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## *Editorial*

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### *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 ȘIȘEȘTI);
- ✓ 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<sup>+</sup> 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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## INVESTIGATION OF CONSTRUCTIVE GEOMETRICAL AND FILLING COEFFICIENTS OF COMBINED GRINDING SCREW CONVEYOR

/

### ДОСЛІДЖЕННЯ КОНСТРУКТИВНОГО ГЕОМЕТРИЧНОГО КОЕФІЦІЄНТА ТА КОЕФІЦІЄНТА ЗАПОВНЕННЯ КОМБІНОВАНОГО ГВИНТОВОГО ТРАНСПОРТЕРА-ПОДРІБНЮВАЧА

P.G. Pankiv V.R.<sup>1)</sup>, Ph.D. Eng. Tokarchuk O.A.<sup>2)</sup>

<sup>1)</sup> Ternopil Ivan Pul'uj National Technical University, Ternopil / Ukraine;

<sup>2)</sup> Vinnitsa National Agrarian University, Vinnitsa / Ukraine

E-mail: vitalijpankiv25@gmail.com

**Keywords:** grinding screw conveyor, worm conveyor, spiral curl, knife-chopper, coefficient, volume, screw diameter, varied pitch of the screw.

#### ABSTRACT

*This paper presents the structure and technological processes of combined grinding screw conveyor. The theoretical dependencies, which describe the nature of the geometric factor of screw conveyor and load factor of combined grinding screw conveyor, depending on its design parameters, are also substantiated here.*

#### РЕЗЮМЕ

*Наведено будову та технологічний процесу роботи комбінованого гвинтового транспортера-подрібнювача. Обґрунтовано теоретичні залежності, які описують характер зміни геометричного коефіцієнта шнекового конвеєра та коефіцієнта заповнення комбінованого гвинтового транспортера-подрібнювача залежно від його конструктивних параметрів.*

#### INTRODUCTION

Further development of the agricultural sector of Ukraine is possible through the use of progressive mechanization means for agricultural products production processes. Improving the technical and economic performance of processing enterprises is achieved through the development and introduction of energy saving technologies and technical facilities that are designed for preparation and processing of agricultural raw materials (Baranovsky V.M., 2014, Hevko R.B., Klendiy O.M., 2014).

Screw conveyors (augers, conveyors) have gained wide acceptance in various industries. In particular, in the agricultural sector, screw conveyors are designed for horizontal, slope and vertical continuous moving of stream at considerable distances of agricultural products, such as root crops, grains, meal mixture. In addition, screw conveyors due to their design features also can simultaneously perform related functions - mixing of materials, grinding or crushing of materials, dosage, etc. (Hevko Iv.B., 2013).

The combination of performing one or more technological operations, along with the transportation of materials, which is inherent for the combined screw conveyor, is their defining feature.

Improvement of existing designs of screw transport mechanisms can significantly increase the performance and reliability of technological operations and contributes to the further development of production. Screw conveyors are part of comprehensive mechanization and automation. According to various estimates, their share in cargo handling operations is 40-45% (Baranovsky V.M., Potapenko M.V., 2016).

Purpose of work is to improve technological process parameters of simultaneous grinding and transportation of roots through the development and justification of working bodies' parameters of combined grinding screw conveyor. Investigation of transportation process technological parameters is based on the analysis of combined grinder conveyor design features.

#### MATERIAL AND METHODS

Screw conveyors, as separate technical element of transport mechanisms, are widely used in layout schemes of machines for reloading or moving materials due to their simple design, of maintenance service and the ability to load and partial unload the material at any location of the processing line.

Screw transport mechanisms are widely used in the construction of agricultural machinery - grain harvesters, beet and potato harvesters, fertilizers, grinders, seed disinfectant, etc. (Voytyuk D.G., et al., 2015; Hevko R.B., Zalutskyi S.Z., et al., 2015).

Also screw conveyors are used for the mechanization of loading and unloading processes of bulk and large-size materials, such as corn and different kinds of root crops - wheat, corn, sugar and fodder beet, rape plant, chicory. For this purpose, as transportation means for the mechanization of livestock farms, bakeries use mobile assembled augers, trucks and transporters.

Combined grinding screw conveyors are widely used in agriculture production sector, processing and food branches of industry which are specified due to the wide range of technological processes of products collecting and recycling.

Therefore, during their designing should be taken into account the specific technical requirements and functional performances of machines to carry out the relevant work, and also the features of transport-technological processes, agrobiological, physical and mechanical properties of the products to be transported (Hevko Iv.B., 2008).

Investigation of transportation process technological parameters is based on the analysis of combined grinder conveyor design features.

## RESULTS

Analysis of the current state of screw transport mechanisms functioning showed that there are significant preconditions for further research, aimed at the development and application of energy-saving, high technology for combined screw conveyors. They will ensure effective implementation of various functions of related operations for simultaneously transporting and grinding agricultural crop in their processing.

Based on the given analysis of technological parameters for materials transportation of agricultural production, we have offered constructive scheme of the improved combined grinding screw conveyor, fig. 1.

Combined grinding screw conveyor (combined SGC) consists of a loading bunker 1 and 2 and the guide tube. In the guide tube 2 is installed the screw conveyor, which is designed as a drive shaft 3 on which is installed the drum 4. On the drum of drive shaft, along separate helical lines, fixed spiral turns 5 and plate knife-grinders 6 are installed on the drum between the spiral turns and at an angle to the cross-section of the drum. Screw lines of spiral turns and grinder blades are made with variable step, concurrently step of spiral turns and step of plate grinder blades with a constant lifting angle of spiral line towards the unloading part of the guide tube.

