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THROUGHPUT CAPABILITY OF THE COMBINED SCREW CHOPPER CONVEYOR

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Summary. *Improving existing designs of screw transport mechanisms and justification of their rational parameters and operating modes can significantly improve the performance and reliability of manufacturing operations. Based on the identification of existing processes and structures of screw mechanisms proposed improved screw conveyor chopper, which provides simultaneous grinding and transportation. Taking into account structural features of the combined screw conveyor-chopper (constructive geometric factor and filling factor of the working space of screw conveyor) developed a mathematical model, which characterizes the throughput capability of the technological process of grinding and transporting of roots in a given period of time depending on the structural parameters of the loading channel (bunker) and structural-kinematic parameters of screw conveyor with variable step.*

Key words: *screw conveyor, throughput capability, constructive geometric factor, filling factor, screw diameter, screw step, screw angular velocity.*

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Problem setting. Screw conveyors as transport mechanisms are used in agriculture production and food processing industries, the specificity of which is due to the presence of a wide range of processes of collection and processing of plant products.

In particular, screw conveyors in the agricultural sector are designed for horizontal, inclined and vertical moving of agricultural products, such as root crops, grains, feed mixtures over long distances in continuous flow. In addition, screw conveyors because of their design features can also simultaneously perform related functions, such as mixing materials, grinding or crushing materials, dosage, etc. [1].

Screw transport mechanisms and screw conveyors are widely used as separate technical elements of transport mechanisms in the design of agricultural machinery such as grain and beet harvesters, fertilizers, crushers, seed dressers etc. [2], as well as in layout diagrams of machines for handling or moving materials due to their simplicity of design and maintenance, and the ability to load and unload the materials fully or partially in any place of the tech line [3].

The combination of performing one or more manufacturing operations, along with the transportation of materials, which is inherent in combined screw conveyors, is their defining feature.

Therefore, the development of improved designs of screw conveyors, which provide simultaneous grinding and transporting materials, and substantiation of rational parameters of transporting mechanisms operating parts is an important scientific task.

Analysis of the known research results. Screw conveyors are part of comprehensive mechanization and automation of manufacturing processes. According to [4] their share in cargo handling operations is 40 – 45%. Analysis of the current state of operation of screw transport mechanisms [5 – 8] showed that there are significant preconditions for further research aimed at the development and application of energy-saving, high-tech combination of screw conveyors, which provide quite effective implementation of related functional operations such as transportation and simultaneous grinding of raw agricultural products during its processing.

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The purpose of the work. The aim is to improve the parameters of technological process of simultaneous crushing and transporting roots by developing and substantiation of the combined screw grinder conveyor (combined SGC) operating parameters.

Objective setting. Improving economic indicators and technological efficiency of processing industries is achieved by developing and implementing energy saving production technologies and facilities that are designed for preparation and processing agricultural sector raw materials.

Improvement of existing designs of screw transport mechanisms and substantiation of their rational parameters and operating modes can significantly improve performance and reliability of manufacturing operations.

Therefore, during their design, the specific technical requirements as well as functional and performance characteristics of the machines for the relevant works, and the peculiarities of transport processes, as well as agro-biological and physical and mechanical properties of the products to be transported should be taken into account [5].

Presentation of main material. The main criteria that characterize the technological and economic efficiency of the use of any transporting machinery or equipment is its performance, power consumption of the transporting process, performance reliability and stability of the technical process, service life, etc. [9].

Based on the analysis of agricultural production transporting process performance, we have offered a design map of an improved combined SGC, Fig. 1.

Root crop is fed into the loading bunker 1 and moves further into the guide tube 2 to the screw conveyor, or to the grinder knives 6. During the rotation of the drive shaft 3 and consequently drum 4 and knife-grinders simultaneous grinding of the roots and transportation (moving) of their chopped particles takes place by means of grinder knives and spiral turns 5 in the direction of unloading section of the guide tube.

Combined SGC has its own specific technological and structural elements and processes that significantly distinguish it from the basic traditional screw mechanisms and is characterized by operational and technological indicators, including technological capacity, or adaptability [10] regulates the performance of the transport mechanisms and ultimately processing performance of the entire complex.

