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ELABORATION AND RESEARCHES OF HIGHLY EFFECTIVE INSTALLATION FOR VIBRO-BLOWING DEHYDRATION OF DISPERSIVE WASTE OF FOOD PRODUCTIONS

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There are schemes of equipment for dehydration of damp dispersive waste of food productions (spirit grain, beer pallets, beet pulp, coffee and barley slag) analyzed in this article. These wastes at the majority of food enterprises of Ukraine are poured out onto the ground and that leads to environment pollution. However, in case of dehydration of these wastes to humidity 20 – 25%, they can be used as valuable additions to agricultural forages or as high-energy fuels. Thus, the problems of waste utilization and protection of nature from pollutions are resolved simultaneously. Besides, the enterprise gets a profit from the sales of forage additions or fuel. The known equipment for mechanical dehydration, for example, the screw-presses and the decanter centrifuges, provides the waste final humidity no less 74 – 76%, therefore waste demand of an additional drying after the dehydration at this equipment. That brings to a significant increase of energy expenses. An application of the vibro-blowing dehydration at the installations with the hydraulic pulse drive provides waste final humidity 20 – 25%, but these installations are complex by design, have big dimensions and high cost. A drying in pulverizing or in vacuum dryers is most power-consuming dehydration method (expenses of energy - 740 ÷ 2248 kW h/ ton of dehydrated waste). Equipment for the chemical and biological dehydration is the large multiple-unit complexes with low specific productivity. Therefore, article authors offer a scheme of the installation with the combined unbalanced and hydraulic drive that has a relatively simple design, compact dimensions, high reliability and at the same time, in correspondence with the authors' estimation, will provide necessary, above indicated humidity. Also equations for determination of the main working parameter – the pressure in the press-form of the proposed installation are presented in the article.

Key words: installation for dehydration, damp dispersive waste, food productions, combined unbalance and hydraulic drive.

Fig. 6. F. 16. Ref. 12.

1. Definition of problem

There is a problem of utilization of damp dispersive waste (spirit grain, beer pallets, beet pulp, coffee and barley slag) that is actual for the food enterprises of Ukraine and other countries. In the majority of cases these waste are poured off at the special land plots or in the nearest ponds and this causes severe pollution of the environment. But if to realize the waste dehydration to humidity 20 – 25% their hard phase can be used as a valuable addition to agricultural forages or as high-energy fuel. So to solving of the problem utilization of damp dispersive of food productions it is necessary a highly effective method and an equipment for waste dehydration that provide a full automatized continuous working process, with given productivity and humidity 20 – 25% of dehydrated waste. This equipment must be reliable and simple in utilization and in repair.

2. Analysis of the latest research and publications

There are several dehydration methods of damp dispersive materials: mechanical, thermal, chemical and biological [1]. Also different combinations of the specified main dehydration methods are widely used.



The mechanical method is realized at the screw presses and at the decanter centrifuges (fig. 1), which provide high productivity of the working process. But after dehydration at this equipment waste humidity makes up 74 – 76% [2], therefore it is necessary to perform their additional drying for achievement of this specified value. This feature causes an additional significant energy expense for the whole process. The author of article elaborated and researched a scheme of an installation with the hydraulic pulse drive for the three-stage two-component vibro-blowing dehydration of food production waste [3] (fig. 2). In accordance with calculations, this installation can provide a constant working process with productivity about 792 t of dehydrated waste per h; their final humidity 20 – 22% and power-consuming 6,78 kW h / t of dehydrated waste. However, shortcomings of this installation are design and operational complexity, high level of noise and vibrations in course of operation, high cost. Also the hydraulic pulse drive that is used in this installation can not be reliable enough in the conditions of a mass-line production.

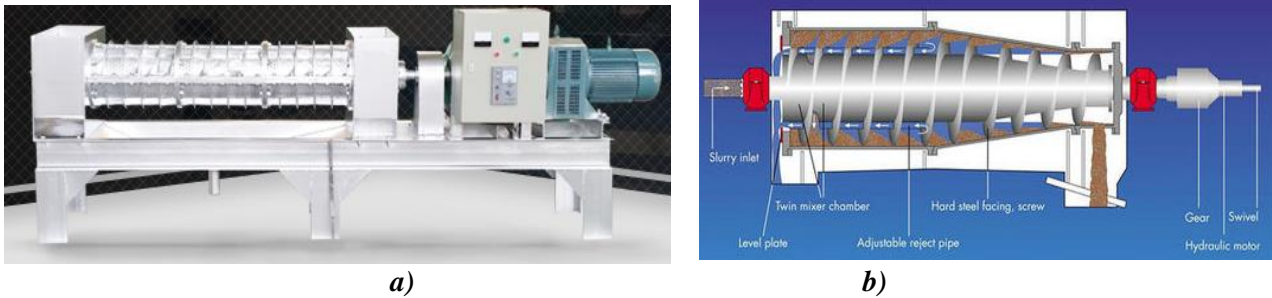


Fig. 1. Photos of a screw press (a) and decanter centrifuge (b)