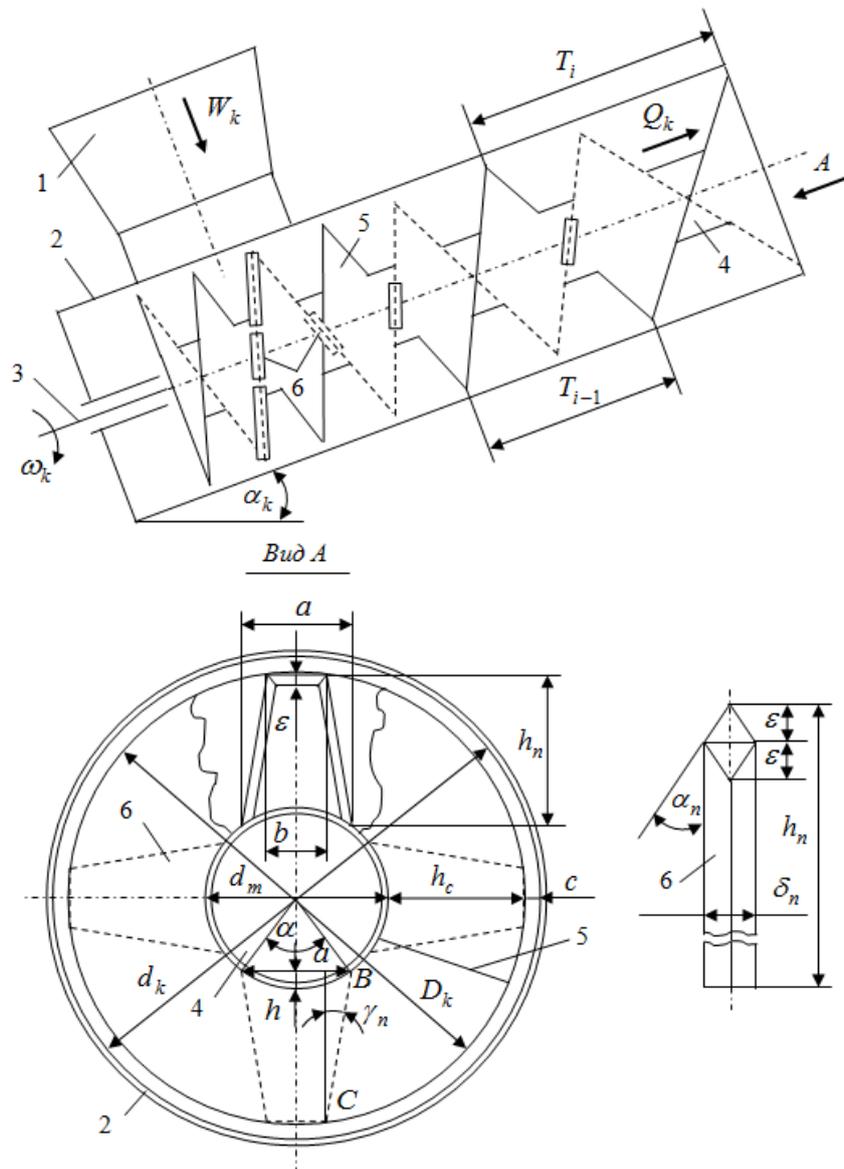
The material, for example root crops, fed into the loading bunker 1, which later moved to the guide tube 2 to the screw conveyor, or to the plate grinder knives 6. During the rotation of the drive shaft 3 and, accordingly, the drum 4 and the plate grinder knife occurs simultaneous grinding of root crops and transportation (movement) of root crops milled particles by the related installation of plate grinder knives at an angle to the cross-section of the drum and its attachment to the drum along the spiral line. In addition, simultaneously with the movement of root crops milled particles by plate grinder knives also occurs their transportation as spiral turns towards unloading part of the guide tube.

By increasing the speed of the axial movement of root crops milled particles, increased performance of combined SGC was generated.

The main criteria that characterize the technological and economic efficiency of any transport vehicles or mechanisms, which move or deliver materials to a given point, is the productivity of their performance, consumption of power inputs during materials transportation process, reliability and stability, performance of the process, work resource and others (Rogatinsky R., 2012).

Combined SGC (fig. 1) has its own specific technological and structural elements and processes that significantly distinguish it from the traditional basic screw mechanisms. Simultaneous presence of technological operations, grinding and transporting of the material (root crops), or the presence of grinder blades 6, which are installed in interterm space of screw conveyor along helical lines, make significant adjustments to existing techniques and calculating methods for the screw mechanisms.

In this respect, one of the priorities and the special factors, which will regulate the calculated productivity of combined SGC, is an index that characterizes volumetric filling factor of screw conveyor working space (Hevko R.B., Dzyura V.O., Romanovsky R.M., 2014). In turn, filling factor of screw conveyor working space depends not only on the amount of material that goes into it, but also on the design of the screw conveyor main transporting element (Hevko R.B., Zalutskyi S.Z., Tkachenko I.G., et al., 2015).



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

In the general context, filling factor of screw conveyor working space shows, which is the part of useful volume filled with material that moves along the turns of the screw.

Then, taking into account known provisions (Hevko R.B., Zalutskyi S.Z., Tkachenko I.G., et al., 2015) we represented the filling factor of combined SGC (hereinafter - filling factor  $k_z$ ) as the ratio of the interterm space volume of screw conveyor, which is filled with grinded root crops, and the total volume of combined SGC, as follows:

$$k_z = V_{zk} / V_z \quad (1)$$

where

$V_{zk}$  – filled volume of screw conveyor space,  $m^3$ ;

$V_z$  – total amount of combined SGC, space,  $m^3$ .

To determine the set volume  $V_{zk}$ ,  $V_z$  and ultimately filling factor  $k_z$  and calculate performance let's consider the composite structural and design scheme to determine the technological indicators of combined SGC, which is shown in fig. 1.

We initiate indication of the first helical turn step by alphabetic expression  $T_1$ , second helical turn –  $T_2$ , and last  $i$  - helical coil -  $T_i$ .

