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Editorial

The National Institute of Research-Development for Machines and Installations designed to Agriculture and Food Industry - INMA Bucharest has the oldest and most prestigious research activity in the field of agricultural machinery and mechanizing technologies in Romania.

Short History

- *In 1927, the first research* ***Center for Agricultural Machinery*** *in Agricultural Research Institute of Romania - ICAR (Establishing Law was published in O.D. no. 97/05.05.1927) was established;*
- *In 1930, was founded* ***The Testing Department of Agricultural Machinery and Tools*** *by transforming Agricultural Research Centre of ICAR - that founded the science of methodologies and experimental techniques in the field (Decision no. 2000/1930 of ICAR Manager - GHEORGHE IONESCU ŞIŞEŞTI);*
- *In 1952, was established the Research Institute for Mechanization and Electrification of Agriculture - ICMA Băneasa, by transforming the Department of Agricultural Machines and Tools Testing;*
- *In 1979, the Research Institute of Scientific and Technological Engineering for Agricultural Machinery and Tools – ICSITMUA was founded - subordinated to Ministry of Machine Building Industry - MICM, by unifying ICMA subordinated to MAA with ICPMA subordinated to MICM;*
- *In 1996 the National Institute of Research-Development for Machines and Installations designed to Agriculture and Food Industry – INMA was founded – according to G.D. no.1308/25.11.1996, by reorganizing ICSITMUA, G.D no. 1308/1996 coordinated by the Ministry of Education and Research G.D. no. 823/2004;*
- *In 2008 INMA has been accredited to carry out research and developing activities financed from public funds under G.D. no. 551/2007, Decision of the National Authority for Scientific Research - ANCSno. 9634/2008.*

As a result of widening the spectrum of communication, dissemination and implementation of scientific research results, in 2000 was founded the institute magazine, issued under the name of SCIENTIFIC PAPERS ***(INMATEH),*** *ISSN 1583 – 1019.*

Starting with volume 30, no. 1/2010, the magazine changed its name to ***INMATEH - Agricultural Engineering,*** *appearing both in print format (ISSN 2068 - 4215), and online (ISSN online: 2068 - 2239). The magazine is bilingual, being published in Romanian and English, with a rhythm of three issues / year: January-April, May-August, September-December and is recognized by CNCSIS – with B^{+} category. Published articles are from the field of AGRICULTURAL ENGINEERING: technologies and technical equipment for agriculture and food industry, ecological agriculture, renewable energy, machinery testing, environment, transport in agriculture etc. and are evaluated by specialists inside the country and abroad, in mentioned domains.*

*Technical level and performance processes, technology and machinery for agriculture and food industry increasing, according to national requirements and European and international regulations , as well as exploitation of renewable resources in terms of efficiency, life, health and environment protection represent referential elements for the magazine „****INMATEH - Agricultural Engineering****”.*

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CONTENT

KINETIC FEATURES OF VIBRATING AND FILTRATION DEWATERING OF FRESH-PEELED PUMPKIN SEEDS
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ОСОБЛИВОСТІ КІНЕТИКИ ВІБРАЦІЙНО-ФІЛЬТРАЦІЙНОГО ЗНЕВОДНЕННЯ СВІЖЕОЧИЩЕНОГО НАСІННЯ ГАРБУЗА

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Keywords: *vibration and filtration dewatering, pumpkin seeds, drying coefficient, vibration.*

ABSTRACT

Drying coefficients depending on the main process parameters of fresh-peeled pumpkin seeds (FPPS) vibration and combined dehydration and relative drying coefficient on the basis of the constructed graphic dependence are defined. Dependences for calculation of moisture and time of FPPS dewatering in the studied change range of drying process parameters are displayed.

РЕЗЮМЕ

Визначено коефіцієнти сушіння залежно від основних параметрів процесу вібраційно-фільтраційного зневоднення свіжеочищеного насіння гарбуза (СОНГ) та відносний коефіцієнт сушіння на основі побудованої графічної залежності. Виведено залежності для розрахунку вологості та часу зневоднення СОНГ в досліджуваному діапазоні зміни параметрів процесу сушіння.

