of roasting the cottonseed jam is one of the main and necessary stages of obtaining cottonseed oil by pressing. The quality of the extracted oil and meal largely depends on the roasting process. However, there are factors that affect the course of the roasting process: the density of the heat flow with the maximum length of radiation wave λ = 1.1 micron, the thickness of the layer of the processed material and the duration of processing. Their influence on the process of thermal treatment of cottonseed jam was studied on experimental IR installation.

The jam, moistened according to a well-known method from /5/, have been used for experiments. A portion of jam weighing 100 g is placed on a pallet with a certain thickness with the IR-lamps on, and the time is recorded.

The process of thermal treatment of cottonseed jam was studied under the influence of short-wave infrared radiation of IR generators of KG-200-1000 type, recommended in /1, 2, 3, 4, 5/ at a maximum length of radiation wave λ = 1.1 micron. By changing the density of the heat flow during the thermal treatment, we determine the yield of black oil and its quality indicators. As can be seen from the table 1, with an increase in the heat flow density from q = 4.8 kW/m^2, the yield of black oil decreases, as well as the acid number increases, which negatively affects the yield of refined oil.

Table 1

Dependence of black oil yield								
From the length of radiation wave								
λ[micron]	0,5	0,7	0,85	1,0	1,15	1,25	1,3	1,5
У[Гр]	1,5	2,5	3,1	3,2	3,5	3,1	2,4	1,7
From the heat flow density								
q[kW/m^2]	3,0	3,8	4,0	4,4	4,8	5,2	5,6	6,0
У[Гр]	2,2	2,6	3,3	3,95	4,4	4,2	4,1	3,8
From the thickness of the layer of the processed material with one-sided irradiation								
δ[mm]	8	10	12	14	15	16	18	20
У[Гр]	1,2	2	2,8	3,7	3,9	3,8	3	1,7
At double-sided radiation								
δ[mm]	8	10	12	15	18	22	25	30
У[Гр]	1,4	2,3	3,1	3,7	4,1	4,8	4,6	3,9

With a decrease in the heat flow density, the duration of the thermal treatment process lengthens, the acid number increases, and the quality of the thermal-moisture treatment deteriorates in the lower layers of the processed jam (undercooking).

With an increase in the thickness of the layer of the processed material over 15 mm, undercooking in the lower layers can be traced, which reduces the yield of press black oil and increases the oil content of the oilcake, as a result, the extraction process becomes more difficult. This is because radiation does not penetrate into the pulp in the lower layers; thermal-moisture treatment occurs due to the thermal conductivity of the layer. With an increase in the cooking time, the upper layers are overcooked. At the same time, the change in the heat flow density and the layer thickness affect the humidity (Fig. 1, 2) and temperature

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(Fig. 3, 4) of the processed material during the thermal treatment (roasting).

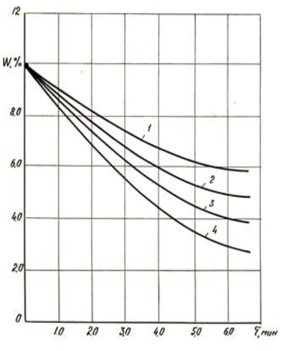

Fig. 1. The change in the moisture content of jam over time at $\delta = const = 22\ mm$: $1 - q = 3.3\ kW/m^2$, $2 - q = 3.9\ kW$ $4 - q = 6.0\ kW/m^2$

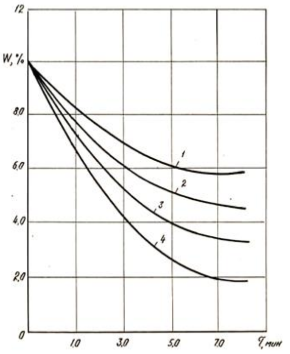

Fig. 2. The change in the moisture content of jam over time at $q = const = 4.8\ kW/m^2$:
$1 - \delta = 30\ mm$, $2 - \delta = 25\ mm$, $3 - \delta = 20\ mm$, $4 - \delta = 10\ mm$

