

Метою дослідження є вивчення процесу і основних закономірностей шнекових пресів і можливості їх ефективного використання для пресування порошку кави в автоматичних кавових машинах. Методологічною і теоретичною основою дослідження служать основні положення теорії переробки сипких середовищ, інтегральне і диференціальне числення.

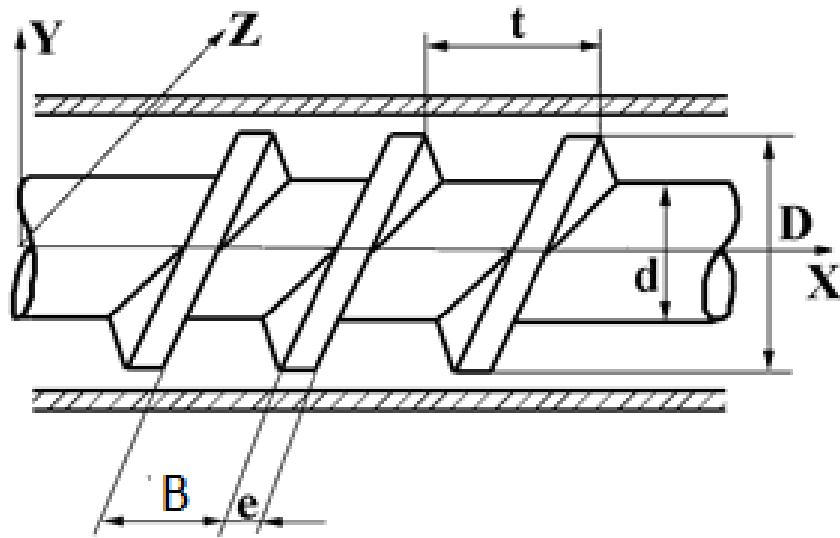
Ключові слова: автоматична кавова машина, мелена кави, шнековий прес, математична модель, раціональні параметри.

V.P. MISYATS, T.I. KULIK
 Kyiv National University of Technologies and Design
 S.P. LISEVYCH, O.S. POLISCHUK
 Khmelnytskyi National University