According to fig. 1, total volume  $V_z$  of combined SGC space consists of internal volume of the guide tube 2, or the volume of straight hollow cylinder:

$$V_z = 0,25\pi d_k^2 L_k = 0,25\pi (D_k + 2c)^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j), [\text{m}^3] \quad (2)$$

where

$d_k$  – inner diameter of the covering, m;

$L_k$  – working height of the guide tube, or the length of screw conveyor, m;

$D_k$  – outside diameter of screw conveyor, m;

$c$  – the gap between the external edge of the spiral turn and the inner diameter of the guide tube, m;

$T_1, T_2, \dots, T_i$  – the step of first, second,  $i$ -th spiral coil, m;

$n_1, n_2, \dots, n_j$  – the total number of spiral turns per one step, m.

Filled volume of screw conveyor space  $V_{zk}$  by the grinded root crops will be determined according to the following considerations.  $V_{zk}$ , essentially, is a useful volume where root crops are placed loaded and grinded during the transportation.

The useful volume of screw conveyor  $V_{zk}$  consists of volume difference of screw conveyor total volume  $V_k$  and the total volume, occupied by the working elements of screw conveyor  $V_e$ , or the amount of drum volume  $V_{dm}$ , the volume of spiral turns  $V_c$  and the volume  $V_n$  knives-grinders, as follows:

$$V_{zk} = V_k - V_e; \quad V_e = V_{dm} + V_c + V_n; \quad V_{zk} = V_k - V_{dm} - V_c - V_n, [\text{m}^3] \quad (3)$$

where

$V_{dm}$  – total volume of the screw conveyor,  $\text{m}^3$ ;

$V_{dm}$  – the volume of the tube drum of the screw conveyor,  $\text{m}^3$ ;

$V_e$  – total volume, occupied by the working elements of the screw conveyor,  $\text{m}^3$ ;

$V_c$  – volume occupied by the spiral turns,  $\text{m}^3$ ;

$V_n$  – volume occupied by knife-grinders,  $\text{m}^3$ .

After substituting (2) and (3) in (1), we obtain:

$$k_z = \frac{1 - \frac{V_e}{V_k}}{0,25\pi (D_k + 2c)^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j)} \quad (4)$$

Let's designate in (4) the ratio  $V_e/V_k = k_n$ , where the symbol  $k_n$  is the definition of constructive geometric factor of combined SGC (hereinafter – constructive geometric factor  $k_n$ ), only during one configured constructive cycle of combined SGC technological process.

Then, the relation (4) will have the following form:

$$k_z = \frac{(1 - k_n) V_k}{0,25\pi (D_k + 2c)^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j)} \quad (5)$$

To set the limits of structural changes of geometric factor  $k_n$  determine the total volume of screw conveyor  $V_k$ , total volume occupied by the working elements of the screw conveyor  $V_e$  which consists of the volume of the screw conveyor tube drum  $V_{dm}$ , the volume occupied by the spiral turns  $V_c$ , the volume

occupied by knife-grinders  $V_n$ .

However, according to fig. 1 and (Berd J., 2008) we have:

$$V_k = 0,25\pi D_k^2 L_k, [\text{m}^3]; \quad V_{d_m} = 0,25\pi d_m^2 L_k, [\text{m}^3]; \quad V_c = F_n l_c z, [\text{m}^3]; \quad V_n = V_{1n} \theta_n, [\text{m}^3] \quad (6)$$

where

$d_m$  – diameter of the screw conveyor tube drum, m;

$F_n$  – cross sectional area of screw conveyor card bales turn  $F_n = \delta_c h_c, \text{m}^2$ ;

$\delta_c$  – thickness of the spiral turn card bales, m;

$h_c$  – height of the spiral turn card bales  $h_c = 0,5(D_k - d_m), \text{m}$ ;

$l_c$  – total length of the spiral line by the average diameter of the screw conveyor, m;

$z$  – number of the screw conveyor activities, units;

$V_{1n}$  – volume of one knife-grinder,  $\text{m}^3$ ;

$\theta_n$  – the amount of knife-grinders, units.

Or:

$$V_k = 0,25\pi D_k^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_i), [\text{m}^3] \quad (7)$$

$$V_{d_m} = 0,25\pi d_m^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_i), [\text{m}^3] \quad (8)$$

$$V_c = 0,5\delta_c z (D_k - d_m) \left( n_1 \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + n_2 \sqrt{T_2^2 + 0,25(D_k + d_m)^2} + \dots \right), [\text{m}^3] \quad (9)$$

The volume  $V_n$ , occupied by knife-grinders 6 can be determined according to the following considerations. Each knife-grinder made in straight prism form, which is based on equilateral trapezium, with this three working side edges of the prism from two sides sharpen with the grinding angle  $\alpha_n$ , and side edge, which relies on a large basis  $b$  of the trapezium has the shape of a segment whose radius is the radius of the tube drum  $r_m$  of the screw conveyor.

Then the volume  $V_n$ , occupied by knife-grinder will be equal:

$$V_n = (V_{np} - V_z - V_{cn}) \theta_n, [\text{m}^3] \quad (10)$$

where

$V_{np}$  – volume of direct prism,  $\text{m}^3$ ;

$V_z$  – total volume of direct prisms that are cut during the sharpening of side edges with basis  $BC$ ,  $\text{m}^3$ ;

$V_{cn}$  – volume of straight prism, which is cut out of side edge with basis  $b$ ,  $\text{m}^3$ .