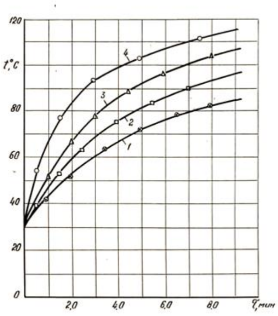

Fig. 3. Change in the temperature of jam depending on the time of IR treatment at $q = 4.8\ kW/m^2$ $W = 9,5\%$ $1 - \delta = 30\ mm$, $2 - \delta = 25\ mm$, $3 - \delta = 15\ mm$, $4 - \delta = 10\ mm$

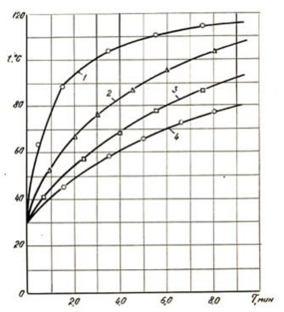

Fig. 4. Change in the temperature of jam depending on the time of IR treatment at $\delta = 25\ mm$, $W = 9,5\%$: $1 - q = 6.0 \frac{kW}{m^2}$, $2 - q = 4.8\ kW/m^2$, $3 - q = 3.9 kW/m^2$, $4 - q = 3.3\ kW/m^2$

The effect of IR-roasting on the extraction time is determined in the following sequence:

a) sampling of jam. For the experiments, we used the jam of seeds of the 1st grade with oil content of 24%, selected at the Bukhara oil-extraction plant. Oil content of jam is 40%; moisture content is 8.5 ÷ 10.5%. Jam samples were taken manually brought to a weighed portion of 500 g for analysis.

b) treatment of jam. The heat flow is set $q = 4.8\ kW/m^2$, the processing time is τ = 10 minutes, the thickness of the jam layer is δ = 22 mm. The product of the moisture-thermal treatment of the jam in the roaster, called the pulp, is taken out of the installation. The residual moisture content of the IR-treated jam is 4.5 ÷ 5%. Separately, after IR-treatment of the product and after treatment in a roaster, 30 g of pulp are taken, placed in a 250 ml flask, poured over with 150 ml of extraction gasoline and carefully mixed. Then the contents are poured onto a sieve with a diameter of 0.25 mm and the solvent content in the product is determined, direct extraction is carried out in 8 flasks (4 flasks for the pulp after IR-treatment and 4 flasks for the pulp from the roaster). The extraction process is carried out under isothermal conditions. Before processing, each flask is numbered and the duration of the extraction is indicated:

I r, I IR-flasks $\tau = 30\ min$;

II r, II IR-flasks - $\tau = 1\ h$;

III r, III IR-flasks - $\tau = 1{,}5\ h$;

IV r, IV IR-flasks - $\tau = 2\ h$.

After the extraction time has finished, miscella and the remainder of oilcake are taken from each flask in turn, and its oil content is determined. The experiments are carried out three times, and then the average value is taken. The data obtained are entered in a comparative Table 2;

c) analysis of the results obtained.

Table 2.

Existing roasting method			IR-roasting of jam		
Duration of extraction, min	Reducing oil in the material		Duration of extraction, min	Reducing oil in the material	
	g	%		g	%
0	39.0	100	0	39.0	100
30	31.7	81.3	30	25.0	64.1
60	28.4	72.8	60	24.1	61.6
90	24.8	63.6	80	23.9	61.3
120	24.0	61.5	100	23.8	61.0
150	23.8	61.0	120	23.8	61.0

The jam roasted in a 6-vat brazier in the traditional way is extracted until the oil is completely removed within 150 minutes. The jam prepared by IR-roasting is extracted much faster. So, in the first case, in 30 minutes of extraction 18.7% is extracted (at 40% oil content of jam), and in the second this value is 35.9%. To extract 39% of the oil, in the first case, the extraction time reaches 150 minutes, and 100 minutes in the second case.

Mathematical description of the effect of IR roasting on the extraction time is given by the formula.

$$y = 79.9216 \cdot e^{-0.00367\tau}$$

In conclusion, thereby, under the influence of IR-rays, intensive penetration of moisture into the cells of the oil-containing material occurs, and the heating of the material and partial evaporation of moisture, the destruction of the oil-containing cells of the material leads to the opening of the pores of the material, and this leads to significantly increasing its extractability. In addition, with IR-roasting of jam, as with the existing method, complete extraction of the oil is ensured, and extraction process is reduced by 1.5 times.

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