International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 04, 2020
ISSN: 1475-7192

TITLE: CONSTRUCTION OF AUTOMATIC LINES CONNECTING SEVERAL MECHANICAL OPERATIONS IN PROCESSING LEATHER SEMI-FINISHED PRODUCT

*1Bakhadirov G.A. *2Khusanov K.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author BGA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author KK managed the literature searches and manuscript editing and review. Both authors read and approved the final manuscript.

ABSTRACT---*This paper studies the construction of automatic lines that connect several operations involved in processing leather semi-finished product. These automatic lines are deemed to provide improved product quality and production efficiency. As well as this, the kinematics of the cutter shaft is another focused area of this research. The paper proposes a conveyor that ensures a stable operation of automatic lines of leather semi-finished product processing, and tests whether the conveyor is effective indeed. The results suggest that, without stopping the technological cycle of the sheet material processing, it ensures stable functioning of the automatic line. In obtaining the findings, mathematical modelling is selected as the key method, and MS Excel spreadsheet is used to derive the results.*

Keywords---*Conveyor, Automatic lines, Leather semi-finished product, planning, straightening, machining, soaking, softening.*

I. INTRODUCTION

Major objectives in leather industry under market economy are to improve the quality and reduce the cost of production, to increase the competitiveness of goods and the efficiency of their production, to meet the requirements of environmental

[1*]*Doctor of Technical Sciences, Professor, Institute of Mechanics and Seismic Stability of Structures named after M.T. Urazbaev, Academy of Sciences of the Republic of Uzbekistan*
[2*]*Candidate of Physical and Mathematical Sciences, associate professor of the Department of "Theoretical and Building Mechanics", Tashkent Institute of Irrigation and Agricultural Mechanization Engineers*
Author: Bakhadirov G.A
Address: 100170, Uzbekistan, Tashkent,
Mirzo-Ulugbek district, 13 Ziyolilar st.
Tel: +(99893)375-26-23
E-mail: instmech@rambler.ru
Corresponding author: Khusanov K
Address: 100000, Uzbekistan, Tashkent,
Mirzo-Ulugbek district, 39 Kori-Niyaziy st.
Tel: +99899 0203050
E-mail: author.uzb@mail.ru

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

standards. All this could be achieved by substantial improvements intechnological equipment and, in particular, the equipment for leather mechanical processing, the use of multifunctional machines, i.e. creating automatic lines connecting several mechanical operations for leather semi-finished product processing instead of machines performing asingle operation.Since production processes are an integrated set of various machine operations carried out by a specific set of technological equipment, it is obvious that the most effective(in terms of economic indices and product quality) equipment should be based on optimal machine processes, that is, there is a need to implement an advanced technology.

Leather manufacturing process has not changed for many years and manual labor is the main part of it (Polomoshnykh et al 2013; Bakhadirov, and Khusanov 2008). To construct automatic lines connecting several operations for leather semi-finished products processing, providing improved product quality and production efficiency, it is necessary to study the sequence of basic processes and operations of leather manufacturing. Among mechanical operations of leather semi-finished product processing, the following ones are highlighted: scouring, planing, wringing, bussing, softening, polishing. These determine the quality of leather. Mechanical processing of leather semi-finished product surfacein light industry is carried out as the main operation of the technological process, conductedto change geometric dimensions of leather semi-finished product (Burmistrov 2006; Bakhadirov 2005; Kaplin 1999; Polomoshnykh et al 2013; Polato 2007*a*, 2009*b*; Bakhadirov 2010).

At each operation of mechanical processing of leather semi-finished product listed above,the operators do load, unloading and holding leather semi-finished product. In addition, inter-operational transportation is carried out manually on carts or other devices.

Line automation involves the construction of production lines representing the modules of a certain type: conveying device –unit or equipment to perform a technological process or operation - automatic packer -conveying device.

II. MATERIALS AND METHODS

The proposed conveying device is located between two technological machines for leather semi-finished product processing (for example, the wringing and putting out machines). From the wringing machine, leather semi-finished product movesthrough a roller conveyor to the first group of conveyor strings atspeed $\vec{\vartheta}_1$. Next, the leather semi-finishedproduct moving at speed $\vec{\vartheta}_2$ through the second group of conveyor stringsis fed to a putting out machine.

The technical result is that the proposed conveyor, without stopping technological process of leather semi-finished product processing, ensures a stable operation of an automatic line of leather semi-finished product processing. On this line, the wringing and putting out machines should bethrough passage ones. The developed automatic line for the wringing and putting out a leather semi-finished product on a roller machine to remove moisture from leather semi-finished product, to smooth wrinkles, creases and to increase the size of leather semi-finished product, gives the desired result (Ainetdinov 2013; Leather, Fur, Lining 2014).