In such case (Shipachev V.S., 2003):

$$V_{np} = F_{mp} \delta_n = \frac{a+b}{2} h_n \delta_n, [\text{m}^3]; \quad V_z = 2V_{1z} + 4V_{2z}, [\text{m}^3]; \quad V_{cn} = F_c L_k, [\text{m}^3] \quad (11)$$

$$V_{1z} = 0,125\delta_n^2 b t g \alpha_n, [\text{m}^3]; \quad V_{2z} = 0,125\delta_n^2 h_n / \cos \gamma_n, [\text{m}^3] \quad (12)$$

$$V_z = 0,25\delta_n^2 b t g \alpha_n + \frac{0,5\delta_n^2 h_n}{\cos \gamma_n}, [\text{m}^3] \quad (13)$$

$$F_c = r_m^2 [(\pi\alpha / 180) - \sin \alpha] / 2, [\text{m}^2] \quad (14)$$

where

$F_{mp}$  – area of main prism (trapezoid area)  $\text{m}^2$ ;

$a, b$  – base of trapezoid, m;

$V_{1z}$  – volume which is cut out from one side of side edge with the base  $b$ ,  $V_{1z} = 0,5\delta_n b / 2, \text{m}^3$ ;

$\varepsilon$  – triangle height  $\varepsilon = 0,5\delta_n \operatorname{tg} \alpha_n$ , m;

$\alpha_n$  – skew angle of side edge, grade;

$V_{2z}$  – volume which is cut out from one side of side edge with the base  $BC$ ,  $V_{2z} = 0,5\delta_n \varepsilon BC$ , m<sup>3</sup>;

$BC = h_n / \cos \gamma_n$  – length of the side edge  $BC = h_n / \cos \gamma_n$ , m;

$\gamma_n$  – the angle between the knife height and trapeze edge, grad;

$F_c$  – segment area with height  $h$ , tighten by chord  $a$  and a central angle  $\alpha$ , m<sup>2</sup>;

$r_m$  – the radius of the screw conveyor drum tube (m), with this  $a = 2r_m \sin(\alpha/2)$ , from where  $\sin(\alpha/2) = a/2r_m$ ,  $\alpha/2 = \arcsin(a/2r_m)$ .

Then according to (11), (14) we will have:

$$V_{cn} = 0,25d_m^2 \left[ \left( \pi \arcsin \frac{a}{d_m} \right) / 180 - \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right] (T_1 n_1 + T_2 n_2 + \dots + T_i n_j), \text{ [m}^3\text{]} \quad (15)$$

Substituting the values of the components from (11) (13) (15) in equation (10) we obtained a formula for determining the volume  $V_n$ , which is occupied by knives-grinders:

$$V_n = \left( (a+b)h_n \delta_n - 0,5\delta_n^2 \left( \operatorname{btg} \alpha_n + \frac{h_n}{\cos \gamma_n} \right) - 0,5d_m^2 \times \right. \\ \left. \times \left[ \left[ \left( \pi \arcsin \frac{a}{d_m} / 180 \right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right] (T_1 n_1 - T_2 n_2 - \dots - T_i n_j) \right] \right) \frac{\theta_n}{2}, \text{ [m}^3\text{]} \quad (16)$$

Then, the total volume  $V_e$  of the screw conveyor, according to (3), (8), (9) and (16), is defined by the formula:

$$V_e = 0,25\pi d_m^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j) + 0,5\delta_c z (D_k - d_m) \times \\ \times \left( n_1 \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + n_2 \sqrt{T_2^2 + 0,25(D_k + d_m)^2} + \dots + n_j \sqrt{T_j^2 + 0,25(D_k + d_m)^2} \right) + \\ + 0,5\theta_n \left( (a+b)h_n \delta_n - 0,5\delta_n^2 \left( \operatorname{btg} \alpha_n + \frac{h_n}{\cos \gamma_n} \right) - 0,5d_m^2 \times \right. \\ \left. \times \left[ \left[ \left( \pi \arcsin \frac{a}{d_m} / 180 \right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right] (T_1 n_1 - T_2 n_2 - \dots - T_i n_j) \right] \right) \text{ [m}^3\text{]} \quad (17)$$

However, according to (4), the constructive geometric factor  $k_n$  of the screw conveyor will be determined by applying the formula:

$$k_n = \frac{0,5\pi d_m^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j) + \delta_c z (D_k - d_m) \times \\ \times \left( n_1 \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + n_2 \sqrt{T_2^2 + 0,25(D_k + d_m)^2} + \dots + n_j \sqrt{T_j^2 + 0,25(D_k + d_m)^2} \right) + \\ + \theta_n \left( (a+b)h_n \delta_n - 0,5\delta_n^2 \left( \operatorname{btg} \alpha_n + \frac{h_n}{\cos \gamma_n} \right) - 0,5d_m^2 \times \right. \\ \left. \times \left[ \left[ \left( \pi \arcsin \frac{a}{d_m} / 180 \right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right] (T_1 n_1 - T_2 n_2 - \dots - T_i n_j) \right] \right)}{\pi D_k^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j)} \quad (18)$$

Thus, according to (5), the filling factor  $k_z$  is determined by dependence:

$$k_z = \frac{D_k^2}{(D_k + 2c)^2} - \frac{0,5\pi d_m^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j) + \delta_c z (D_k - d_m) \times \left( \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + n_2 \sqrt{T_2^2 + 0,25(D_k + d_m)^2} + \dots \right) + \dots}{\pi (D_k + 2c)^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j)} + \theta_n \left( \frac{(a+b)h_n \delta_n - 0,5\delta_n^2 \left( \text{btg} \alpha_n + \frac{h_n}{\cos \gamma_n} \right) - 0,5d_m^2 \times \left[ \left( \frac{\pi \arcsin \frac{a}{d_m}}{180} \right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right] \times (T_1 n_1 - T_2 n_2 - \dots - T_i n_j)}{\pi (D_k + 2c)^2 (T_1 n_1 + T_2 n_2 + \dots + T_i n_j)} \right) \quad (19)$$

For practical application of obtained dependences (18) and (19) let's simplify them through the formalization of constructive execution of combined screw conveyor SGC.

For this, let's accept the assumption that:

– the number of turns  $n_1, n_2, \dots, n_j$  of each  $n$ -th  $T_i$  step is the same, which means  $n_1 = n_2 = \dots = n_j = n_z$ ;

– each next step of turns starts with the first increases in constant value  $\Delta T$ , thus:  $T_2 = T_1 + \Delta T; \dots; T_i = T_{i-1} + \Delta T$ ;

– the number of knife-grinders that are installed on the screw conveyor tube drum between one pair of two adjacent spiral turns is the same and equal  $\theta_1$ .