ANALYTICAL STUDY OF THE WORKING OF THE MECHANICAL APPLIANCE FOR CAVE PRESERVATION

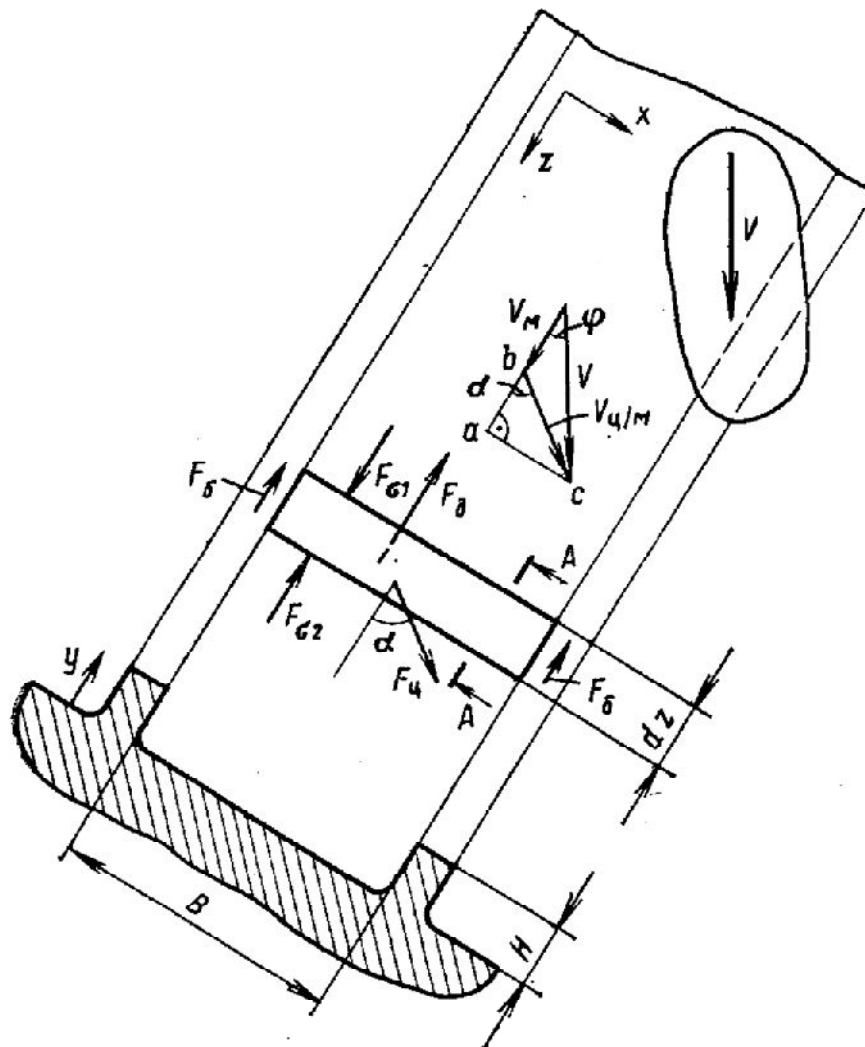
The purpose of the study is to study the process and the basic laws of screw presses and the possibility of their effective use for pressing powder coffee in automatic coffee machines. The methodological and theoretical basis of the study are the main provisions of the main provisions of the theory of processing of friable media, integral and differential calculus. The mathematical analysis of the motion process and the condensation of powder material in the screw conduit of the screw press is carried out. Formulas for determining the pressure produced by the press, volume productivity and power consumption are obtained. For the first time the theoretical justification of the choice of rational structural parameters of the screw, providing maximum pressure at the output of the device. The dependence of the screw device performance on the transport angle is obtained. The pressure and discharge characteristics of the device are established. It is established that the maximum value of pressure almost does not depend on the depth of the screw holes. The results of the study can be used to improve the design of machines for the automatic preparation of coffee beverages.

Key words: automatic coffee machine, ground coffee, screw press, mathematical model, rational parameters.



.1. B - ; t - ; D - ; d - ;
 B - ; t - ; e -

$$\sigma_{xx} = k \times \sigma_{zz} ; \sigma_{yy} = k \times \sigma_{zz} ; \quad (1)$$



.2.

$$F_{\sigma 1} + F_{\sigma 2} - F_{\sigma z} = 0 \tag{2}$$

$$F_{\sigma 1} = \tilde{\sigma}_{zz} \times B \times H ; F_{\sigma 2} = (\tilde{\sigma}_{zz} + d\tilde{\sigma}_{zz}) \times B \times H ; F = \sigma_{yy(y=0)} \times f \times B \times dz \tag{3}$$

$$F = \sigma_{yy(y=H)} \times f \times B \times \left(\frac{R_c}{R}\right) dz ; F = \tilde{\sigma}_{xx} \times f \times H \times 0,5 \left(1 + \frac{R_c}{R}\right) dz \tag{4}$$

$$\tilde{\sigma}_{zz} = \frac{1}{H} \int_0^H \sigma_{zz}(y) \times dy ; \tilde{\sigma}_{xx} = \frac{1}{H} \int_0^H \sigma_{xx}(y) \times dy \tag{5}$$

$$\frac{R_c}{R} = 0,5 \left(1 + \frac{R_c}{R}\right) \tag{6}$$

$$-\frac{d\tilde{\sigma}_{zz}}{dz} + \frac{f}{H} \times \left[\sigma_{zz(y=0)} \times \cos \alpha - \sigma_{zz(y=H)} \times \frac{R_c}{R} - \sigma_{zz} \times \frac{H}{B} \times \left(1 + \frac{R_c}{R}\right) \right] = 0 \tag{7}$$

