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Design Calculation of the Main Parameters of the Working Drums in Interaction with the Prefabricated

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ABSTRACT: The article describes the basic mechanics of the processes occurring in the working drums, the definition of the separation factor D_s, and the parameters $R_б$,$\omega_\delta$in the relationship of geometric, kinematic and power parameters allow the flow of the process in the processing of semi-finished products from the working fluid.

KEYWORDS: semi-finished product, working fluid, centrifugal force, mass, inertia force, power, friction force, trim, moment of inertia.

I. INTRODUCTION.

Studies [1] found that the mechanics of the processes occurring in the drums, determined by the separation factor of the diametrical section D_s and depends on the boundary conditions of the space, characterized by the parameters R_σ and ω_σ.

Therefore, when designing the working bodies of the drums, their geometric and kinematic parameters must be mutually linked through the factor D_s. At a given loading weight of the semi-finished product of the machine m_3, the useful capacity of the drum in the air dry state:

$$V_{semis} = m_3 \mathcal{V}_{у} [1]$$

$\mathcal{V}_{у}$ - specific capacity of the drum (specific module), where determined empirically.

The volume module of the drum (the volume per 1 kg of loaded semi-finished product) when mixed with working fluids is 8,8-16 $дм^3/кг$.

The value of the volume module determines the mobility of the semi-finished product in the drum during liquid processing, and therefore the intensity of the mechanical impact on them. Increase the volume modulus contributes to the improvement of the impregnated leather with fluids.

The calculated capacity of the inner drum is determined by the following formula:

$$V_р = \pi * D_\sigma^2 * L_\sigma/4 \ = m_3 \mathcal{V}_{у} К_1 [2]$$

where D_σ - drum diameter; L_σ - length drum; $К_1$ - coefficient taking into account the volume occupied by kollek protruding inside the drum.

Denoted, $\frac{D_\sigma}{L_\sigma}$=$К_2$, то$m_3 \mathcal{V}_{у} К_1/4К_2$, where

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$$D_\sigma = \sqrt[3]{\frac{4}{\pi}} + V_p K_2 [3]$$

The diameter of the inner drum for liquid treatment with a side hatch can be determined by the empirical formula:

$$D_\sigma = 0{,}16\sqrt{m_3} - 0{,}0065 m_3 [4]$$

The angular speed of rotation of the drum will be equal to

$$\omega_\sigma = 3/\sqrt[3]{D_s/R_\sigma}\, \omega_\sigma = 2\pi * \Pi_\sigma [5]$$

The values of separation factor D_s on the operations of tanning flushing is taken 0,7-0,85. The critical frequency of rotation of the drum, which the semi-finished product is taken to the wall of the drum under the action of centrifugal force approximately equal to: $n_{\text{кр}} \approx 0{,}6/R_\sigma$, the actual operating

$$n_{\text{р}} = (0{,}65 - 0{,}78) n_{\text{кр}}$$

Bulk modulus of drum machines for liquid treatment is in the range of 16-25 $\text{дм}^3/\text{кг}$. Factor D_s separation at a centrifugal spinning reels take in working 270-300, and in the washing of prefabricated 0,75-0,82. In the intermediate spin speed of the working drum is about two times less than the final.

The power consumption of the working drum can be found from the ratio of the forces of useful and harmful resistances. The moment of the useful resistance forces is determined from the equilibrium condition of the mass of the semi-finished product and the working fluid inside the drum. When the drum rotates, the semi-finished product and the working fluid takes the form approaching the shape of a cylindrical segment AFD somewhat mixed relative to the vertical in the direction of rotation. In this case, the center of gravity of the segment can be at points C_0 and C. The center of gravity of the segment at point OC is located at a distance from the axis of rotation of the axis of the axis of rotation therefore, the useful moment of resistance during rotation of the drum

$$M_n = G_T/l = G_T * b * \sin\alpha\, [6]$$

where $G_T = mg$ is the gravity of the semi-finished product in the working fluid.

Mass of semi-finished product impregnated in the working fluid inside the drum,

$$m_{\text{M}} = m_{semis} + 2{,}25 * 10^{-3} * m_{semis} * \rho_{liq} [7]$$

where m_{semis} - mass of the mix in to wet process,

$2{,}25 * 10^3$- the average volume of liquid contained in 1 kg of semi-finished product,

ρ_{liq} - density of the working fluid (for washing $\rho_{liq} = 1{,}6 * 10^3$ $\text{кг}/\text{м}^3$.