INTRODUCTION

At present stage of industry development technical and economic policy of conserving resources becomes increasingly important. It requires the implementation of new scientific ideas and technologies in production intensification. Following a strict regime of economy of raw materials, fuel and energy with simultaneous intensification technologies can be up to 75...85% increase in inputs. Drying, as a process, is the main production stage and most significantly affects its economic indexes *(Rymar T., 2009)*, accounting for about 20% of total production costs *(Poperechnyj A., 2007)*.

It is known that high-intensity filtering dehydration is dispersed by drying and sheet material and has advantages over traditional methods of dehydration, such as: the availability period of the free moisture mechanical displacement; the use of thermal agent with low temperature capabilities; reducing costs of thermal energy in the process, increasing the speed of drying; improving the quality of drying materials, avoiding stage of cleaning agent heat *(Mykychak B. et al, 2012)*. Significant prospects for improving the efficiency of dehydration of fresh-peeled pumpkin seeds (FPPS), as a subject to final sowing and food (pharmaceutical) demands is a combination of filtration and dewatering vibrating action, requiring an in-depth theoretical and experimental study.

Many authors *(Hanyk Ya., 1992; Atamanjuk V., 2007; Stanislavchuk O., 2007)* have devoted their papers to the investigation of heat and mass transfer process during drying of materials of different nature, while *(Tsurkan O. et al, 2014)* researched the process vibration filtration dehydration of FPPS, a paper based on experimental data and where is obtained basic analytical dependence describing the process hydrodynamics. In the work *(Tsurkan O. et al, 2015)*, it is shown the time dependence of the critical speed and vibration-filtration dehydration, and proved dominant influence pressure drop and vertical oscillations of dehydration intensity of high damp fresh-peeled pumpkin seeds in the first drying period on the basic parameters of the process. Theoretical and experimental study of heat transfer processes during the second period of filtration, dispersed materials drying is considered in detail *(Atamanjuk V. and Gumnytskyj Ya., 2009)*. Energy and technical, technological aspects of drying process intensification of high damp seeds, including pumpkin seeds, are covered in *(Palamarchuk I. et al, 2016).*

In the article, we generalize the vibration kinetics and combined dehydration of FPPS in the second period and set dependencies for calculating humidity and FPPS dehydration time in the test range changing process parameters, in particular, the ratio of vertical and horizontal components of the vibration amplitude at a vibration frequency *f* = 15 Hz revs of stirrer-cleaner *n* from 0 to 1.2 r/min, as auxiliary operating parameters, in the vibrating dryer *(Palamarchuk I. et al, 2016)*.

MATERIAL AND METHODS

Based on own studies *(Tsurkan O. et al, 2009)* and the existing ones *(Holubkovych A., 1986*) we determined the type of relation of moisture and material and the corresponding interval limits of FPPS humidity, making it possible to justify the dehydration rational ways (table 1) and the corresponding constructive scheme of drying equipment *(Pravdjuk N. et al, 2011)*. In general, the process of combined dehydration of FPPS, of the 1st class of cleaning seeds and surface layer (according to the classification given in *(Holubkovych A., 1986*), also depending on the type of material, and moisture relation based on moisture intervals (table 1) can be divided into two conditional periods. In the first period of FPPS dehydration, humidity changes in the range 44 – 52% as typical mechanical removal of moisture through the channels between seeds (BSC) – macro pore layer of FPPS and pre-slight warming of seeds. For the second period of combined dehydration of FPPS humidity changes within 44 – 38% as typical decreasing drying speed and kinetic curves depicted curved sections, the angle of which indicates a slowdown in the process of dehydration (*Tsurkan O. et al, 2015*). This can be explained by the fact that the amount of moisture, delayed both by adsorption forces (bridging, drip, wet point) and surface tension forces on the seeds surface, is gradually reducing, and the process of evaporation due to heat small seeds is quite slow.