The presence of technological operations of material (root) transportation and milling or the presence of grinding knives 6 which are placed between the turns of the screw conveyor in a spiral line makes significant adjustments to existing procedures and methods for calculating the screw conveyor mechanisms. By increasing the total speed of axial movement of grinded root particles by the spiral coils 5 and grinding knives the productivity of combined SGC increases significantly.

We justify rational parameters of combined SGC with analytical studies based on its capacity or productivity Q_m. The major structural and kinematic parameters of operating mechanisms of combined SGC and their interrelation are regulated by value criteria of screw conveyor technological and operational stability key indicators**.**

In this case, according to Fig. 1 performance Q_m of combined SGC in the overall context is regulated by screw conveyor capacity, which is denoted by Q_k. Thus the operational process technological effectiveness criterion of simultaneous grinding and transporting of root by screw conveyors is a condition in which the capacity $Q_k(t)$ of the screw conveyor should not be lower (equal or higher) than the supply of roots $W_k(t)$ over certain time t.

In order to formalize the process of root loading for further simultaneous grinding and transportation by combined SGC let us consider functional diagram of the loading channel operational process shown in Fig. 2.

Using the loading device, root 4 through a loading mouth 2 enter the bunker 1, and then through the upper and lower output aperture neck 3 are poured into the inner operational volume of combined SGC, or between the turns of the screw conveyor, where the simultaneous grinding and transporting of roots with subsequent discharge of chopped root crops through SGC discharge channel takes place.

On this basis, we can write the inequality that characterizes manufacturability of simultaneous grinding and transporting of root by combined SGC screw conveyors or their rational operation condition

$$dM_k / dt \geq dW_k / dt \text{, або } Q_k \geq W_k \text{,} \tag{1}$$

where dM_k / dt – unloaded weight of chopped root crops through the combined SGC discharge channel at the time t, kg;

dW_k / dt – total weight (feed) of root loaded through the combined SGC loading channel (bunker) at the time t, kg;

Q_k – performance of combined SGC screw conveyors, kg/s;

W_k – supply of roots that are loaded through the SGC loading bunker by second, kg/s.

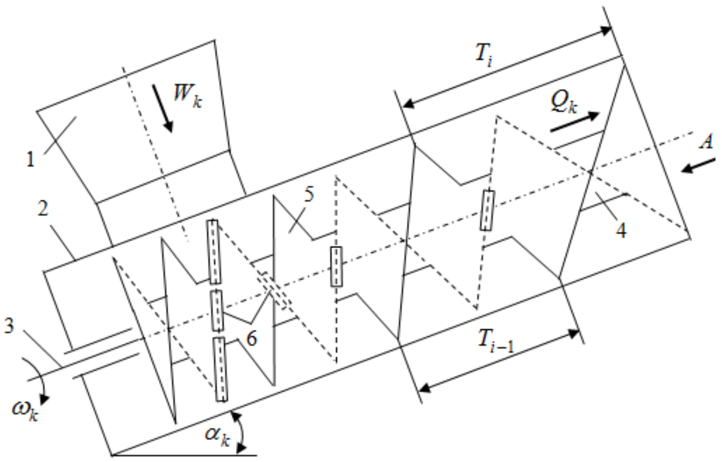

Figure 1. Construction scheme of combined screw grinder conveyor: 1 – loading bunker; 2 – guide tube; 3 – drive shaft; 4 – drum; 5 – spiral turn; 6 – grinder knife

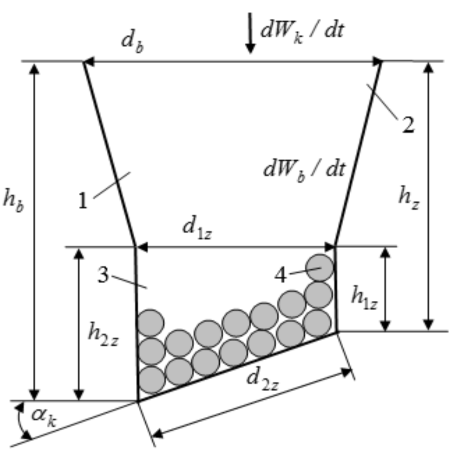

Figure 2. Scheme of combined screw grinder conveyor: 1 – loading bunker; 2 – guide tube; 3 – drive shaft; 4 – drum