The two functions of this conveyor are to increase labor productivity by automating the transportation process and partial straightening of the sheet material during transportation, and to gain the desired speed forthe sheet material after partial straightening.

The frame is mounted on the shear lifts,which provide the ability to control the height of reception and feeding of the

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 04, 2020
ISSN: 1475-7192

sheet material. Endless strings of transporting conveyor consist of two groups that alternately envelope the supporting roller of the straightening unit and provide the ability to control the difference in speeds of the sheet material at the entrance and exit from the processing zone. The device comprises a conveyor belt, a putting outunit and a control system II [see figure 1 below].

The inter-operational transporting device comprises a string transporting conveyor, whichconsists of two groups of strings (1 and 2) –putting outunit Iand a control system II.

The strings of group 1 [left-hand side offigure 1]envelope the grooves oftransporting roller 3,supporting roller 4 of putting out unitI. The strings of group2 envelope the grooves of transporting roller 5. The rings (6)are freely installed in the grooves ofsupporting roller 4 ofputting outunit I. Pressure roller 10 is installed in the section of the strings of group2 [right-hand side of figure 1] above supporting roller5.

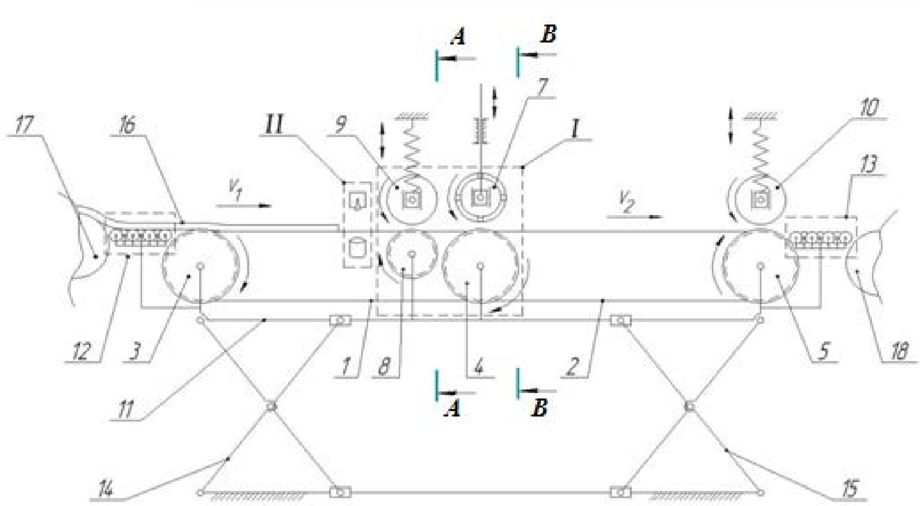


Figure 1. Inter-operational conveying device, side view

The endless strings of group 1 and group 2 envelop supporting roller 4 ofputting out unit I, by turns. Supporting rollers 3, 4, 5 and 8 are mounted on frame 11. Roller conveyor 12 is attached to frame 11in the section of the strings of group 1, in front ofsupporting roller 3. Roller conveyor 13 is attached to the frame 11 [figure 2 below] in the section of the strings of group 2, behind supporting roller 5. Frame 11 is mounted on two shear lifts14 and 15. Shear lifts 14 and 15 provide the ability to control the height of the reception and feeding of sheet material 16 between two processing machines 17 and 18 [see:figure 1].

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

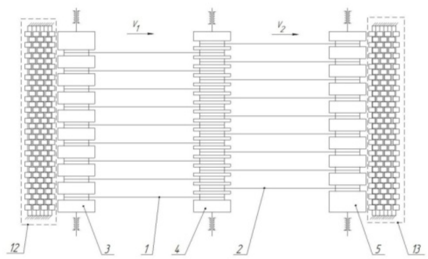
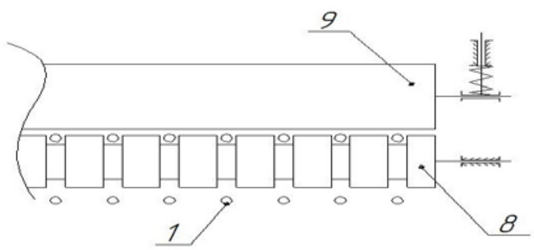


Figure 2. Inter-operational conveying device, top view (the pressure and straightening rollers are not shown)

On the section of strings of group 1, in front ofputting out unit I, a supporting roller 8 and a pressure roller 9 are installed[figure 3].