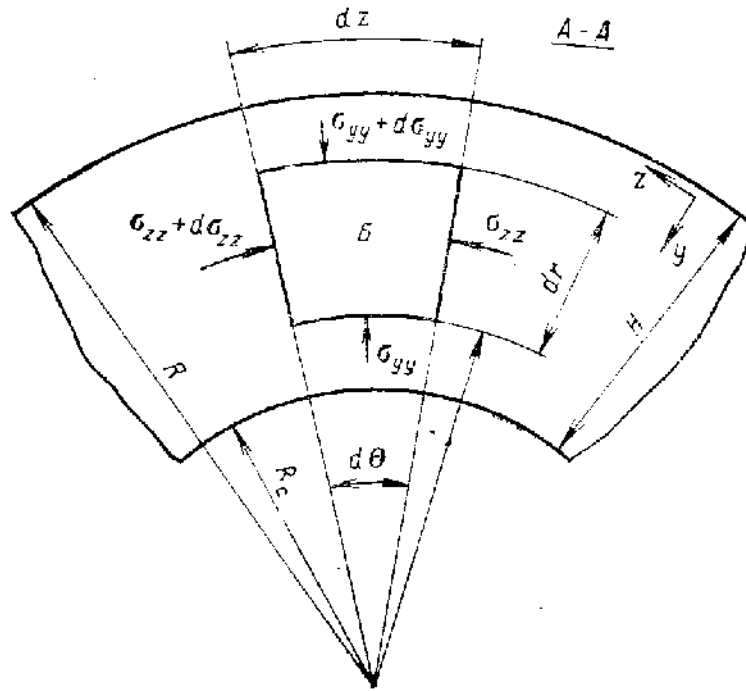
$$\sigma_{yy} r d\theta - (\sigma_{yy} + d\sigma_{yy})(r + dr) d\theta + (2\sigma_{zz} + d\sigma_{zz}) dr \times \operatorname{tg} \left(\frac{d\theta}{2}\right) = 0 \tag{8}$$

$$\operatorname{tg} \left(\frac{d\theta}{2}\right) \approx 0,5 d\theta \tag{9}$$

$$\sigma_{zz} (1-k) \frac{1}{r} - k \frac{d\sigma_{zz}}{dr} = 0 \tag{10}$$

$$\sigma_{zz(r=R)} = \sigma_{zz(y=0)} ; \sigma_{zz(r=r)} = \sigma_{zz(r)} \tag{11}$$

$$\sigma_{zz(r)} = \sigma_{zz(y=0)} \left(\frac{r}{R}\right)^{\left(\frac{1-k}{k}\right)} \tag{12}$$



.3.

$\tilde{\sigma}_{zz}$:

$$\tilde{\sigma}_{zz} = \frac{1}{R - R_C} \int_{R_C}^R \sigma_{zz}(r) dr. \tag{12}$$

(11) (12),

$$\sigma_{zz}(y=H) = \tilde{\sigma}_{zz} \frac{1 - \bar{R}_C}{k} \left(1 - \bar{R}_C^{\frac{1}{k}} \right)^{-1}, \tag{13}$$

$$\bar{R}_C = R_C / R.$$

$$\sigma_{zz}(y=H), \tag{12} \tag{13} \quad r = R_C:$$

$$\sigma_{zz}(y=H) = \tilde{\sigma}_{zz} \frac{1 - \bar{R}_C}{k} \left(1 - \bar{R}_C^{\frac{1}{k}} \right)^{-1} \bar{R}_C^{\left(\frac{1}{k} - 1 \right)} \tag{14}$$

$$\sigma_{zz}(y=0) \quad \sigma_{zz}(y=H) \tag{13} \tag{14},$$

σ_{yy} z :

$$\frac{f \times F_\alpha}{H} \tilde{\sigma}_{zz} = \frac{d\tilde{\sigma}_{zz}}{dz}, \tag{15}$$

$$F_\alpha = \frac{1 - \bar{R}_C}{1 - \bar{R}_C^{1/k}} \cos \alpha - \frac{1 - \bar{R}_C}{1 - \bar{R}_C^{1/k}} \bar{R}_C^{1/k} - k \frac{H}{B} (1 + \bar{R}_C). \tag{16}$$

$$\tilde{\sigma}_{zz}(z=0) = \sigma_0 \quad \tilde{\sigma}_{zz}(z):$$

$$\tilde{\sigma}_{zz}(z) = \sigma_0 \exp \left(\frac{f \times F_\alpha \times z}{H} \right) \tag{17}$$