The functional relationship between the dimensional parameters of the loading bunker 1 (Fig. 2) and structural and kinematic parameters of combined SGC, is determined based on the theoretical analysis of the total weight (supply) of loaded root dW_k / dt through a loading mouth, loading bunker capacity dW_b / dt (kg), required rated capacity dQ_k / dt of screw conveyor at the time t. In this regard, the condition (1) is written as

$$dQ_k / dt \geq dW_b / dt \geq dW_k / dt \text{.} \tag{2}$$

To formalize the operational process of combined SGC loading channel, we make the following assumptions (Fig. 2):

- consumption of root crops through the output aperture 3 of bunker 1 to the screw conveyor in the final aspect, is no less than the capacity dQ_k / dt of the screw conveyor at the time t;

- movement mechanism of the root in the volume of the loading bunker 1 is described (governed) by the basic processes of free leaking of a matter from the container;
- consumption of root crops through the outlet 3 takes place in the root draining into the funnel at an angle of repose until the destruction period of dynamic discharging arch height;
- cross-section of a loading neck 2 and the upper opening of the discharging neck of the bunker 1 have circular shapes and cross-section of the lower opening of the discharging neck 3 has the shape of an ellipse; let us denote the diameter of the loading neck by d_b, the diameter of the upper opening of the discharging neck by d_{1z}, and small and large ellipse axis, by $a_1 = d_{1z}$, $b_1 = d_{2z}$ respectively.

Throughput capacity of the bunker dW_b / dt in the general context is regulated by roots flow through the lower opening of the bunker discharging neck.

According to the accepted preliminary assumptions, and the fact that cross-sectional area of the upper outlet or area S_1 of a circle with a diameter d_{1z} is always smaller than cross-sectional area of the lower outlet or the area of an ellipse S_2 whose small axis is equal to the diameter of the circle d_{1z}, i.e. $S_1 < S_2$, material discharge through the bunker discharging neck (or in our case throughput capacity of the bunker dW_b / dt) is governed primarily by the material discharge through the top opening of the bunker discharge neck.

We know that according to [2] throughput capacity of the bunker W_b (kg/s) is determined

$$W_b = V_v \rho S_o = \frac{\lambda_u \rho S_o \sqrt{3{,}2 g R_k}}{\sqrt{f_m}}, \tag{3}$$

where $V_v = \lambda_u \sqrt{3{,}2 g R_k}$ – velocity of load discharge from the opening of the bunker, m/s;
λ_u – drag coefficient of load;
R_k – consolidated critical radius of the opening, m;
ρ – load volume weight, kg/m^3;
S_o – area of load discharge opening of the bunker output channel, m^2;
g – acceleration of gravity, m/s^2;
f_m – internal friction coefficient.

Then according to (3) throughput capacity of the bunker dW_b / dt (kg) at the period of time t is determined by the formula

$$dW_b = \frac{\lambda_u \rho_k S_1 \sqrt{1{,}6 g d_{1z}}}{\sqrt{f_m}} dt, \tag{4}$$

where $\lambda_u = 0{,}65$ – coefficient of resistance for dry lump materials;
$\rho_k = 550$ kg/m^3 – volume mass of roots;
$S_1 = 0{,}25\pi (d_{1z} - a')^2$ – the area of the upper output neck opening of the bunker taking into account the lumpiness of load, m^2;
d_{1z} – combined diameter of the upper hole of the bunker output neck, m;
a' – average transverse dimension of roots, m;
$f_m = 0{,}25 d_{1z} / (h_{1z} + h_{2z})$ – internal friction coefficient, h_{1z}, $h_{2z} = h_{1z} + d_{2z} \sin \alpha_k$ – arch height, m.