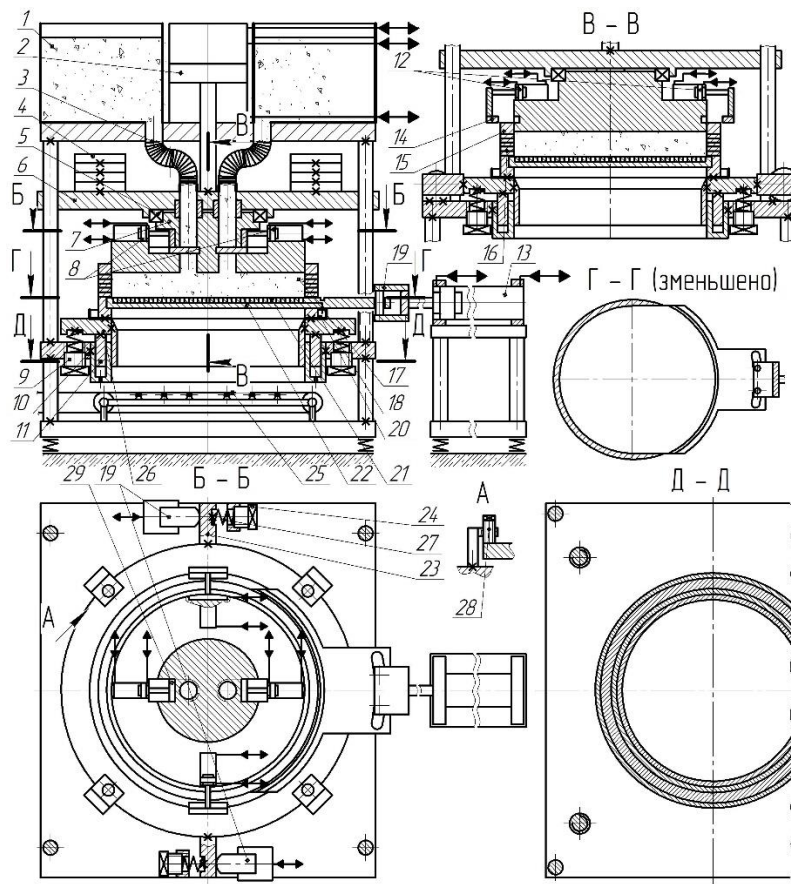


Fig. 2. Scheme of an installation with the hydraulic pulse drive for a three-stage two-component vibro-blowing dehydration of food production waste:

1 – tank with waste; 2, 8, 11, 12, 13, 19 – hydro-cylinders; 3 – crinkled hose; 4 – inertia loads; 5 – bearing; 6 – walking beam; 7 – chisel; 9, 24, 28 – adjusting screws; 10 – bed; 14 – holder; 15 – press-form; 16, 21 – openings for filtrate; 17 – portion of waste; 18, 27 – springs; 20 – tank for filtrate; 22, 29 – dampers; 23 – pivot rod; 25 – band conveyer; 26 – vibro-table



The same shortcomings are typical for the scheme of the installation that was elaborated in the research [4].

A thermal equipment for dehydration – spray, drum, rolling and vacuum driers [5] (fig. 3) – provide waste final humidity 6 – 8%, but they are the most power-consuming machines (expenses of energy 740 ÷ 2248 kW h/ ton). In course of operation of spray driers some part of dehydrated material is remained at the inner surfaces of the drier chamber and some part goes away with air outwards [6].



a)



b)

Fig. 3. Photos of a spray (a) and drum (b) driers

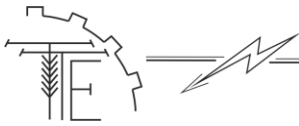
Chemical dehydration methods are realized by the way of an addition to the processed material of various reagents (sulfuric acid or extractants) with a further heating or boiling of the resulting suspension, and removal of the solid phase by a centrifugation or filtration [7]. Most widespread methods of the chemical group are coagulation, flotation and extracting [2, 5]. Their general advantages are simplicity of process and equipment (fig. 4). The disadvantages of the coagulation are high cost, difficulties with preparation, storage, transportation and dosage of coagulants. In addition to that, their application leads to a rapid corrosion of the inner surfaces of the tanks of a dewatering equipment [7]. Also chemical methods often have a quite low process productivity and after their realization waste have a relatively high final moisture content (about 60% for fruit cake) [8, 9].