After removing moisture through BSC, the layer of FPPS still contains a significant amount of moisture that is delayed both by adsorption forces and due to the presence of blind channels from which moisture is replaced. In through BSC of complex form streams of drying agent turbilize, tear film of moisture in the form of small droplets of fog and render them out of material structure.

To reach the humidity range of about 38% cohesive-adhesive properties of seed layer are weakened, and seed acquires discrete properties (table 1).

Table 1

Rational methods of FPPS dehydration depending on type of relationship between moisture and the material

Type of moisture relation during dehydration	The hydrodynamic characteristics of FPPS	Rational way of dehydration		The driving factors and the intensification of dehydration process
		Filtration dehydration	Convection drying	
Capillary **W_{ca} =(52- 47)%**	**Local drag reduction adjacent to vibrating surfaces of LFPPS**	**Filtering displacement of moisture from cross-mating BSC "top-down"**	**Preheat of LFPPS, slight evaporation of moisture**	**Submission of a drying agent of FPPS "top-down"** **• Slight heating of the drying agent (t = 30°C)** **• Dilution under FPPS (P_d = 450 Pa)** **• Vibration action** **• Preferably vertical vibrations** **• The mechanical mixing of LFPPS** **• Cleaning of perforated surfaces of supply-drying agent selection**
	Fluidization, destruction of cohesive-adhesive bonds	**Displacement of moisture from the deadlock, non-connected BSC "top-down"**		
Rope **W_r =(47- 44)%**		**Two phase movement drip-air mixture "top-down"**		
Capillary-butt (glands) **W_{cb}=(44-38)%**				
Capillary-butt (spot) W_{cb} =(38-24)%	Reduction of hydrodynamic resistance, ability to aerovibroboiling	Two-phase movement drip-air mixture "bottom-up"	Intense convective drying in AVBL	Vibration performance, stable AVBL •Filing drying agent «bottom-up» • Heating drying agent (t_{da2} = 50°C) • Pre-heating of seeds (t_{s1} = 26°C)
Surface film-drop W_{sf} =(24-15)%				
Inside physico-chemical relation $W_{ph\ ch}$ =(15-10)%				

Note: *LFPPS – layer of fresh-peeled pumpkin seeds; AVBL – aerovibroboiling layer. Highlight: vibration filtration, dewatering study method.*

Under the influence of vibration and drying agent flow in the direction of "perforated bottom – a layer of seeds" created aerovibroboiling layer (AVBL), which can increase the temperature of the drying agent and significantly intensify the process of dehydration, which can be divided into two periods: the constant and the decreasing speed drying.

In this article, we studied the kinetics of the second period of vibration filtration dehydration of FPPS within the humidity range 44 – 38%.

Experimental studies were conducted using research and industrial design vibration dryers, developed and manufactured at the processes and equipment department for food processing industries named by Professor P.S. Bernik Vinnytsia, National Agrarian University, realizing vibration filtration dehydration and convective drying AVBL *(Pravdjuk N. et al, 2011)*.

To summarize the kinetics vibration filtration dehydration of FPPS in the second period we used the equation curve speed drying method proposed by A. Lykov, which has the form *(Lykov A., 1968)*:

$$-\frac{dW}{d\tau}=K\cdot\left(W-W_{\mathrm{m}}\right) \qquad (1)$$

where:

$\frac{dW}{d\tau}$ – the moisture change over time (speed drying), %/s;

W – running material moisture, %;

W_{m} – the equilibrium moisture content, %;

K – drying rate (1/s), which is defined by the formula: $K=\chi\cdot N$;

χ – relative drying rate, %;

N – drying speed in the first period, %/s.