After substituting component values in (4) and simplifying obtain

$$dW_b = \frac{\lambda_u \rho_k \pi (d_{1z} - a')^2 \sqrt{1{,}6 g d_{1z}(2h_{1z} + d_{2z} \sin \alpha_k)}}{2\sqrt{d_{1z}}} dt \,. \tag{5}$$

Screw conveyor productivity Q_k (kg/s) according to [11] is recognized by the general formula of continuous action machine productivity or

$$Q_k = F_v \rho \mu_n \psi_\alpha V_w \,, \tag{6}$$

where F_v – the cross sectional area of the load flow, m^2;
μ_n – screw feeder rate (performance coefficient);
ψ_α – screw conveyor to the horizon angle factor;
V_w – average speed of movement (transportation) of load towards the discharging part of the screw conveyor, m/s.

The screw feeder rate value μ_n according to [11] depends on the filling factor k_z of screw conveyor that defines shared filling volume of the operating channel of the gutter and coefficient λ_c, which takes into account the «leak» mass of material in the gaps and is determined as their difference.

The average speed V_w of the axial movement of the material by the turns of the screw conveyor is determined through a correction slip factor k_v of material on the operating surface, which allows for a decrease of average speed V_w relative to the theoretical speed of axial movement of the screw turns $V_{o.m}$ along its axis of rotation, while screw conveyor performance decrease takes place due to existing sliding friction of material particles on the surface of its design.

Sliding coefficient k_v depends on many factors, the main of which are: the angle of ascent of spiral coiling α of spiral turns on the drum screw conveyor or factor k_a, that shows the degree of influence of elevation angle α of helical line along the middle range of the last round of the screw conveyor; factor of sealing k_y of material by turns of the screw conveyor; screw diameter, etc., while according to [11]

$$\mu_n = k_z - \lambda_c \,; \quad V_n = V_{o.m} k_v \,; \quad k_v = k_\alpha k_y \,. \tag{7}$$

In this regard, we can say that in our case:

- for practical absence of «leakage» of crushed root crops through the gap, the screw feeder rate value μ_n is equal to filling factor k_z, or $\mu_n = k_z$;

- average speed V_w of axial movement of crushed root crops by turns of screw conveyor in accordance with $T_i = T_{i-1} + \Delta T$ is determined

$$V_n = \frac{T_i \omega_k}{2\pi} k_v = \frac{(T_{i-1} + \Delta T) k_v}{2\pi} \frac{d\varphi_k}{dt} \,, \tag{8}$$

where ω_k – screw conveyor angular velocity, rad/s;

φ_k – screw conveyor turning angle, rad;

- cross sectional area of the load flow F_v will be equal to the area of the internal cross-section of the enclosure F_k, that is

$$F_k = 0{,}25\pi d_k^2 = 0{,}25\pi\left(D_k + c\right)^2; \tag{9}$$

- let us formulate the fill factor of combined SGC (hereinafter - filling factor k_z) as the ratio of the volume of space between turns of screw conveyor, filled with chopped root vegetables to the total volume of combined SGC, that is, $k_z = V_{zk}/V_z$, where V_{zk} the filled volume of screw conveyor, m^3; V_z – combined SGC total volume, m^3.

$$k_z = \frac{(1-k_n)V_k}{0{,}25\pi(D_k+2c)^2(T_1n_1+T_2n_2+\ldots+T_in_j)}; \quad k_n = V_e/V_k, \tag{10}$$

where k_n – constructive geometric factor;

$V_e = V_{d_m} + V_c + V_n$ – the total volume of screw conveyor operating elements, m^3;

V_{d_m} – the volume of the screw conveyor drum pipe, m^3;

V_c – the volume of the spiral coils, m^3;

V_n – the volume of knife-grinders, m^3;

D_k – outer diameter of the screw conveyor, m;

c – the gap between the outer end face of the spiral coil and the inner diameter of the casing, m;

T_1, $T_2,\ldots,T_i$ – first, second, i-th pitch of spiral coil, m;

n_1, $n_2,\ldots,n_j$ – the total number of spiral turns of one pitch, m.