In this case:

– the sum of  $T_1 n_1 + T_2 n_2 + \dots + T_i n_i$   $n$ -th steps of spiral turns, which is equal to the screw conveyor length  $L_k$ , can be represented as dependence:

$$T_1 n_1 + T_2 n_2 + \dots + T_i n_j = \frac{n_z n}{2} [T_1 + \Delta T (n-1)], [\text{m}] \quad (20)$$

where

$n_z$  – number of turns of each  $T_i$ -th step;

$n$  – number of  $T_i$ -th steps;

– total number of knives  $\theta_n$ , that are installed on the screw conveyor tube drum will be equal:

$$\theta_n = \theta_1 (n_z n - 1), [\text{units}] \quad (21)$$

In addition, also accept the assumption that each knife-grinder designed as straight prisms whose height is equal to  $\delta_n$  and the basis of the prism is an equilateral trapezium, whose height is equal to  $h_n$ , we can notice that the height of the trapezoid will be approximately equal to the height of the spiral coil, or  $h_n \cong h_c \cong 0,5(D_k - d_m)$ , three working side edges of the prism on both sides will have sharpening angle  $\alpha_n$ .

In this case, the volume  $V'_n$  which is occupied by knives-grinders will be equal:

$$V'_n = (V_{np} - V_z) \theta_1 (n_z n - 1) = \frac{\theta_1 (n_z n - 1) [(a+b)(D_k - d_m) \delta_n \cos \gamma_n - \delta_n^2 (\text{btg} \alpha_n + 0,5(D_k - d_m))]}{\cos \gamma_n}, [\text{m}^3] \quad (22)$$

Then, equations (18) and (19) will have a final form:

$$k_n = \frac{d_m^2}{2D_k^2} \left[ 1 + \frac{4\Omega\delta_c z(D_k - d_m)}{\pi m D_k^2 [2T_1 + \Delta T(n-1)]} + \frac{\theta_1(n_z n - 1)\delta_n}{\pi} \times \left( \frac{2(a+b)(D_k - d_m)\cos\gamma_n - \delta_n [btg\alpha_n \cos\gamma_n + 0,5(D_k - d_m)]}{n d_m^2 [2T_1 + \Delta T(n-1)]\cos\gamma_n} \right) \right] \quad (23)$$

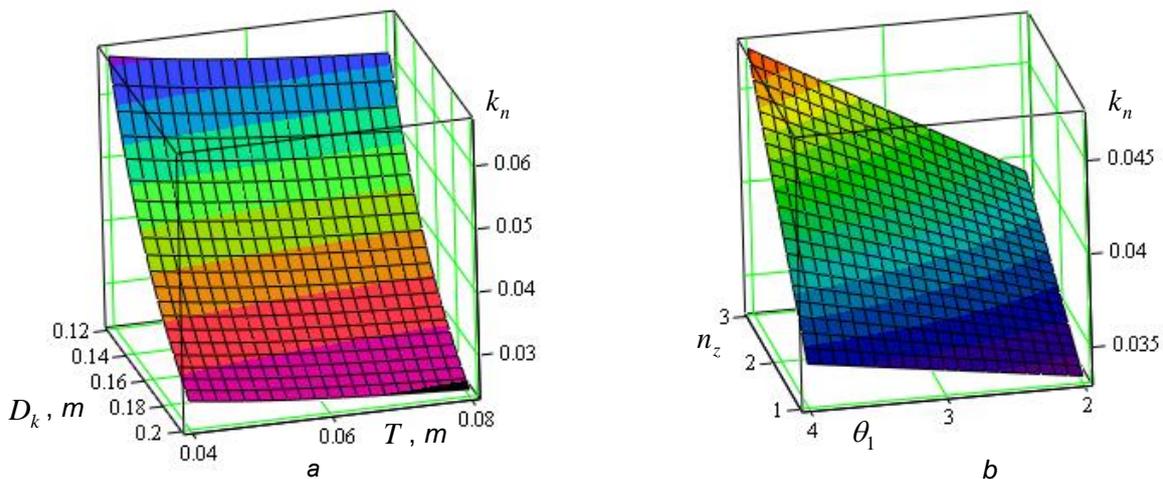
$$k_z = \frac{D_k^2 - \frac{d_m^2}{2}}{(D_k + 2c)^2} \left[ 1 + \frac{4\Omega\delta_c z(D_k - d_m)}{\pi m D_k^2 [2T_1 + \Delta T(n-1)]} + \frac{\theta_1(n_z n - 1)\delta_n}{\pi} \times \left( \frac{2(a+b)(D_k - d_m)\cos\gamma_n - \delta_n [btg\alpha_n \cos\gamma_n + 0,5(D_k - d_m)]}{n d_m^2 [2T_1 + \Delta T(n-1)]\cos\gamma_n} \right) \right] \quad (24)$$

where

$$\Omega = \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + \sqrt{T_2^2 + 0,25(D_k + d_m)^2} + \dots + \sqrt{T_i^2 + 0,25(D_k + d_m)^2} = \sqrt{T_1^2 + 0,25(D_k + d_m)^2} + \sqrt{(T_1 + \Delta T)^2 + 0,25(D_k + d_m)^2} + \dots + \sqrt{[T_i + \Delta T(n-1)]^2 + 0,25(D_k + d_m)^2}; \Theta = \left[ \left( \pi \arcsin \frac{a}{d_m} / 180 \right) + \frac{a}{d_m} \cos \arcsin \frac{a}{d_m} \right].$$

According to initial conditions  $d_m = 0.04$  m;  $\Delta T = 0.01$  m;  $\delta_n = 0.002$  m;  $n_z = 2$ ;  $n = 3$ ;  $\alpha_n = \pi/6$  grad.;  $a = 0.03$  m;  $b = 0.02$  m;  $c = 0.002$  m, according to equation (23) results the built dependence of constructive geometric factor  $k_n$ , and according to (24) – the filing factor  $k_z$ .

