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Impact of Pulsed Electric Field on Structure Formation of Cotton Shell during Extraction

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ABSTRACT: Change of structure formation of cottonseed cake by impact of pulsed electric field (PEF) is determined. Electric conductivity of raw materials without and with processing in PEF in different frequencies is determined. Increase in oil yield in extraction technology based on the disintegration of raw material cells was revealed

KEYWORDS: cottonseed cake, extraction, pulsed electric field, macrostructure of raw material, technological parameters, disintegration index, electrical conductivity

I. INTRODUCTION

The extraction of plant oil from oil-containing raw materials is carried out by methods of compression and extraction [1,2]. The extraction process is characterized by a high oil yield [2] and the least material technological and energy costs [1].

Recently, to intensify the extraction of oil-containing raw materials, various methods of electrophysical processing have been used, both raw materials and the solvent used for this process [3-8]. In this direction, large-scale studies have been carried out in the Russian Federation [9.10] and foreign [11-13]. Research is focused mainly on the use of sunflower and soybean oil seeds as raw materials.

This work is devoted to the study of the intensification of the extraction process using methods of exposure to a pulsed electric field on the extracted raw materials. Particular attention is paid to changing the macrostructure of a cotton shell by the action of a pulsed electric field (IEP).

Objective aimed at studying the influence of a pulsed electric field on the structure formation of a cotton shell during extraction.

Objects of study a cotton shell and a pulsed electric field. The determined parameters were electric frequencies, microstructure of cell membranes, and field strength.

II. MATERIALS AND METHODS

Research on the macrostructure of cotton cake was carried out by microcopying. Extraction was carried out in a laboratory setup. Technological indicators of the extraction of raw materials by the action of a pulsed electric field are established by modern methods of physicochemical research [14,15].

III. RESULTS AND DISCUSSION

Impulse electric field treatment contributes to the destruction of the integrity of the cell membranes of cotton seeds. At values of the electric field strength above 1 kV / cm, temporary pores form on the surface of the membranes and the process of reversible cell disintegration occurs, the effect of which affects the efficiency of the extraction process.

Figures 1 and 2 show the dependences of the impedance and electrical conductivity of the oil material on the frequency at various mass ratios of the solvent from 10 to 50% before and after processing the IES, with the same field strength 7kV · cm-1. These dependences show that the main deviation of the values of the impedance of oil-bearing material before and after processing the IES occurs at low frequencies (up to 10 kHz) (Fig. 1), while for the values of electrical conductivity, the changes in the values before and after processing the IES are presented at high frequencies (more 10kHz). Thus, knowing the values of the electrical conductivity indices, it is possible to express the magnitude of the effectiveness of the action of IEP on cell destruction (Fig. 3) using the index of disintegration index Z.

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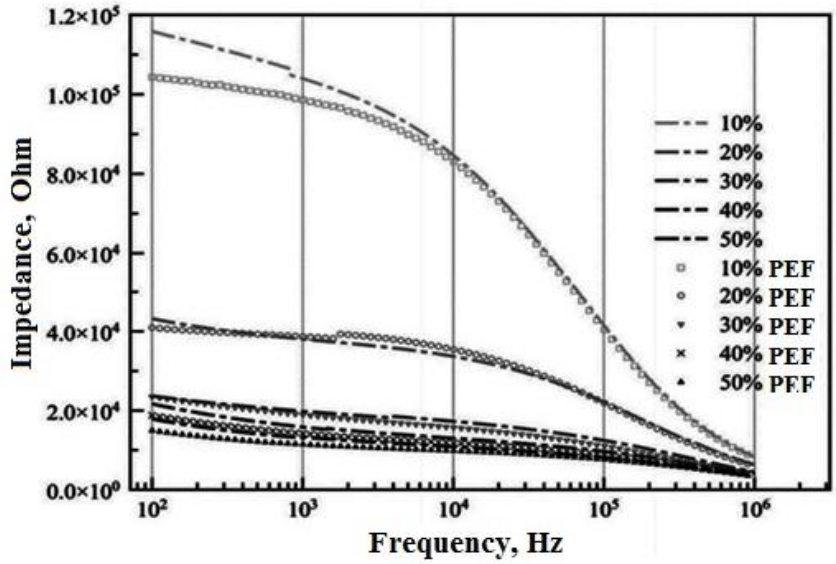