After identifying and substituting components in equation (10) we obtain

$$k_n = \frac{1}{2\pi D_k^2}\left[\begin{gathered}\pi d_m^2 + \frac{4\Omega\delta_c z(D_k-d_m)}{n[2T_1+\Delta T(n-1)]} + \theta_1(n_z n-1)\times \\ \times\left(\frac{2(a+b)(D_k-d_m)\delta_n\cos\gamma_n - \delta_n^2\left(2btg\alpha_n\cos\gamma_n + (D_k-d_m)\right)}{n_z n[2T_1+\Delta T(n-1)]\cos\gamma_n} - d_m^2\Theta\right)\end{gathered}\right]; \tag{11}$$

$$k_z = \frac{D_k^2 - \dfrac{1}{2\pi}\left[\begin{gathered}\pi d_m^2 + \frac{4\Omega\delta_c z(D_k-d_m)}{n[2T_1+\Delta T(n-1)]} + \theta_1(n_z n-1)\times \\ \times\left(\frac{2(a+b)(D_k-d_m)\delta_n\cos\gamma_n - \delta_n\left[2btg\alpha_n\cos\gamma_n + (D_k-d_m)\right]}{n_z n[2T_1+\Delta T(n-1)]\cos\gamma_n} - d_m^2\Theta\right)\end{gathered}\right]}{(D_k+2c)^2}, \tag{12}$$

where d_m – screw conveyor drum pipe diameter, m;

δ_c – thickness of the spiral coil blade, m;

z – number of screw conveyor starts, pcs.;

θ_1 – number of grinding knives between two adjacent coils, pcs.;
δ_n – thickness of the blade, m;
γ_n – angle between knife and its height edge, deg., rad.;
n_z – number of turns of each T_i - th pitch;
n – number of T_i - th pitches;
a, b – the size of knife width, m;
α_n – bevel side knife angle deg., rad;

$$\Omega = \sqrt{T_1^2 + 0{,}25(D_k + d_m)^2} + \sqrt{(T_1 + \Delta T)^2 + 0{,}25(D_k + d_m)^2} + \\ + \ldots + \sqrt{[T_i + \Delta T(n-1)]^2 + 0{,}25(D_k + d_m)^2};$$

$$\Theta = \left[\left(\pi \arcsin \frac{a}{d_m} / 180\right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m}\right].$$

Or given (11) dependence (12) can be reduced to the form

$$k_z = \frac{D_k^2}{(D_k + 2c)^2}(1 - k_n). \qquad (13)$$

According to initial conditions $d_m = 0{,}04$ m, $T_1 = 0{,}08$ m, $\Delta T = 0{,}01$ m, $\delta_n = 0{,}002$ m, $n_z = 2$, $n = 3$, $\alpha_n = \pi / 6$ deg., $a = 0{,}03$ m, $b = 0{,}02$ m, $c = 0{,}002$ m, $\gamma_n = \pi / 12$ we have created dependence of constructive geometric factor k_n (Fig. 3), and according to the relation (12) filling factor k_z, Fig. 4.

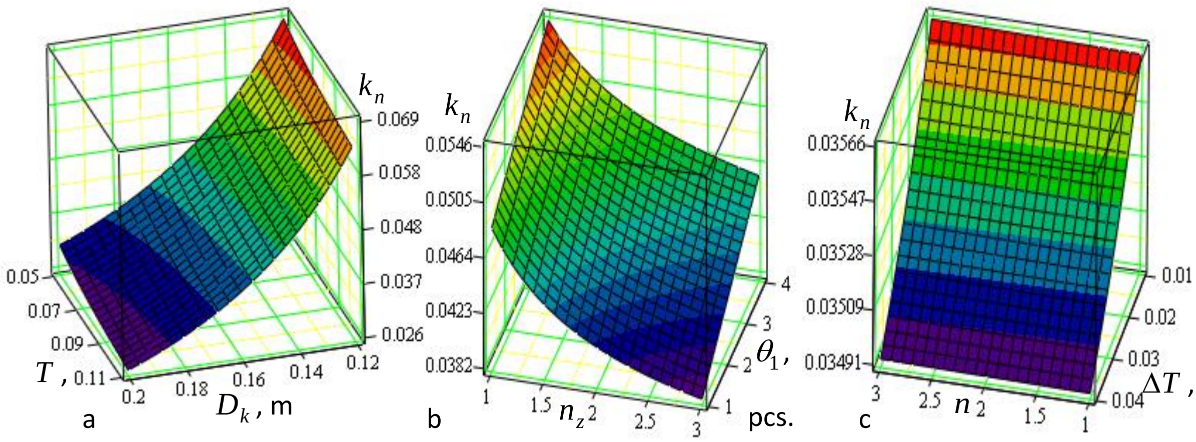

Figure 3. Depende[illegible] f change of constructive geometric coefficient k_n as functional: a – $k_n = f_n(D_k;T)$; б – $k_n = f_n(n_z;\theta_1)$; в – $k_n = f_n(n;\Delta T)$