The integral form of equation (1) can be written:

$$\frac{W-W_{\mathrm{m}}}{W_{\mathrm{cr}}-W_{\mathrm{m}}}=e^{-K\cdot(\tau-\tau_{\mathrm{cr}})}\,. \qquad (2)$$

Having logarithmic equation (2) we get:

$$\ln\left(\frac{W-W_{\mathrm{m}}}{W_{\mathrm{cr}}-W_{\mathrm{m}}}\right)=-K\cdot\left(\tau-\tau_{\mathrm{cr}}\right) \qquad (3)$$

To determine the drying coefficient *K* for the research of kinetics vibration filtration dehydration of FPPS in the second period we built graphical dependence: $\ln\left(\frac{W-W_{\mathrm{m}}}{W_{\mathrm{cr}}-W_{\mathrm{m}}}\right)=f\left(\tau-\tau_{\mathrm{cr}}\right)$, (fig.1-4), which are linear.

RESULTS

Drying factor *K* is defined as the slope of the line to the vertical axis (fig. 1-4). The resulting figures are presented in table 2. The coefficient drying *K* is not a constant (the ratio increases with the vertical and horizontal components of vibration amplitude, with increasing temperature of the coolant and reducing the height of the material) (table 2).

To determine the drying length in the first period *(Tsurkan O. et al, 2015)* we considered the graphical dependence of the critical drying time τ_{cr} and the speed of drying *N* in the first period (fig. 5), according to which such an evident relationship results:

$$\tau_{\mathrm{cr}}=\tau_{\mathrm{I}}=\frac{28{,}1}{N^{0{,}83}} \qquad (4)$$

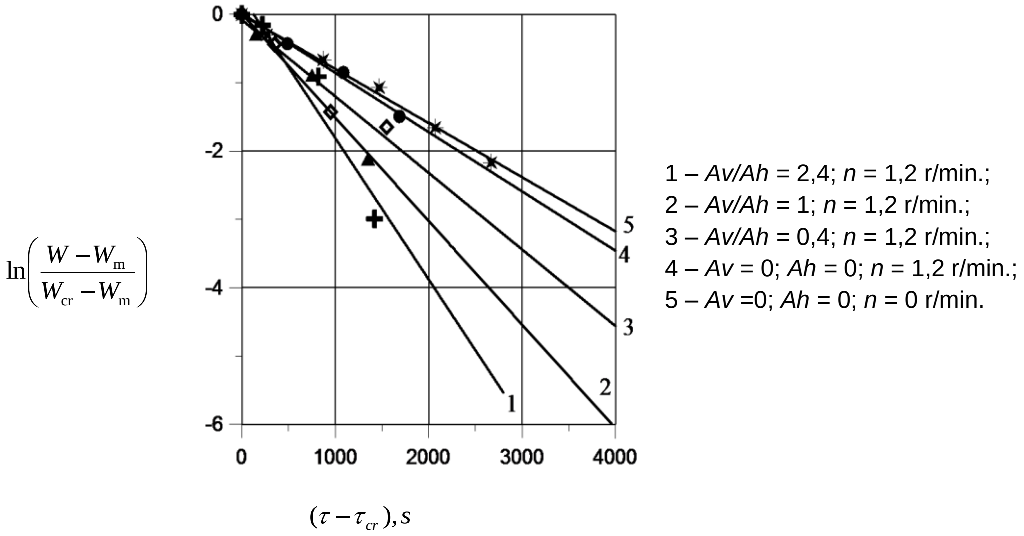

Fig. 1 – Determination of FPPS drying K by vibration filtration dehydration at different ratio of vibration amplitude vertical and horizontal components under the following conditions:

$A\omega^2$ = 55 m/s^2; t = 30°C; K_d = 0,75; ΔP = 1250 Pa

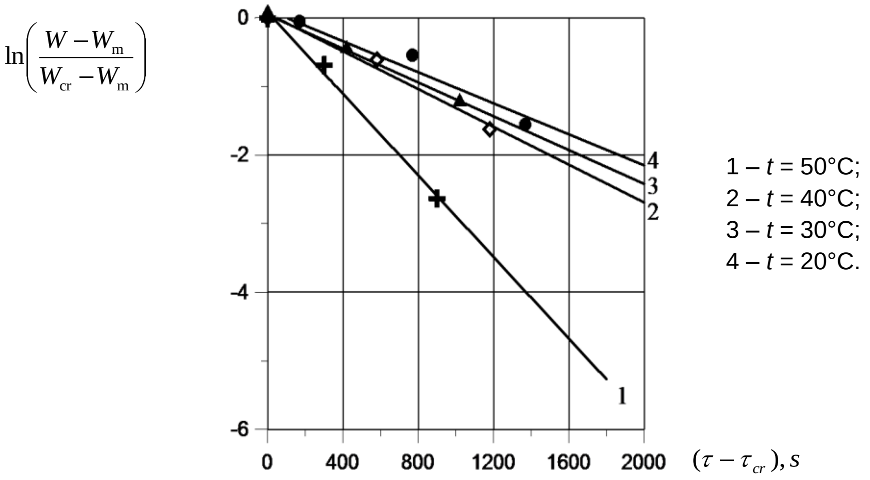

Fig. 2 – Determination of FPPS drying *K* by vibration filtration dehydration at different temperature of drying agent under the following conditions:

K_d = 0,75; ΔP = 1250 Pa; n = 1,2 r/min.; $A\omega^2$ = 55 m/s^2; Av/Ah = 2,4

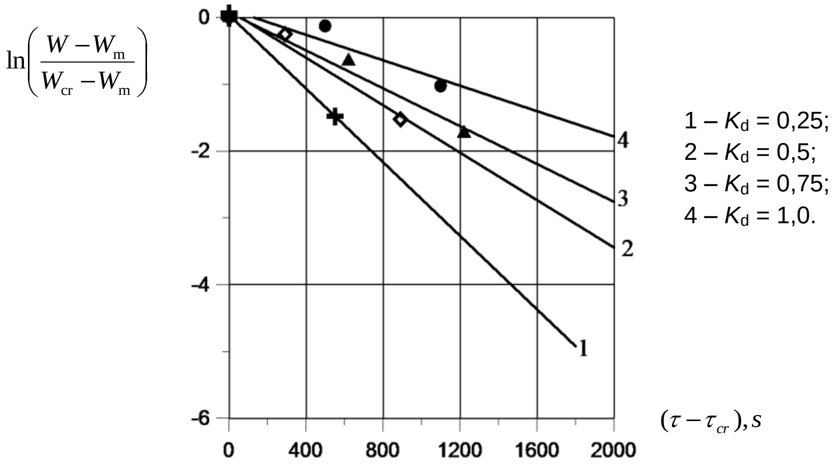

Fig. 3 – Determination of FPPS drying *K* by vibration filtration dehydration at different values of the drying chamber filling circuit K_d under the following conditions:

t = 30°C; ΔP = 1250 Pa; n = 1,2 r/min.; $A\omega^2$ = 55 m/s^2; Av/Ah = 2,4

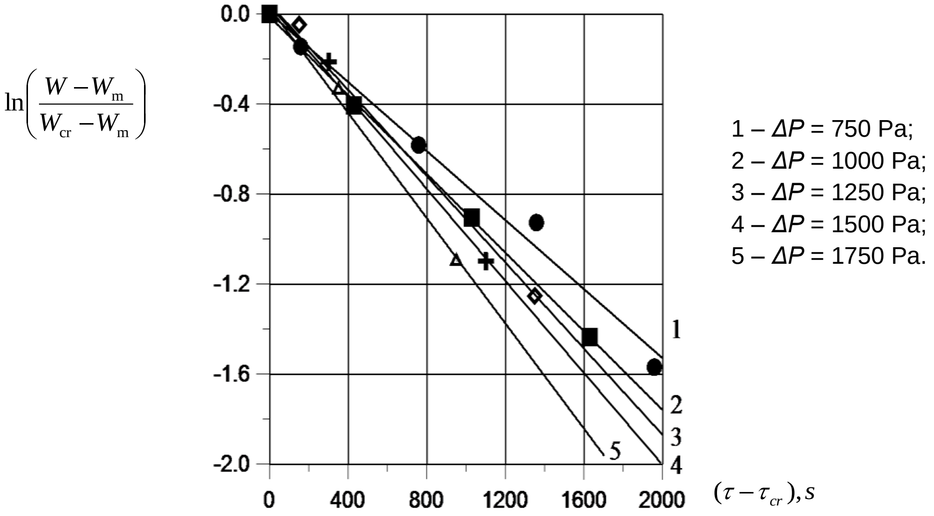

Fig. 4 – Determination of FPPS drying *K* by vibration filtration dehydration at different pressure drop under the following conditions:
$A\omega^2$ = 55 m/s², *t* = 30°C; *K_d* = 0,75; *Av/Ah* = 2,4

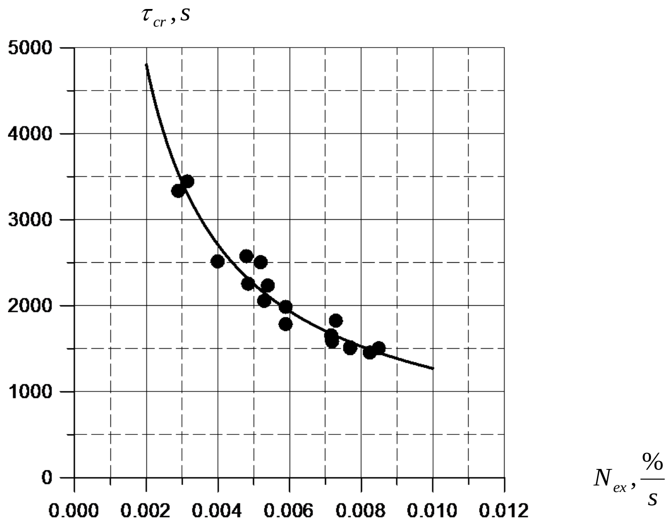

Fig. 5 – Dependence of FPPS drying (*N*) in the first period on vibration filtration dehydration critical time

The calculations built graphical dependence $K = f(N)$ (fig. 6), which is defined as the relative rate of drying slope given in the equation:

$$K = \chi \cdot N \tag{5}$$

Relative factor is drying χ = 0,157%.

Equation (2) is derived to calculate humidity depending on FPPS in time to test a range of parameters for the drying process of the second period:

$$W_{\mathrm{II}} = \left(W_{\mathrm{cr}} - W_{\mathrm{m}}\right) \cdot e^{-0,157 \cdot N \cdot \left(\tau - \tau_{\mathrm{cr}}\right)} + W_{\mathrm{m}} \tag{6}$$

Substituting (4) into the equation (6) we have:

$$W_{\mathrm{II}} = \left(W_{\mathrm{cr}} - W_{\mathrm{m}}\right) \cdot e^{-0,157 \cdot N \cdot \left(\tau - \frac{28{,}1}{N^{0,83}}\right)} + W_{\mathrm{m}} \tag{7}$$

The investigations make it possible to track mutual parameters of first and second periods of FPPS vibration-process filtration dehydration (fig. 6).

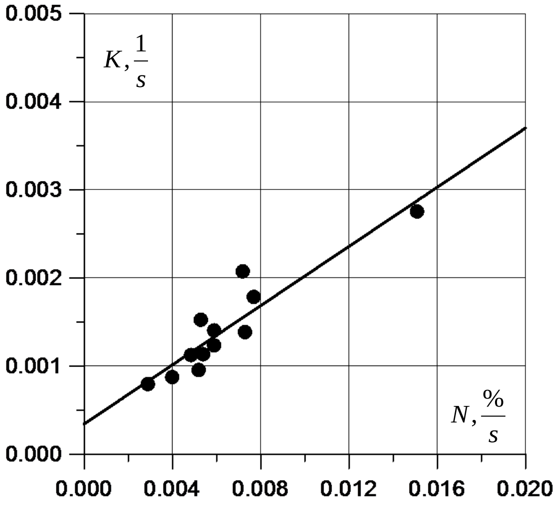

Fig. 6 – Dependence of drying *K* (the second period) on the rate of FPPS vibration filtration dehydration *N* (in the first period)