Analysis of the dependence (fig. 2) showed that constructive geometric factor  $k_n$  depends on the diameter changes  $D_k$  and step  $T$  of the screw conveyor is in the range 0.025...0.07 on a number of variables  $T_i$ -th steps that are equal to  $n = 3$ , number of spiral turns of the same  $T_i$ -th step –  $n_z = 2$  and the



number of knife-grinders, installed between one pair of two adjacent spiral turns  $\theta_1 = 4$  units.

**Fig. 2 - Dependence on change of constructive geometric factor  $k_n$  as functionality**

a –  $k_n = f_n(D_k; T)$  with  $\theta_1 = 3$  units; b –  $k_n = f_n(n_z; \theta_1)$  with  $D_k = 0.16$  m;  $T = 0.05$  m

With this change,  $k_n$ , which is defined as a functional dependence  $k_n = f_n(D_k; T)$  is reversible - with increasing of the diameter  $D_k$  and step  $T$  of the screw conveyor constructive geometric factor  $k_n$  decreases by parabolic function. We established that with increasing the number of knife-grinders  $\theta_1$ , which are installed between a pair of two adjacent spiral turns and the number of spiral turns  $n_z$  of one  $T_i$ -th step,

the constructive geometric factor  $k_n$  increases in direct proportion to the  $\theta_1$  i  $n_z$ , thus, the average growth value of  $k_n$  is in the range 0.002...0.0025 and 0.003...0.005.

In this regard, we can say that structural change in the number of blade-grinders  $\theta_1$  and the number of spiral turns  $n_z$  of one  $T_i$ -th step do not significantly affect the structural change of the factor  $k_n$ .

Three-dimensional graphical interpretation of filling factor changes depending on  $k_z$  as functional  $k_z = f_z(D_k; T)$  and  $k_z = f_z(D_k; \Delta T)$  given, respectively, on fig. 3 and fig. 4.

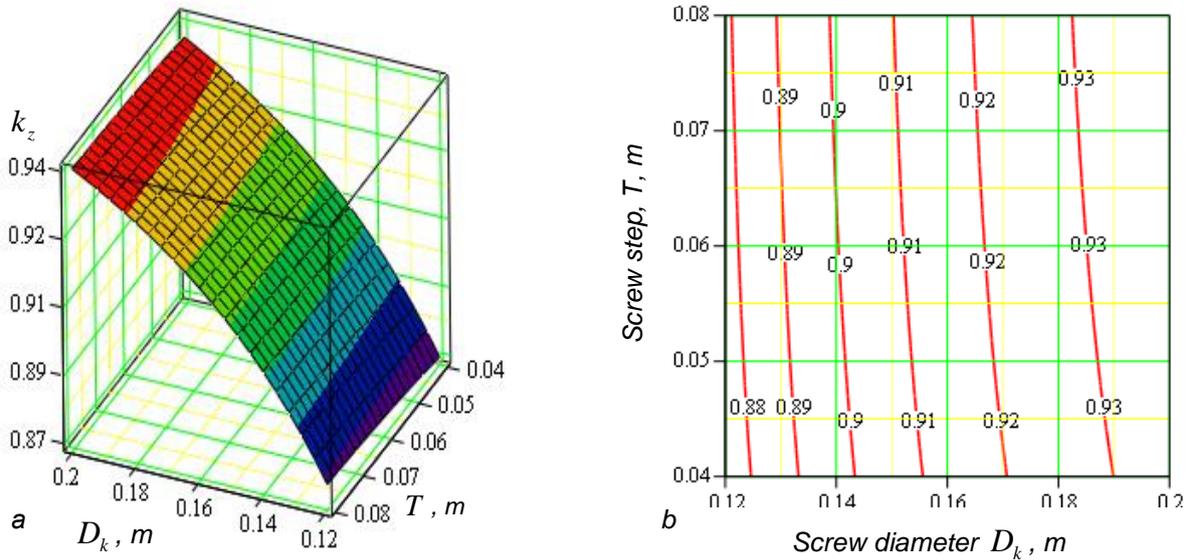


Fig. 3 - Dependence of change of filling coefficient  $k_z$  as functional  $k_n = f_n(D_k; T)$  on  $\theta_1 = 3$   
 a – three-dimensional surface; b – two dimensional surface cross section

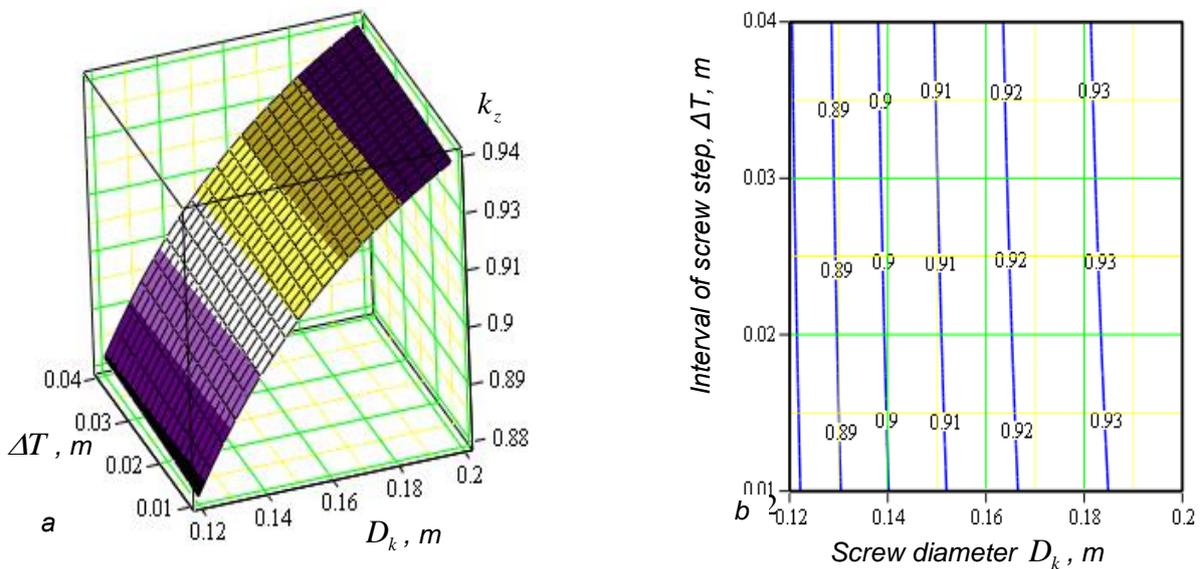


Fig. 4 - Dependence of change of filling coefficient  $k_z$  as functional  $k_n = f_n(D_k; \Delta T)$  on  $\theta_1 = 3$   
 a – three-dimensional surface; b – two dimensional surface cross section