Analysis of the dependences (Fig. 3a) shows that constructive geometric factor k_n depending on the change of the diameter D_k and pitch T of screw conveyor is within 0,026...0,07 number of variables T_i-th pitches equal $n = 3$, number of spiral turns of the same T_i-th pitch – $n_z = 2$ and the number of grinding knives, placed between one pair of two adjacent spiral turns – $\theta_1 = 4$ pieces. The changeable k_n, which is defined as a functional dependence

$k_n = f_n(D_k;T)$ is reversible – with increasing diameter D_k and pitch T of screw conveyor constructive geometric coefficient k_n decreases at parabolic function.

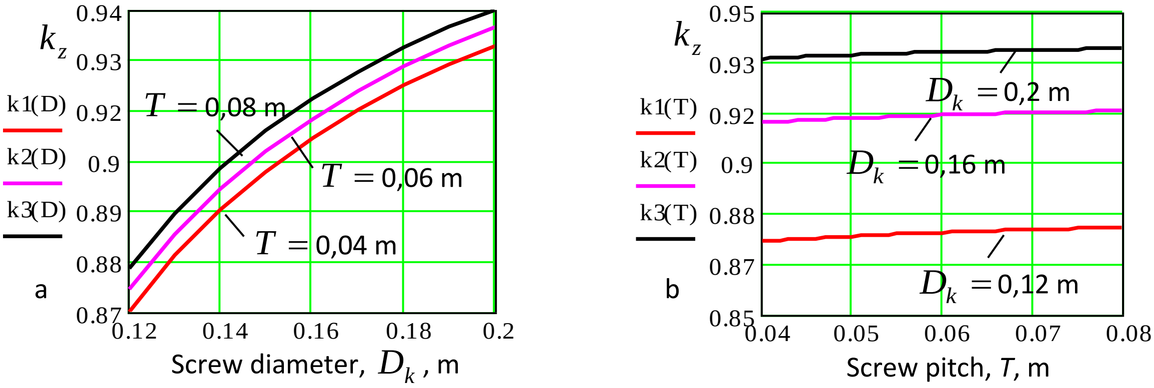

Figure 4. Dependence of change of filling factor k_z as functional $\theta_1 = 3$ pcs.:
a – $k_z = f_D(D_k)$; б – $k_z = f_T(T)$

The analysis (Fig. 3) found that the increasing number of grinding knives θ_1, that are placed between a pair of two adjacent spiral turns and n number of variables -th pitches of SGC screw conveyor, causes constructive geometric factor k_n to increase in direct proportion to the increase in the total number of θ_1 and n.

This average growth value k_n, which is described by functional $k_n = f_n(n_z;\theta_1)$ and $k_n = f_n(n;\Delta T)$ provided growth $\theta_1 + 1$ and $n+1$ is, therefore, within 0,002...0,003 (Fig. 3b) and 0,0005...0,0006 (Fig. 3c), in case of $n+1$, the growth of geometric factor k_n is very low.

With the increase of $n_z + 1$ and $\Delta T + 0{,}01$ m the factor k_n, which is described, respectively, by functional $k_n = f_n(n_z;\theta_1)$ and $k_n = f_n(n;\Delta T)$ decreases by about 0,004...0,005 (Fig. 3b) and 0,002...0,003 (Fig. 3c), which in case of $\Delta T + 0{,}01$, decreasing geometric factor k_n is negligible.

In this regard, we can say that the dominant influence on changing the numeric value of the geometric constructive factor k_n is the screw conveyor diameter D_k the number of knife-grinders θ_1 and number of spiral turns n_z of one T_i- th pitch, and ΔT change of one T_i-th pitch and number of T_i-th pitches is not significant and does not significantly affect the change of k_n.