Fig. 4. Photo of a press-extractor

The examples of biological methods of dehydration are the cultivation of fodder yeast on molasses bard, the processing of alcohol bard in biogas, the coagulation of proteins and the aerobic cultivation of yeast on filtrate. In fact, all these methods are a combination of mechanical, biological and thermal methods of dehydration [9, 10].

The disadvantages of these technologies are a significant complexity and duration of implemented processes. The disadvantages of the equipment for their implementation are design complexity, as well as high cost of it production and operation [11]. For example, to ensure of a reliable and smooth operation of all elements of the biological complex for a cultivation of fodder yeast (fig. 5), the specified yeast quality indicators, a large number of control and regulation devices and an automated control system are required [4, 6, 8]. In general, the processes of the biological dehydration of damp dispersed waste require of significant consumption of electricity, water, compressed air and chemicals. The surfaces of the plate heat exchangers for a cooling are quickly contaminated by waste solid particles and salts during an operation, and therefore need to be periodically cleaned or washed. It is also necessary to strictly observe the rules of a technical operation of heat exchangers [10]. This equipment has considerable capacity and dimensions, relatively low productivity and consists a number of high-alloy steels, bronze, brass and aluminum elements. At the plants with a capacity of more than 4000 dal of alcohol per day yeast machines with a volume of 600 m³ are installed. In this case,



the air flow rate for aeration is 50 - 65 m³ per 1 m³ of the processed waste, and the turnover of the apparatus (duration of processing in it of waste) is 12 hours or more [11]. The installation is equipped with a turbo-blower with a capacity of 10000 m³ / h of air that is brought in operation by an electric motor with a capacity 250 kW.



Fig. 5. Photo of a biological complex for a cultivation of fodder yeast

According to the results of the conducted analysis of methods and an equipment for a dehydration of food production waste we can make a conclusion that for achievement of final waste humidity 20 – 25%, productivity of working process 30 – 40 t dehydrated waste per 24 h (this corresponds to the productivity of a middle alcohol plant) and with a minimal power-consuming (no more than 5 – 10 kW h / t) most effective are a mechanical method of dehydration and the equipment which provides the vibro-blowing loading of processed waste.

3. Aim of research

The aim of this study is an elaboration and research of the highly-effective installation with the combined unbalance and hydraulic drive that provides a continuous fully-automatic three-staged working process of the vibro-blowing dehydration of the waste portion in the closed type press-form. At the same time, this installation must have a relatively simple design, compact dimensions, high reliability, provide necessary, above indicated final waste humidity, productivity and energy efficiency.

4. Results of the research

At the fig. 6 presented authors developed the scheme of an installation for the three-staged vibro-blowing dehydration of food production waste in the closed type press-form.

The waste 19 from the main production of a food enterprise by the piping 1 in the direction of an arrow are feed in the tank 1 and accumulated there. For the dehydration of waste the dampers 8 with help of two hydro-cylinders 6 (see also the section A - A at the fig. 6) are opened and the waste portion 26 through the crinkled rubberized fabric hose 7 under an impact of own gravity fills the area between the punch 10 and base 13. Then the dampers 8 are closed.

At the first stage is realized a static pressing of the portion 26 in the installation press-form for an elimination from it of free liquid [1]. Thus with help of four hydro-cylinders 12 (see also the section A – A at the fig. 6) the punch 10 is pressed to the portion 26 with a force that slowly and gradually increases from a minimal to maximal value. This allows with a minimal energy expenses separate a most part of free and some of capillary connected liquid [1]. The filtrate, eliminated from the portion 26, flows out press-form through the small openings in the punch 10 and dampers 23 walls. These openings are covered from inside by a filtering metallic net (at the scheme the openings and the net are not showed). The net detains waste solid particle and allows to pass it liquid phase. The ensuing from the press-form filtrate is accumulated in the tray 27, in the sloping platform 15 and from there it goes to a rundown (from the tray 27 a filtrate flow out by the flexible piping that is not shown at the scheme).