It was established that the functional change of filling factor  $k_z$  depending on the diameter changes  $D_k$  and step  $T$  of the screw conveyor (fig. 3, fig. 4), in contrast to the structural changes of geometric coefficient  $k_n$  of combined SGC has reversible type - with increasing  $D_k$  and  $T$  filling factor  $k_z$  and also growing in the range 0.87...0.94. In this case 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 of  $k_z$  occurs when the value  $D_k \geq 0.12$  m - in the range of change  $D_k$  from 0.12 to 0.16 (m) filling factor  $k_z$  growing on 0.05. Step change  $T$  and increasing of interval  $\Delta T$  of the screw conveyor has insignificant impact on the quantitative value  $k_z$  by increasing step  $T$  from 0.04 to 0.08 (m) and increasing the step interval  $\Delta T$  from 0.01 to 0.04 (m) filling factor  $k_z$  increases, respectively, on 0.004 and 0.001.

## CONCLUSIONS

The obtained values of filling factor  $k_z = 0.87...0.94$  by its analytical nature, is the most-possible technological parameters of the transporting process of chopped root crops by working bodies of combined SGC and characterizes its maximum degree of workspace filling i.e. it can be stated that the maximum value of filling factor  $k_z$  ranges within  $k_{z,max} = 0.87...0.94$ .

Thus, we established at analytical level, the numerical value of the maximum filling factor  $k_{z,max} = 0.87...0.94$ , is a further step for research of technological and energy parameters of chopped roots transporting process justification of combined SGC productivity and energy costs that are necessary for the simultaneous grinding and transportation, which ultimately will lead directly to a rational justification of structural and kinematic parameters of combined SGC working bodies.

## REFERENCES

- [1] Baranovsky V., (2014), Methodological and structural-technological aspects of development of adapted root crop machinery (Методологічні та конструктивно-технологічні аспекти розробки адаптованих коренезбиральних машин), *Science journal. Journal of TNTU (Науковий журнал. Вісник ТНТУ)*, том 2 (74), pp.106-113, Ternopil/Ukraine;
- [2] Baranovsky V.M., Potapenko M.V., (2016), Improvement of the clearing of systems of chicory root heaps. (Вдосконалення очисних систем вороху коренеплодів цикорію), *Scientific journal. Innovative solutions in modern science*, # 1(1), pp.138-146, Dubai/OAE;
- [3] Byrd J., (2008). *Engineering Mathematics (Инженерная математика)*, Dodeka-XXI, Moskva/RF;
- [4] Hevko Iv.B., (2008), *Spiral transport and technological mechanisms, calculation and design (Гвинтові транспортно-технологічні механізми: розрахунок і конструювання)*, Ternopil, TNTU Ivan Pul'uj, Ternopil/Ukraine;
- [5] Hevko Iv.B., (2013), *Scientific and applied basis for the creation of screw transport and technological mechanisms: dissertation thesis (Науково-прикладні основи створення гвинтових транспортно-технологічних механізмів)*, Doctor. Sc. Sciences, National University "Lviv Polytechnic, Lviv/Ukraine;
- [6] Hevko R.B., Dzyura V.O., Romanovsky R.M., (2014), Mathematical model of the pneumatic-screw conveyor screw mechanism operation, *INMATEH, Agricultural Engineering*, vol.44, no.3, pp.103-110, Bucharest/Romania;
- [7] Hevko R.B., Klendiy O.M., (2014), The investigation of the process of a screw conveyer safety device actuation, *INMATEH, Agricultural Engineering*, vol.42, no.1, pp.55-60, Bucharest/Romania;
- [8] Hevko R.B., Zalutskyi S.Z., Tkachenko I.G., et al., (2015), Development and investigation of reciprocating screw with flexible helical surface, *INMATEH Agricultural Engineering*, vol.46, no.2, pp.133-138, Bucharest/Romania;
- [9] Rogatinsky R., (2012), Model of construction and choice of screw conveyors with advanced technological capabilities (Модель конструювання і вибору гвинтових конвеєрів з розширеними технологічними можливостями), *Science journal. Journal of TNTU (Науковий журнал. Вісник ТНТУ)*, том 3 (67), pp.197-210, Ternopil/Ukraine;
- [10] Shipachev V.S., (2003), *Book of problems in higher mathematics (Задачник по высшей математике)*, 3-rd ed., Moskva/Russia;
- [11] Voytyuk D.G., Aniskevych L.V., Baranowsky V.M., et al., (2015), *Agricultural machines (Сільськогосподарські машини)*, Ahrosvita, Kijv/Ukraine.

## WRITING NORMS

### Article Types

Three types of manuscripts may be submitted:

1. **Regular articles:** These should describe new and carefully confirmed findings, and experimental procedures should be given in sufficient detail for others to verify the work. The length of a full paper should be the minimum required to describe and interpret the work clearly (max.10 pages, **even number**);
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Manuscripts should be written in English (American or British usage is accepted, but not a mixture of these) and submitted **electronically** at the following e-mail addresses: [inmatehjournal@gmail.com](mailto:inmatehjournal@gmail.com)

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The authors are responsible for the accuracy of the whole paper and references.

There are allowed 2 papers by each first author.

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The editorial board will re-review manuscripts that are accepted pending revision.

### NOTE:

Submission of a manuscript implies: that the work described has not been published before (excepting as an abstract or as part of a published lecture or thesis) that it is not under consideration for publication elsewhere.