It has been found that functional change of filling factor k_z depending on change of the diameter D_k and pitch T of the conveyor screw (Fig. 4), in contrast to the changes of constructive geometric factor k_n of combined SGC has reversible nature, that is with the increase of D_k and T filling factor k_z also increases within 0,87...0,94.

In this case the dominant factor that largely regulates the quantitative value of filling factor k_z, is the diameter D_k of the screw conveyor, and a significant increase in k_z is observed at the value of $D_k \geq 0{,}12$ m – within changing D_k from 0,12 to 0,16 (m) the filling factor k_z increases by 0,05.

Changing pitch T and pitch interval increase ΔT of screw conveyor has a slight and insignificant impact on the quantitative value of k_z where by increasing pitch T from 0,04 to

0,08 (m) and pitch interval increase from 0,01 to 0,04 (m) the filling factor k_z increases by 0,004 (Fig. 4a) and 0,001 (Fig. 4b) respectively.

Thus, we can conclude that the maximum value of filling factor k_z of SGC screw conveyor is within $k_{z.\max} = 0{,}87\ldots 0{,}94$, which corresponds to the maximum degree of filling its operating space.

Substituting the values of the components (7) – (9), (12) in the formula (6) and given that $D_k = k_d d_m$ we receive dependence for determining the necessary rated capacity dQ_k / dt of screw conveyor at the time t

$$dQ_k = 0{,}125 \rho_k \psi_\alpha k_a k_y \left(T_1 + n\Delta T\right)\left(\frac{d\varphi_k}{dt}\right) D_k \times$$
$$\times\left(D_k - \frac{1}{2\pi k_d}\left[\begin{array}{l}\dfrac{\pi D_k}{k_d} + \left(\dfrac{4\Omega\delta_c z\left(k_d - 1\right)}{n\left[2T_1 + \Delta T\left(n-1\right)\right]} + \theta_1\left(n_z n - 1\right)\delta_n\right)\times \\ \times\left(\dfrac{2\left(a+b\right)\left(\left(k_d - 1\right)\right)\cos\gamma_n - \delta_n\left[2\dfrac{k_d}{D_k} btg\alpha_n \cos\gamma_n + \left(k_d - 1\right)\right]}{n_z n\left[2T_1 + \Delta T\left(n-1\right)\right]\cos\gamma_n} - \dfrac{D_k}{k_d}\dfrac{\Theta}{\delta_n}\right)\end{array}\right]\right) dt, \qquad (14)$$

or according to (6) – (9) and (13) the formula for determining the performance of the SGC looks as follows:

$$Q_k = 0{,}125 D_k^2 \left(1 - k_n\right)\rho_k \psi_\alpha \left(T_1 + n\Delta T\right) k_a k_y \left(\frac{d\varphi_k}{dt}\right). \qquad (15)$$

Fig. 5 shows the dependence of the performance of the SGC on the basic parameters of screw conveyor, which is built according to (15) as functional: $Q_k = f_Q\left(D_k; T\right)$, $Q_k = f_Q\left(D_k; n_k\right)$ and $Q_k = f_Q\left(D_k; \Delta T\right)$.

We have found that performance Q_k of combined SGC is within $Q_k = 0{,}6\ldots 4{,}6$ kg/s, while, depending on the parameters of the screw conveyor, it has a directly proportional functional nature of the change, so with the increase of diameter D_k, pitch T, rotation speed n_k and pitch increasing interval ΔT of screw conveyor, its productivity Q_k increases. The dominant factors that have a significant impact on combined SGC productivity growth Q_k is rotation speed n_k and the diameter D_k of the screw conveyor.