At the second stage of the working process dehydration the hydraulic drive is switched off, the head ends and rod ends of the hydro-cylinders 12 are connected with the rundown. At this stage the electric motors of the unbalance vibration exciters 6 are switched on. The exciters rotate in an opposite directions but with the



same velocity. As a result punch 10, waste portion 26 and base 13 are brought in a vertical oscillatory swinging movement. An effective braking of the installation executive elements at the end of their up and down strokes provide the springs 18. In a horizontal space the press-form is supported by the springs 5, fixed at the supports 4. As the result the waste portion 26 is exposed by a vibration inertia loading. The solid particles of the portion move with an accelerations, which in 3 – 10 times more than the acceleration of gravity – g . All this provide a transmission of solid particles in a state of the vibro-boiling [1]. In this state takes place a periodical and even redistribution of solid particles in the press-form volume with a more and more dense setting and with a liquid elimination from spaces between solid particles [1]. So from waste is removed not only free capillary connected liquid, but also adsorbitive connected liquid and all this occurs with minimal expenses of energy and time [1].

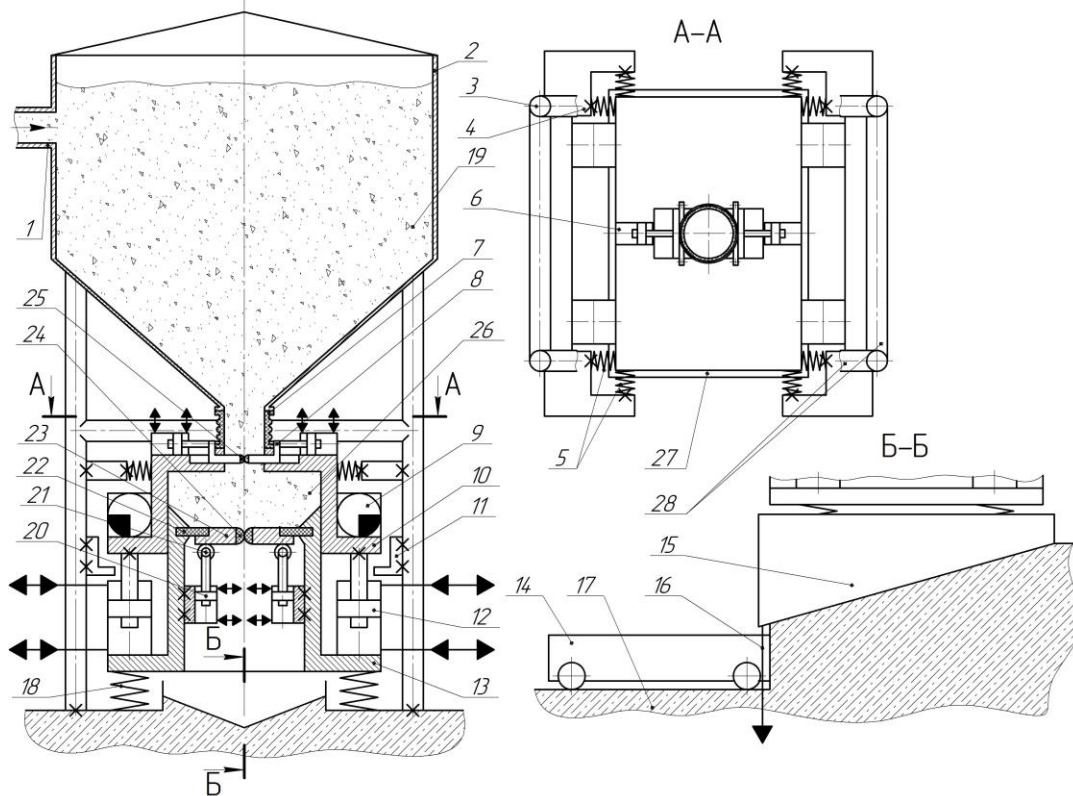
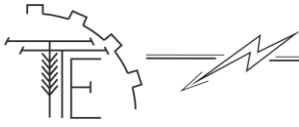


Fig. 6. Scheme of an installation for the three-staged vibro-blowing dehydration of food production waste in the closed type press-form:

1 – piping for a supply waste from the a main production; 2 – tank for waste; 3 – column; 4, 11 – supports; 5, 18 – springs; 6, 12, 20 – hydro-cylinders; 7 – crinkled rubberized fabric hose; 8, 23 – dampers; 9 – unbalance vibration exciter; 10 – punch; 13 – base; 14 – power barrow; 15 – sloping platform; 16 – filtrate rundown; 17 – foundation; 19 – waste from a main production; 21 – roller; 22 – door hinge; 24, 25 – rubber seals; 26 – portion of dehydrated waste; 27 – tray for filtrate; 28 – cross-bars