The drying time in the first period was determined by the formula (4), and the second – in the equation (7) and it is the following:

$$\tau_{\mathrm{II}} = -\frac{1}{0{,}157 \cdot N} \cdot \ln\left(\frac{W - W_{\mathrm{m}}}{W_{\mathrm{cr}} - W_{\mathrm{m}}}\right) \tag{8}$$

The duration of FPPS vibration filtration dehydration investigated the changes range of the process parameters is:

$$\tau_{\text{к}} = \tau_{\mathrm{I}} + \tau_{\mathrm{II}} = \frac{28{,}1}{N^{0{,}83}} - \frac{1}{0{,}157 \cdot N} \cdot \ln\left(\frac{W - W_{\mathrm{m}}}{W_{\mathrm{cr}} - W_{\mathrm{m}}}\right) \tag{9}$$

This shows that the drying depends on the speed of drying *N* in the first period, running, and moisture equilibrium on FPPS movement.

Table 2

Determining factors of drying, depending on changing technological parameters of FPPS vibration-filtration dehydration

Process parameters				First drying period	Second drying period
t, °C	*H*, m	$\frac{A_V}{A_h}$	*n*, r/min	*N*, %/s	*K*, 1/s
30	0.026	2.4	1.2	0.0072	0.00207
		1	1.2	0.0053	0.00152
		0.4	1.2	0.00485	0.00112
		0	1.2	0.004	0.00087
		0	0	0.0029	0.00079
30	0.0075	2.4	1.2	0.0151	0.00275
	0.0175			0.0077	0.00178
	0.026			0.0059	0.0014
	0.03			0.0052	0.00095
50	0.026	2.4	1.2	0.0085	0.00297
40				0.0073	0.00138
30				0.0059	0.00123
20				0.0054	0.00113

Analysing the results of FPPS vibration filtration dehydration process of (table 2) we found that the increase in the ratio of vibration amplitude vertical and horizontal components of the drying $\frac{A_V}{A_h}$ chamber from 0 to 2.4 by the simultaneous increase in rpm stirrer-cleaner *n* from 0 to 1.2 r/min. speed the drying process in the first period increases by 2.4 times.

CONCLUSIONS

1. We determined the type of relation between moisture and the material and the corresponding interval of FPPS moisture limits reasonably rational methods of dewatering and drying constructive scheme appropriate equipment.

2. The increase of the process speed is limited by the maximum allowable temperature of FPPS heating (especially for sowing and pharmaceutical purposes), and fill coefficient of drying chamber volume is limited by compromise productivity values and specific energy equipment.

3. We summarized kinetics vibration filtration dehydration of FPPS in the second period by the method proposed by A. Lykov.

4. According to the research of kinetics vibration filtration dehydration of FPPS in the second period we built a tracker $\ln\left(\frac{W-W_{\mathrm{m}}}{W_{\mathrm{cr}}-W_{\mathrm{m}}}\right)=f\left(\tau-\tau_{\mathrm{cr}}\right)$ determined coefficient *K* and relative drying rate, which is χ = 0.157%.

5. We defined the changes of drying coefficient *K* in key technical parameters of the process: drying coefficient *K* increases with the ratio of vibration amplitude vertical and horizontal components, with increasing temperature of the coolant and reducing the height of the FPPS material.

6. We defined the dependence of calculating FPPS humidity in time to test the range change process parameters and the process of drying and its length depending on drying speed in the first period and running, and the moisture equilibrium on FPPS movement.

7. We confirmed the feasibility process of intensifying FPPS vibration filtration dehydration by increasing the ratio of vibration amplitude vertical and horizontal components of the drying chamber (in case of increase in the ratio $\frac{A_V}{A_h}$ of 0 to 2.4 by the simultaneous increase in rpm stirrer-cleaner *n* from 0 to 1.2 r/min. speed the drying process in the first period increases by 2.4 times).

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