Figure 1 - Dependence of the impedance of processed and untreated IES chopped cotton seeds in frequency with a weight ratio solvent 10, 20, 30, 40 and 50 wt.%

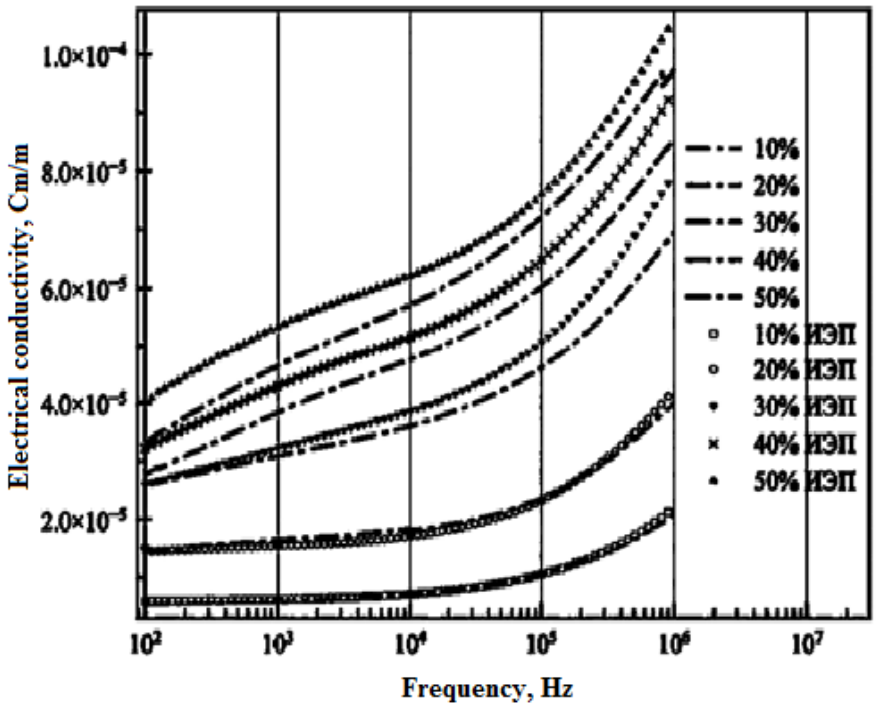

Figure 2 - Dependence of the electrical conductivity of the treated and untreated IEP of crushed cotton seeds on the frequency with a solvent mass ratio of 10, 20, 30, 40 and 50 wt%

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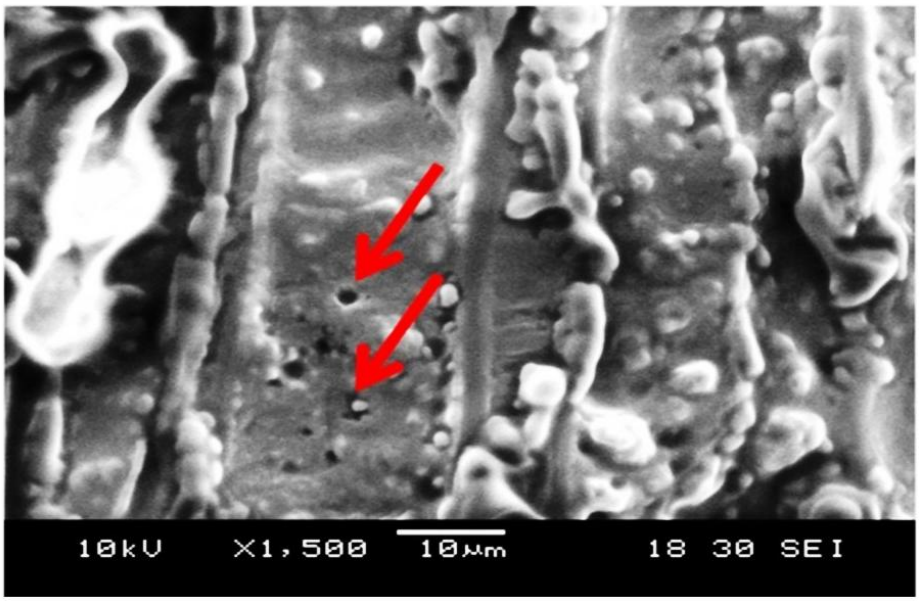