A most intensive regime of the loading of the waste portion is provided at the third stage of the working process dehydration, when it is exposed by the vibro-blowing loading that create unbalance exciters 9 and simultaneously by the static loading, which realize the hydro-cylinders 12. After elimination from the portion 26 of free liquid and most part of capillary connected liquid the high of the portion is decreased and the punch 10 at the end of each its downstrokes will hit at the supports 11. These collision momentums are transmitted to the particles of the portion 26 and provide a more effective dehydration process with elimination of remained capillary connected liquid and most part of adsorbitive connected liquid. Thus, the proposed installation provides from stage to stage a more and more intensive loading of the waste portion with a stable productivity of the dehydration and with a maximal effective use of energy and time.

After achievement of the necessary humidity of the waste in the press-form (this parameter can be determined with help of a corresponding sensor, fixed at the inner surface of the base 13) the drive of the hydro-cylinders 20 is switched on. The pistons of these hydro-cylinders are went down, providing an opening of the dampers 23 and an unloading of the portion 26 from the press-form at the sloping platform 15. The dehydrated waste slide down over this platform in the power barrow 14 or at a belt conveyer. After that the drives of the unbalance vibration exciters are switched off, the dampers 23 are closed, the punch 10 with help



of hydro-cylinders 12 is got up in the upper position and the dampers 8 are opened. The new portion of waste from the tank 2 fills the installation press-form and then begins a next cycle of the waste dehydration.

Equations for determination of the forces: $F_I(t)$ – on the upper executive element and $F_{II}(t)$ – on the lower executive element of the installation, relatively of a vertical axis y at the first stage of the above described working process of dehydration have an appearance

$$m_I(\ddot{y}_I + g) - \alpha_w(\dot{y}_I - \dot{y}_{II}) - c_w(y_I - y_{II}) - \sigma_w - R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - F_{fpr}(t) + k_c \cdot \left[p_d(t) \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right] = F_I(t); \quad (1)$$

$$m_{II}(\ddot{y}_{II} + g) + \alpha_w(\dot{y}_I - \dot{y}_{II}) + c_w(y_I - y_{II}) + \sigma_w + F_{fpr}(t) + R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I) - c_s(y_{II} + y_p) = F_{II}(t); t = 0 \div t_{Iexp} \quad (2)$$

where are: m_I – the mass of the upper executive element of the installation that includes the masses of punch 10 – m_p , unbalance vibration exciters 9 – $m_{e\Sigma}$, rods and pistons of hydro-cylinders 12 – $m_{rp12\Sigma}$, hydro-cylinders 6 – $m_{c6\Sigma}$, dampers 8 – $m_{d8\Sigma}$; $m_I = m_p + m_{e\Sigma} + m_{rp12\Sigma} + m_{c6\Sigma} + m_{d8\Sigma}$;

m_{II} – the mass of the lower executive element that includes the masses of base 13 – m_b , hydro-cylinders 20 – $m_{c20\Sigma}$, waste portion 26 – m_{wp} , dampers 23 – $m_{d23\Sigma}$; $m_{II} = m_b + m_{c20\Sigma} + m_{wp} + m_{d23\Sigma}$;

α_w – a coefficient of a viscous friction between the waste solid particles in the press-form [1];

c_w – a coefficient of a elasticity of waste solid particles [1];

σ_w – an yield point of waste solid particles [1];

R_{pf} – a dry friction force between the surfaces of the base 13 and the piston 10;

$F_{fpr}(t)$ – a friction force in the sealing of the pistons and the rods of the hydro-cylinders 12 that depends from a pressure on the both sides of the piston and the rod, diameters of theirs, a width of the sealing and its friction coefficient [12];

k_c – a number of the hydro-cylinders 12;

$p_d(t)$ – a pressure of the working liquid in the hydro-cylinders 12 rod ends (corresponds to a discharge pressure, with the provision of a resistance head [12]);

p_r – a pressure of the rundown in the hydro-cylinders 12 head end;

d_p – a diameter of the hydro-cylinder 12 piston;

d_r – a diameter of the hydro-cylinder 12 rod;

$c_{s\Sigma}$ – a summary stiffness coefficient of the springs 18;

y_p – a precompression of the springs 18;

y_I, y_{II} – moving of the masses m_I, m_{II} ;

t_{Iexp} – a duration of the first stage that is experimentally determined, with help of a real prototype of the elaborated installation; it is a time from the beginning of the counting out up to the moment of a conclusion of free liquid intensive separation of from the press-form.