σ_0

h

$$\sigma_0 = \rho \times g \times h, \tag{18}$$

$\rho -$

$g -$

$$\sigma, \tag{16}$$

F_α :

$$F_\alpha = \left(\ln \frac{\sigma}{\sigma_0} \right) \frac{H}{Z \times f}, \tag{19}$$

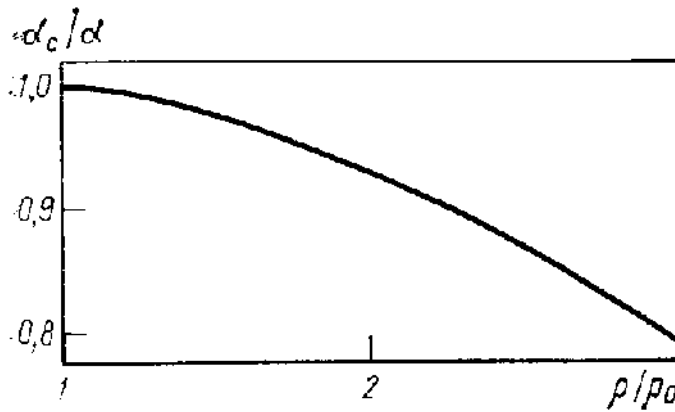
$$Z = \frac{L}{\sin \varphi} \left(L - F_{\alpha} \right) \quad (16)$$

$$Q = V_M \times B \times H \quad (20)$$

$$ctg \alpha = \frac{ab}{bc}; \quad ab = V \cos \varphi - V_M; \quad bc = V \sin \varphi \quad (21)$$

$$Q = B \times H \times V (\cos \varphi - \sin \varphi \times ctg \alpha) \quad (22)$$

$$G = \rho \times V_M \times B \times H \sqrt{b^2 - 4ac} \quad (23)$$



$$\frac{\alpha_c}{\alpha} = f\left(\frac{\rho}{\rho_0}\right)$$

$$\rho_0 \quad \alpha_c \quad \alpha \quad \varphi = 17^\circ \quad \rho$$

$$dW = F \times V_j + 2F V + F V \quad (24)$$

$V /$. 3.2:

$$V / = V \left(\frac{\sin \varphi}{\cos \alpha} \right) \tag{25}$$

$$(25) \quad (21) \quad V / \quad V \quad , \quad (24)$$

$$dW = V \times k \times f \times B \times P_\alpha \times \tilde{\sigma}_{zz}(z) dz , \tag{26}$$

$$P_\alpha = \frac{1 - \bar{R}_C}{(1 - \bar{R}_C^{1/k}) \times k} \frac{\sin \varphi}{\cos \alpha} + \left[\frac{H}{B} (1 + \bar{R}_C) + \frac{1 - \bar{R}_C}{(1 - \bar{R}_C^{1/k}) \times k} \bar{R}_C^{1/k} \right] (\cos \varphi - \sin \varphi \times \text{tg} \alpha) . \tag{27}$$

$$(26) \quad (17) \quad \tilde{\sigma}_{zz} \quad z \quad 0$$

$$Z = \frac{L}{\cos \varphi} ,$$

$$W = \sigma_0 \times V \times k \times B \times H \frac{P_\alpha}{F_\alpha} \times \left[\exp \left(f \frac{F_\alpha \times L}{H \times \sin \varphi} - 1 \right) \right] \tag{28}$$

α

φ . (. 2) .

$$(28) \quad (19) \quad (22))$$

$$\alpha = \varphi .$$

(.) (17) (16):

$$\tilde{\sigma}_{zz}(z) = \sigma_0 \times \exp \left(\frac{f \times \left[\frac{1 - \bar{R}_C}{1 - \bar{R}_C^{1/k}} \cos \alpha - \frac{1 - \bar{R}_C}{1 - \bar{R}_C^{1/k}} \bar{R}_C^{1/k} - k \frac{H}{B} (1 + \bar{R}_C) \right] \times z}{H} \right)$$