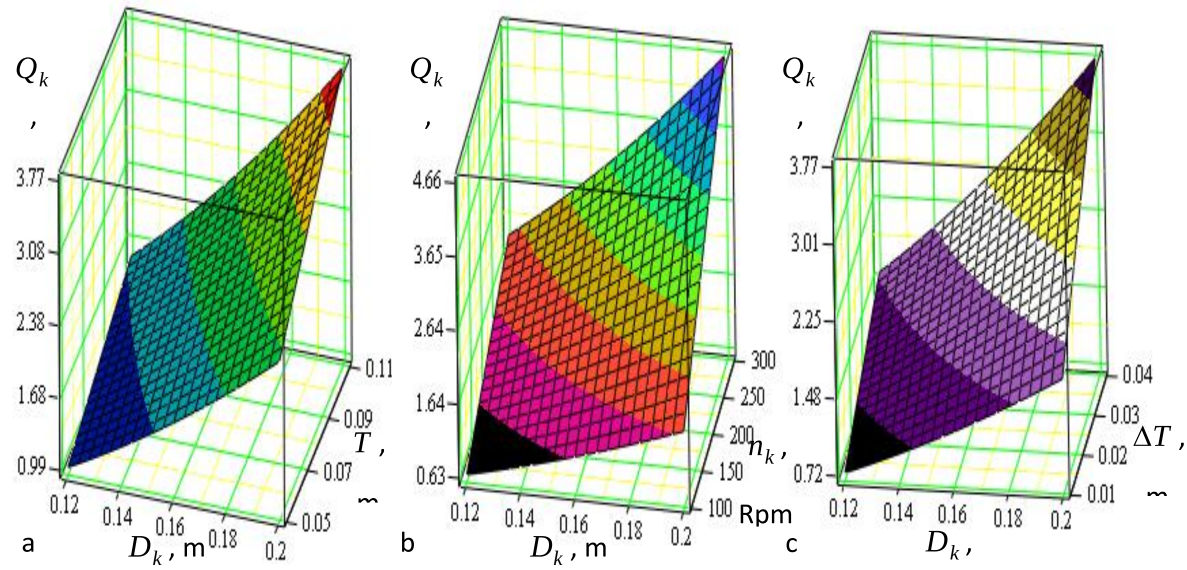

Figure 5. Dependence of productivity change of screw chopper conveyor Q_k as functional: a – $Q_k = f_Q(D_k;T)$; b – $Q_k = f_Q(D_k;n_k)$; c – $Q_k = f_Q(D_k;\Delta T)$

Conclusions. We have found out that the geometric constructive factor k_n of screw conveyor varies from 0,026...0,07 depending on changes in its diameter D_k and pitch T, at the same time, the number of variables T_i-th pitches is $n = 3$; the number of spiral turns of similar T_i-th pitch is $n_z = 2$; the number of grinding knives, placed between a pair of two adjacent spiral turns – $\theta_1 = 4$ pcs.

Functional change of filling factor k_z depending on changes of the diameter D_k and pitch T of screw conveyor, as opposed to changes of combined GTR constructive geometric factor k_n has reversible nature, that is with the increase of D_k and T filling factor k_z also increases within 0,87...0,94.

The dominant factors that have a significant impact on combined SGC productivity Q_k growth, which is in the range of $Q_k = 0{,}6\ldots4{,}6$ kg/s, is the rotation speed n_k and the diameter D_k of the screw conveyor.

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ПРОПУСКНА ЗДАТНІСТЬ КОМБІНОВАНОГО ГВИНТОВОГО ТРАНСПОРТЕРА-ПОДРІБНЮВАЧА

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Резюме. *Удосконалення існуючих конструкцій гвинтових транспортних механізмів і обгрунтування їх раціональних параметрів та режимів роботи дозволяє істотно підвищити продуктивність роботи й надійність виконання технологічних операцій. На основі ідентифікації існуючих технологічних процесів і конструкцій шнекових механізмів запропоновано удосконалений гвинтовий транспортер-подрібнювач коренеплодів, який забезпечує одночасне їх подрібнення й транспортування. З урахуванням конструктивних особливостей комбінованого гвинтового транспортера-подрібнювача (конструктивного геометричного коефіцієнта й коефіцієнта заповнення робочого простору шнекового конвеєра) розроблено детерміновану математичну модель, яка характеризує пропускну здатність технологічного процесу подрібнення й транспортування коренеплодів за певний проміж часу залежно від конструктивних параметрів завантажувального каналу (бункера) та конструктивно-кінематичних параметрів шнекового конвеєра змінного кроку.*

Ключові слова: *шнековий конвеєр, пропускна здатність, конструктивний геометричний коефіцієнт, коефіцієнт заповнення, діаметр шнека, крок шнека, кутова швидкість шнека.*

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