Then a pressure $p_{wI}(t)$ in the medium of the portion 26 at the first stage can is determined as

$$p_{wI}(t) = \frac{F_I(t) + F_{II}(t)}{S_{pw}} = \frac{m_I(\ddot{y}_I + g) + m_{II}(\ddot{y}_{II} + g) + \left[p_d(t) \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right] - c_s(y_{II} + y_p)}{S_{pw}}; t = 0 \div t_{Iexp}, \quad (3)$$

where is S_{pw} – a cross-section area of the portion in the section that contacts with the punch 10.

At the second stage of the dehydration process, when is used only the installation unbalance drive, a stable oscillation cycle of the press-form with the waste can be divided into two phases:

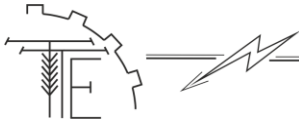
Phase 1 – a moving of the press-form from its lowest position up to a complete stop;

Phase 2 – a moving of press-form from the top to its lowest position.

Equations for determination of the forces $F_I(t)$ and $F_{II}(t)$ at the phase 1 of second stage of the dehydration process have an appearance.

$$F_d(t) - m_I(\ddot{y}_I + g) - \alpha_w(\dot{y}_I - \dot{y}_{II}) + c_w(y_I - y_{II}) + \sigma_w - R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - F_{fpr}(t) = F_I(t); \quad (4)$$

$$R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I) + c_s(y_p - y_{II}) - m_{II}(\ddot{y}_{II} + g) - \alpha_w(\dot{y}_{II} - \dot{y}_I) - c_w(y_{II} - y_I) - \sigma_w - F_{fpr}(t) = F_{II}(t); t = \frac{30}{n_e}, \quad (5)$$



where are: n_e – a linear rotation frequency of the unbalance vibration exciters 9; $F_d(t)$ – a driving force, is created by the vibration exciters that is changed in accordance with an equation

$$F_d(t) = F_e \cos \omega_e \cdot t = 2 \cdot m_e \pi^2 d_e n_e^2 k_e \cos \frac{\pi n_e}{30} t;$$

$$t = 0 \div T_{c.e} = 0 \div \frac{2 \cdot \pi}{\omega_e} = 0 \div \frac{60}{n_e}, \quad (6)$$

where is F_e – a centrifugal force created by a rotation of the unbalance vibration exciters 9;

ω_e – a rotation circular frequency of theirs;

$m_e, d_e, k_e, T_{c.e}$ – mass, circle diameter of the rotation, amount and period of rotation of the vibration exciters.

A pressure $p_{wII-1}(t)$ in the medium of the portion 26 at the phase 1 of second stage can is determined as

$$p_{wII-1}(t) = \frac{F_d(t) - m_I(\ddot{y}_I + g) - m_{II}(\ddot{y}_{II} + g) + 2 \cdot c_w(y_I - y_{II}) + c_s(y_p - y_{II}) - 2 \cdot R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - 2 \cdot F_{fpr}(t)}{S_{pw}}; \quad t = \frac{30}{n_e}. \quad (7)$$

Equations for determination of the forces $F_I(t), F_{II}(t)$ at the phase 2 of second stage of the dehydration process have an appearance

$$F_d(t) + m_I(\ddot{y}_I + g) - \alpha_w(\dot{y}_I - \dot{y}_{II}) - c_w(y_I - y_{II}) - \sigma_w - R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - F_{fpr}(t) = F_I(t); \quad (8)$$

$$R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I) + c_s(y_{II} - y_p) + m_{II}(\ddot{y}_{II} + g) - \alpha_w(\dot{y}_{II} - \dot{y}_I) - c_w(y_{II} - y_I) - \sigma_w + F_{fpr}(t) = F_{II}(t); \quad t = \frac{30}{n_e}. \quad (9)$$

A pressure $p_{wII-2}(t)$ in the medium of the portion 26 at the phase 2 will be

$$p_{wII-2}(t) = \frac{F_d(t) + m_I(\ddot{y}_I + g) + m_{II}(\ddot{y}_{II} + g) + c_s(y_{II} - y_p) - 2 \cdot \sigma_w + 2 \cdot R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I)}{S_{pw}}; \quad t = \frac{30}{n_e}. \quad (10)$$