$$H = R - \bar{R}_C ; B = 2R \times \sin \varphi$$

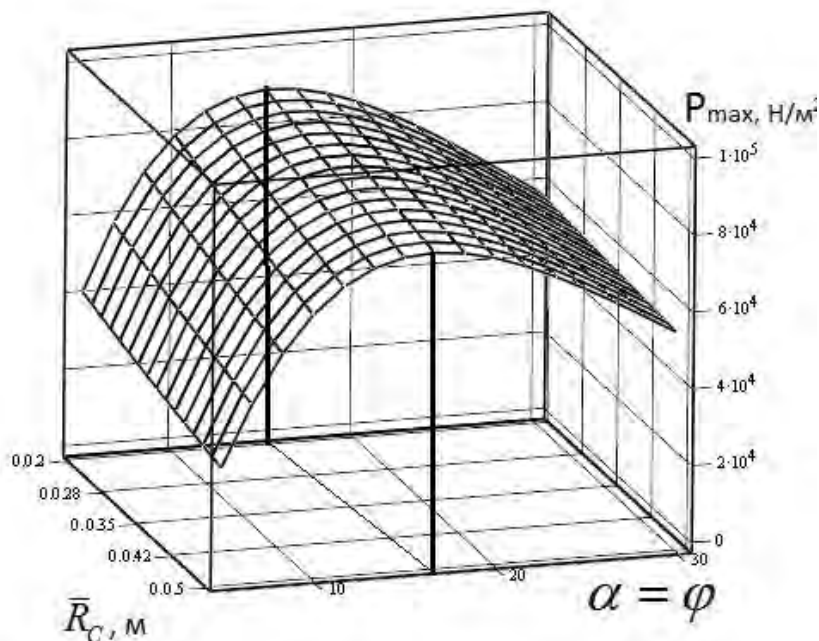
$$\alpha = \varphi$$

)

φ

\bar{R}_C .

. 5.

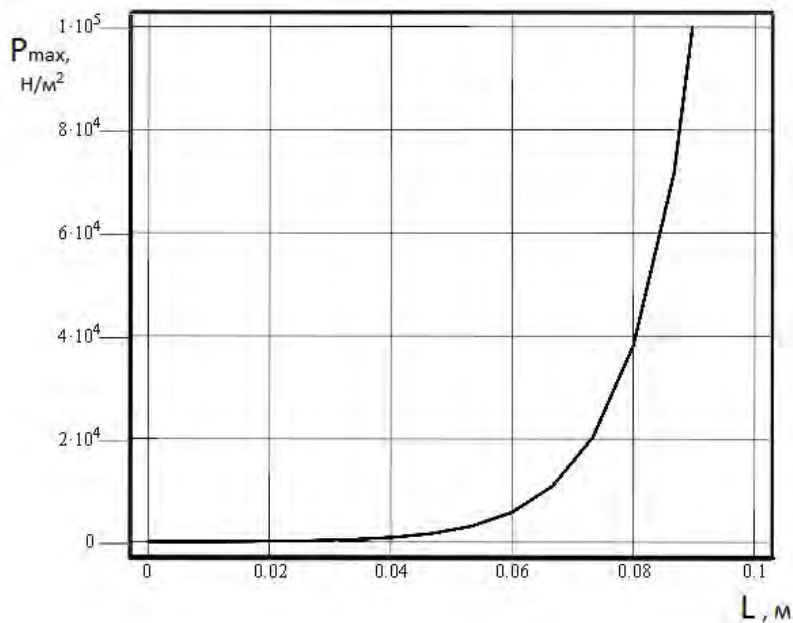


. 5.

φ

\bar{R}_C

(. 6).



. 6.

. 5 . $\varphi=16...18$.
 $\varphi=17$.
 (. 6) , 9500 / ² , 45 . 15
 45 ; 20 ; 17 ; 90 .
 / . . . , - : , 1986. - 488 .

References

Basov N.Y. Raschet y konstruyrovanye oborudovaniya dlia proyzvodstva y pererabotky polymernykh materialov / N.Y. Basov, Iu.V. Kazankov, V.A. Liubartovych. – Moskva : Khymiya, 1986. – 488 s.

/Received : 15.2.2018 . /Printed :24.3.2018 .
 : . . . ,