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- Manuscripts should be concise, in **1.15 line spacing**, and should have 2 cm all over margins. The font should be **Arial 10 pt**. Ensure that each new paragraph is clearly indicated, using **TAB at 1 cm**.
- Title will be **Arial 12 pt**. and explicit figures will be **Arial 9 pt**.
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Should be a brief phrase describing the contents of the paper. Avoid long titles; a running title of no more than 100 characters is encouraged (without spaces).

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Under the paper's title, after a space (enter) 9 pt., write **authors' names** and **affiliations (Arial 8 pt.-Regular)**

When the paper has more than one author, their name will be followed by a mark (Arabic numeral) as superscript if their affiliation is different.

*Corresponding author's name* (next row), (**Arial 8 pt.**). Should be added also: phone, fax and e-mail information, for the paper corresponding author (**font: 8 pt., Italic**).

**KEYWORDS** (**In English**) about 4 to 10 words that will provide indexing references should be listed (**title: Arial 10pt, bold italic, text Arial 10 pt., italic**).

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**ABSTRACT** (in English and Native language, Arial 10 pt.), the title *bold*; the text of abstract: *italic*) should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The Abstract should be max.250 words. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

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**Formulae, symbols and abbreviations:** Formulae will be typeset in Italics (preferable with the Equation Editor of Microsoft Office 2003) and should be written or marked as such in the manuscript, unless they require a different styling. They should be referred to in the text as Equation (4) or e.g. (4). The formulae should be numbered on the right side, between brackets (Arial 10 pt.):

$$P = F \cdot v \quad (1)$$

Terms of the equation and the unit measure should be explained, e.g.

*P* is the power, [W];

*F* – force, [N];

*v* – speed, [m/s]

SI units must be used throughout.

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**Figure** (Arial 9 pt., Bold, Center) should be typed in numerical order (Arabic numerals). Graphics should be high resolution (e.g.JPEG). Figure number is followed by what represent the figure or graph e.g.:

**Fig.1 – Test stand**

**Legend:** Arial 8 pt, *Italic, Center*, e.g.

1 - plansifter compartments; 2- break rolls; 3 – semolina machines; 4 – reduction rolls; 5 – flour

**ACKNOWLEDGMENTS** (Arial 10 pt.) of people, grants, funds etc should be brief (if necessarily).

**REFERENCES** (Arial 10 pt.)

(in alphabetical order, in English and in the original publication language).

Minimum 10 references, last 10 years, minimum 3 references from the last 2 years

It can be used "References" tool from the *Word Editor*.

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References should be alphabetically, with complete details, as follows:

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**Books:** Names and initials of authors, year (between brackets), title of the book (Italic), volume number, publisher, place, pages number or chapter, ISSN/ISBN:

[1] Vlăduț V., (2009), *Study of threshing process in axial flow apparatus (Studiul procesului de treier la aparatele cu flux axial)*, vol.1, "Terra Nostra" Publishing House, Iași/Romania;

**Journal Article:** Names and initials of authors, year (between brackets), full title of the paper, full name of the journal (Italic), volume number, publisher, place, page numbers:

[1] Lizhi Wu, Yan Di., (2005), *Demonstrational study on the land consolidation and rehabilitation (LCR) project of saline-alkali soil in arid areas: a case study of Lubotan LCR project in Pucheng County, Shaanxi Province (干旱区盐碱化土地整理工程实证研究-以陕西蒲城县卤泊滩土地整理项目为例)*, *Transactions of the Chinese Society of Agricultural Engineering*, vol.21, no.1, Madison/Wisconsin, pp.179-182;

[2] Leonov I.P., (1973), *Basic machine theory for tobacco stringing. Post-harvest care of tobacco and rustic tobacco (Основы теории машин для закрепления табака на шнуры. Послеуборочная обработка табака и махорки)*, *Collection of scientific articles (сборник научно-исследовательских работ)*, pp.37-45;

**Conference or Symposium:** Names and initials of authors, year (between brackets), full title of the paper (Regular), full name of the conference/symposium (Italic), volume number, publisher, place, page numbers

[1] Bungescu S., Stahl W., Biriș S., Vlăduț V., Imbrea F., Petroman C., (2009), *Cosmos program used for the strength calculus of the nozzles from the sprayers (Program Cosmos folosit pentru calculul de rezistență la zgomot al aparatelor de distribuție)*, *Proceedings of the 35 International Symposium on Agricultural Engineering "Actual Tasks on Agricultural Engineering"*, Opatija / Croatia, pp.177-184;

**Dissertation / Thesis:** Names and initials of authors, year (between brackets), full name of the thesis (Italic), specification (PhD Thesis, MSc Thesis), institution, place;

[1] Popa L., (2004), *Research on the influence of structural and functional parameters of the braking system on the braking performance of agricultural trailers (Cercetări privind influența caracteristicilor constructive și funcționale ale sistemelor de frânare asupra performanțelor de frânare ale remorcilor agricole)*, PhD dissertation, Transylvania University of Brașov, Brașov / Romania.

**Patents:** Names and initials of authors, year (between brackets), patent title (Italic), patent number, country:

[1] Grant P., (1989), *Device for Elementary Analyses*. Patent, No.123456, USA.

**Legal regulations and laws, organizations:** Abbreviated name, year (between brackets), full name of the referred text, document title/type (Italic), author, place:

[1] \*\*\* EC Directive, (2000), *Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000, on the incineration of waste, Annex V, Official Journal of the European Communities, L332/91, 28.12.2000, Brussels.*

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- **two authors:** both authors' names and the year of publication: (Adam and Brown, 2008; Smith and Hansel, 2006; Stern and Lars, 2009)

- **three or more authors:** first author's name followed by "et al." and the year of publication: "As has recently been shown (Werner et al., 2005; Kramer et al., 2000) have recently shown ...."

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- Acronyms may be acceptable, but must be defined at first usage.



**Edited by: INMA Bucharest**

6 Ion Ionescu de la Brad Blvd., sect. 1, Bucharest, ROMANIA

Tel: +4021.269.32.60; Fax: +4021.269.32.73

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