At the third stage of the dehydration of the waste portion in course of utilization of the unbalanced and hydraulic drives simultaneously, equations for determination of the forces $F_I(t), F_{II}(t)$ at the phase 1 of an oscillation cycle of the vibration exciters can be recorded as

$$F_d(t) - m_I(\ddot{y}_I + g) - k_c \cdot \left[p_d \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right] - \alpha_w(\dot{y}_I - \dot{y}_{II}) + c_w(y_I - y_{II}) + \sigma_w - R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - F_{fpr}(t) = F_I(t); \quad (11)$$

$$R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I) + c_s(y_p - y_{II}) - m_{II}(\ddot{y}_{II} + g) - \alpha_w(\dot{y}_{II} - \dot{y}_I) - c_w(y_{II} - y_I) - \sigma_w - F_{fpr}(t) = F_{II}(t); \quad t = \frac{30}{n_e}, \quad (12)$$

where is p_d – an adjusted discharge pressure of the working liquid in the hydro-cylinders 12 rod ends.

A pressure $p_{wIII-1}(t)$ in the medium of the portion 26 at the phase 1 of third stage can is determined as

$$p_{wIII-1}(t) = \left[\frac{F_d(t) - m_I(\ddot{y}_I + g) - m_{II}(\ddot{y}_{II} + g) + 2 \cdot c_w(y_I - y_{II}) + c_s(y_p - y_{II}) - \left[p_d \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right]}{-2 \cdot R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - 2 \cdot F_{fpr}(t) - k_c \cdot \left[p_d \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right]} \right] / S_{pw}; \quad t = \frac{30}{n_e}. \quad (13)$$

Equations for determination of the $F_I(t), F_{II}(t)$ at the phase 2 of third stage of the dehydration have an appearance

$$F_d(t) + m_I(\ddot{y}_I + g) + k_c \cdot \left[p_d \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right] - \alpha_w(\dot{y}_I - \dot{y}_{II}) - c_w(y_I - y_{II}) - \sigma_w - R_{pf} \cdot \text{sign}(\dot{y}_I - \dot{y}_{II}) - F_{fpr}(t) = F_I(t); \quad (14)$$

$$R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I) + c_s(y_{II} - y_p) + m_{II}(\ddot{y}_{II} + g) - \alpha_w(\dot{y}_{II} - \dot{y}_I) - c_w(y_{II} - y_I) - \sigma_w + F_{fpr}(t) = F_{II}(t); \quad t = \frac{30}{n_e}. \quad (15)$$

A pressure $p_{wIII-2}(t)$ in the medium of the portion 26 at the phase 2 of this stage will be

$$p_{wIII-2}(t) = \frac{F_d(t) + m_I(\ddot{y}_I + g) + m_{II}(\ddot{y}_{II} + g) + k_c \cdot \left[p_d \cdot \left(\frac{\pi \cdot d_p^2}{4} - \frac{\pi \cdot d_r^2}{4} \right) - p_r \frac{\pi \cdot d_p^2}{4} \right] + c_s(y_{II} - y_p) - 2 \cdot \sigma_w + 2 \cdot R_{pf} \cdot \text{sign}(\dot{y}_{II} - \dot{y}_I)}{S_{pw}};$$



$$t = \frac{30}{n_e} \quad (16)$$

A value of the pressure $p_w(t)$ in the medium of the dehydrated waste portion in the press-form at different stages and phases of the installation working cycle allows to determine of a productivity of the dehydration process that is one of most important characteristics of it efficiency.

5. Conclusions

1. There are different methods and equipment for dehydration of waste food productions that have various disadvantages. For example, a mechanical dehydration at the screw presses and the decanter centrifuges do not provide a necessary humidity of waste – 20 ÷ 25%. Elaborated earlier schemes of the installations with the hydraulic pulse drive for a vibro-blowing mechanical dehydration are very complex and expensive in the realization. The thermal method is power-consuming (740 ÷ 2248 kW h/ ton). The equipment for a chemical and biological dehydration is large multiple-unit complexes with the low specific productivity.

2. Therefore for an improvement of a technology and equipment for a dehydration of waste food productions the authors of the article offer a scheme of a installation that realizes a method of the three-staged mechanical dehydration in the closed press-form, with an utilization of the static and vibro-blowing loading. The proposed installation is equipped with a combined unbalance and hydraulic drive. The installation has a relatively simple design, compact dimensions, high reliability and in correspondence with an authors estimation, will provide the necessary, above indicated final humidity of dehydrated waste with minimal energy and time expenses.

3. Also the equations for determination of the main working parameter – the pressure in the press-form of the proposed installation are presented in the article. These equations can be used in further theoretical research of the installation and for an elaboration of it design procedure.