The mass of the liquid carried away by the semi-finished product during the rotation of the drum,

$$m_{liq} = 0{,}15 m_{liq}$$

where m_{liq} is the mass of free liquid in the drum, kg

Since

$$m_{liq} = \rho_{liq} * v_{liq} * m_{semis} - 2{,}25 * 10^{-3} * m_{semis} * \rho_{liq} \approx G * m_{semis} [8]$$

$$m_{\text{liq}} = 0.15 * G * m_{semis} = 0.9 * m_{semis}$$

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The total weight of the semi-finished product raised tracing paper drum, depends on the amount and type when loaded into the liquid drum and is:

$$m = m_{semis} + m_{liq}.$$

Jointly solving equation [7] and [8]

Get $m = m_{semis}(1{,}9 + 2{,}25 * 10^{-3})\rho_{liq}$ [9]

Volume occupied by impregnated working fluids and free liquid,

$$V = V_{oф} + V_{liq} = (m_{semis}/\rho_{liq} + 2{,}25 * 10^{-3} * m_{semis}) + G * m_{semis}/\rho_{liq} = m_{semis}(1/\rho_{semis} + G/\rho_{liq} + 2{,}25 * 10^{-3}) \quad [10]$$

where ρ_{liq} - semi-finished product power (take $1{,}5 * 10^3$ $кг/м^3$)

The area occupied by the semi-finished product and the working fluid in the plane of the cross section of the drum,

$$S = {}^{V}/_{L_\sigma}$$

where L_σ - length of drum, m

the ADF segment enables the determination of the central angle α from the expressions

$$S = R_\sigma^2/2 \ * (\frac{\pi}{180} * \alpha * \sin\alpha) \qquad [11]$$

where R_σ is the radius of the drum, m

Knowing the angle α, you can find the chord of the segment by the formula

$$L_x = D_\sigma * \sin(\frac{\alpha}{2})$$

where D_σ - drum diameter, m

The distance from the axis of rotation to the center of gravity of the segment is determined by geometric calculations:

$$b = l_x^3/12S \qquad [12]$$

Consequently, the power of the drum from the useful moment of resistance during its rotation

$$N_n = M_n * \omega_\sigma/1000 \qquad [13]$$

where ω_σ is the angular velocity of the drum, p/s

Power of friction force kW, in rolling bearings are determined by the formula

$$N_{mp} = P_{гс} * \pi * n * f * d/1000 \qquad [14]$$

where $P_{гс}$ is the geometric sum of the gravity mass of the semi-finished product and the working fluid, the mass of the drum and the tension of the drive belts

f-coefficient of friction: d-diameter of the half axis.

Power driving forces on the floor of the axis of the drum will be

$$N_\sigma = N_n + N_{тр} \qquad [15]$$

a power consumption taking into account drive losses

$$N_{потр} = N_\sigma/\eta \qquad [16]$$

where:η - the efficiency of the drive

Start-up power N_{start} is spent on elevation AKD angle α_0 preodolenie of inertia of the drum and the mass of products and mass of fluid, friction in the bearings:

$$N_{start} = N_{bearing} + N_\sigma + N_{semis} + N_{тр} \qquad [17]$$

$N_{bearing}$ - defines by formula

$$N_{bearing} = F_T * b(1 - \cos\alpha_0)\,\pi n(500\alpha_0) \qquad [18]$$

Given the run-up drum at the half turn $\tau_р = \frac{1}{2\pi}$, power decomposable not overcome the forces of inertia of the drum will equal:

$$N_{и.б} = \frac{J_\sigma \omega_\sigma^2}{2\tau_р 1000}$$

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where $J_{б}$ is the moment of inertia of the drum mass.
Power to overcome the inertia of the mass of semi-finished product and liquid

$$N_{liq} = \frac{J_{liq}\,\omega_{б}^{2}}{2\,\tau_{p}1000}$$

where J_{liq} - the moment of inertia of the semi-finished product and liquid.

II. CONCLUSION.

When designing the working drums needed to be linked to parameters such as geometric $D_{б}, R_{б}, L_{б}, \gamma_{б}, \alpha_{0}$ and kinematic $\omega_{б}, \vartheta_{б}, n_{б}$ and dynamic parameters - $m_{б}, m_{liq}, m_{semis}, J_{б}, J_{liq}, J_{semis}, G_{T}, G_{semis} \ldots\ldots$, that contribute to create a high performance working drums for liquid processing of expensive semi-finished products of the leather industry.

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