Figure 3 - Formation of pores on the surface of the cell membrane after IEP impact

Figure 4 shows a graph of the dependence of the disintegration index on the field strength in the studied range, built according to the data of experiments No. 5, 8, 11, 19 and 22 (Table 1) after the IEP processing the frequency in the range 100 Hz - 1 MHz, with an electric field strength of 7 kV /cm.

Table 1
Experimental Results on the Hyper Greco-Latin Square

№ experiment	E (кВ/см)	*F (Гц)*	C (%)	τ (с)	W (мкс)	Y (%)
1	1	0,5	10	10	10	38,1
2	1	1,5	20	30	20	40,1
3	1	5	30	60	30	38,4
4	1	10	40	90	40	40,5
5	1	15	50	120	10	42,4
6	3	0,5	30	90	50	39,6
7	3	1,5	40	120	10	45,4
8	3	5	50	10	20	44,2
9	3	10	10	30	30	46,3
10	3	15	20	60	40	41,8
11	5	0,5	50	30	40	47,3
12	5	1,5	10	60	50	40,5
13	5	5	20	90	10	43,2
14	5	10	30	120	20	40,0
15	5	15	40	10	30	47,4
16	6	0,5	20	120	30	44,2
17	6	1,5	30	10	40	44,3
18	6	5	40	30	50	47,8
19	6	10	50	60	10	45,1
20	6	15	10	90	20	45,6
21	7	0,5	40	60	20	47,3
22	7	1,5	50	90	30	48,2

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23	7	5	10	120	40	47,0
24	7	10	20	10	50	44,8
25	7	15	30	30	10	47,2

With an increase in the field strength, the disintegration index also grows, reaching a maximum of 41%, at a field strength of 7 kV / cm

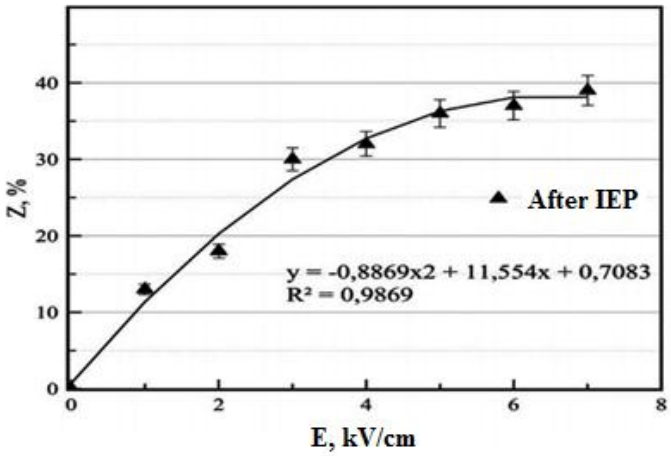

Figure 4 - Dependence of the disintegration index on the field strength

Disintegration (opening) of cells caused by IEP processing allows to accelerate or facilitate the release of intracellular components, thus accelerating the extraction process.

Thus, the studies carried out made it possible to establish some regularities of the extraction of cotton cake by the influence of IEP.

Conclusion: It has been experimentally established that the disintegration of cotton shell cells by the action of a pulsed electric field makes it possible to increase the yield of oil in the technology of extraction of oil seeds.

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