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РОЗРОБКА ТА ДОСЛІДЖЕННЯ ВИСОКОЕФЕКТИВНОЇ УСТАНОВКИ ДЛЯ ВІБРУДАРНОГО ЗНЕВОДНЕННЯ ДИСПЕРСНИХ ВІДХОДІВ ХАРЧОВИХ ВИРОБНИЦТВ

В даній статті проаналізовані схеми установок для зневоднення вологих дисперсних відходів харчових виробництв (спиртової барди, пивної дробини, бурякового жому, кавового та ячмінного шלאму). Ці відходи на більшості харчових підприємств України виливаються на землю, що призводить до забруднення навколишнього середовища. Однак в разі зневоднення цих відходів до вологості 20 - 25% вони можуть бути використані в якості цінних добавок до сільськогосподарських кормів або в якості високоенергетичного палива. Таким чином, в комплексі вирішуються проблеми утилізації відходів і збереження природи від забруднень, крім того, підприємство отримує прибуток від реалізації кормових добавок або палива. Відоме обладнання для механічного зневоднення, таке як шинкові преси та декантерні центрифуги, забезпечує кінцеву вологість відходів 74 - 76%, тому при їх використанні відходи вимагають додаткової сушки. Це призводить до значного збільшення витрат енергії. Застосування віброударного зневоднення на установках з гідроімпульсним приводом забезпечує кінцеву вологість відходів 20 - 25%, однак останні конструктивно складні, мають великі габарити і високу вартість. Сушка в розпилювальних або вакуумних сушарках є найбільш енергоємною (витрати енергії від 740 до 2248 кВт·год на тонну зневоднених відходів), а обладнання для хімічного і біологічного зневоднення являє собою великі багатокорпусні комплекси з низькою питомою продуктивністю. Тому автори статті пропонують схему установки з комбінованим дебалансним та гідравлічним приводом, яка має відносно просту конструкцію, компактні розміри, високу надійність і в той же час, за оцінкою авторів, забезпечить необхідну, зазначену вище вологість. Також в статті наведені рівняння для визначення основного робочого параметра – тиску у прес-формі запропонованої установки.

Ключові слова: установка для зневоднення, вологі дисперсні відходи, харчові виробництва, комбінований дебалансний та гідравлічний привід.

Рис. 6. Ф. 16. Лит. 12.

РАЗРАБОТКА И ИССЛЕДОВАНИЯ ВЫСОКОЭФФЕКТИВНОЙ УСТАНОВКИ ДЛЯ ВИБРУДАРНОГО ОБЕЗВОЖИВАНИЯ ДИСПЕРСНЫХ ОТХОДОВ ПИЩЕВЫХ ПРОИЗВОДСТВ

В данной статье проанализированы схемы установок для обезвоживания влажных дисперсных отходов пищевых производств (спиртовой барды, пивной дробины, свекольного жома, кофейного и ячменного шלאма). Эти отходы на большинстве пищевых предприятий Украины выливаются на землю, что приводит к загрязнению окружающей среды. Однако в случае обезвоживания этих отходов до влажности 20 – 25% они могут быть использованы в качестве ценных добавок к сельскохозяйственным кормам или в качестве высокоэнергетического топлива. Таким образом, в комплексе решаются проблемы утилизации отходов и сохранения природы от загрязнений, кроме того, предприятие получает прибыль от реализации кормовых добавок или топлива. Известное оборудование для механического обезвоживания, такое как шинковые прессы и декантерные центрифуги, обеспечивает конечную влажность отходов 74 - 76%, поэтому при их использовании отходы требуют дополнительной сушки. Это приводит к значительному увеличению затрат энергии. Применение виброударного обезвоживания на установках с гидравлическим импульсным приводом обеспечивает конечную влажность отходов 20 - 25%, однако последние конструктивно сложны, имеют большие габариты и высокую стоимость. Сушка в распылительных или вакуумных сушилках является наиболее энергоёмкой (затраты энергии от 740 до 2248 кВт·ч на тонну обезвоженных отходов), а оборудование для химического и биологического обезвоживания представляет собой крупные многокомпонентные комплексы с низкой удельной производительностью. Поэтому авторы статьи предлагают схему установки с комбинированным дебалансным и гидравлическим приводом, которая имеет относительно простую конструкцию, компактные размеры, высокую надёжность и в то же время, по оценке авторов, обеспечит необходимую, указанную выше влажность. Также в статье приведены уравнения для определения основного рабочего параметра предлагаемой установки – давления в пресс-форме.

Ключевые слова: установка для обезвоживания, влажные дисперсные отходы, пищевые производства, комбинированный дебалансный и гидравлический привод.

Рис. 6. Ф. 16. Лит. 12.



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