A-AB-B



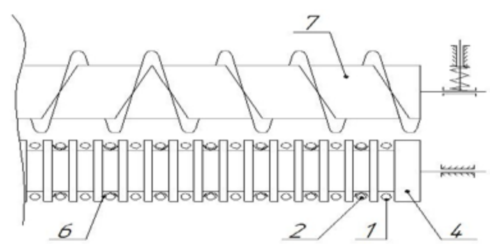
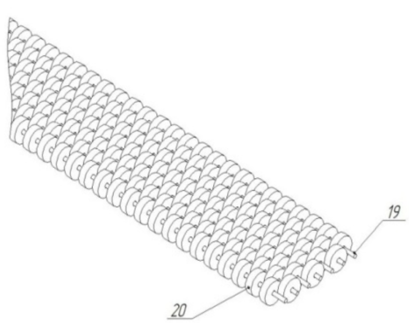


Figure 3 [left] and figure 4. String locations on putting out unit, section *A-A* andsection *B-B*

Putting out unit I consists of supporting roller 4, with rings 6 installed in the grooves and controlled screw straightening roller 7 [see: figure 4].



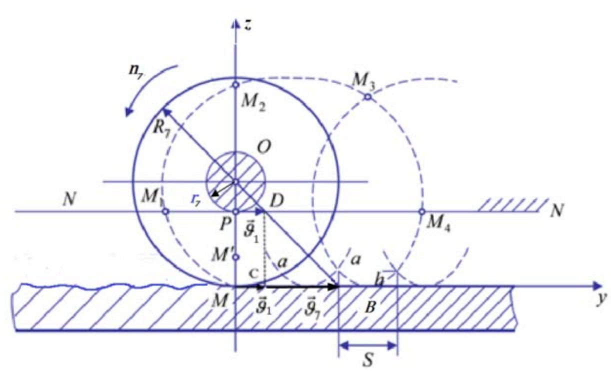


Figure 5. Roller conveyor **Figure 6.** The trajectory of the blade face of straightening roller 7

Roller conveyors 12 and 13 [figure 2] consist of parallel mounted axes 19, with rollers 20 [figure 5], which can rotate freely on axis 19.Rollers 20 on adjacent axes are set in staggered order relative to each other. This arrangement of rollers

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

20 prevents sheet material 16 [figure 1] from falling into the inter-roller space and allows the movement of sheet material 16 with minimal friction [figure 5]. The device is equipped with a control unit II [see:figure 1].

At the beginning of the operation, controlled screw-straighteningroller 7 ofputting out unit I is raised. Processed sheet material 16, from processing machine 17, through roller conveyor 13, is fed to the strings of group 1 and moves at a certain speed ϑ_1. When sheet material 16 passes through control system II, a signal is given, and screw straightening roller 7 ofputting out unit I is lowered, rotating along with the movement of sheet material 16. The straightening of sheet material 16 begins [figure1].

When the end-point of sheet material 16 leaves the zone of control system II, a signal is given and screw straightening roller 7 ofputting out unit I is lifted, and sheet material 16 on the strings of group 2, starts moving at a speed ϑ_2 along roller conveyor 13, and is fed to processing machine 18. Pressure roller 10 provides a uniform feeding ofsheet material 16 to processing machine 18. It is possible to adjust the speeds ϑ_1 and ϑ_2 with the operation of endless strings of the conveyor consisting of group 1 and group 2, which envelope supporting roller 4 of putting out unit I by turns; the strings of group 2 envelope the grooves of supporting roller 5 and rings 6 freely mounted in the grooves of supporting roller 4 of putting out unit I [figure 1].

The accepted conditions for the direction of linear velocities of the blade faces of straightening roller 7 and the leather semi-finished product are the same [figure 6]. Processed material 16 [see:figure 1] is located on an endless string and movestranslationalat speed ϑ_1. The blades MM' of straightening roller 7 rotate counterclockwise relative to the center O with a circular velocity equal to $\overline{\vartheta}_7$.As is known, the blade point velocity of the cutter shaft depends on the angular velocity of the shaft and the distance from the blade point to the axis of shaft rotation. Given this circumstance, wedetermine the trajectory and velocity of point M of the straightening roller relative to the moving leather semi-finished product. We need to consider two cases: when blades MM' of straightening shaft 7 have a constant pitch and blades MM' of straightening shaft 7 have a variablepitch.

Given that the screw shaft makes a plane motion, wedetermine the dependence of the leather semi-finished product velocity $\vec{\vartheta}_1$ upon the velocity of the straightening shaftblade $\vec{\vartheta}_7$. To do this, we establish the position of the instantaneous center of velocity at point *P* ($\vartheta_p = 0$) . Velocities $\vec{\vartheta}_1$ and $\vec{\vartheta}_7$ are shownin Fig. 6. We need to connect the center of the straightening roller*O* with point M (the origin of vectors $\vec{\vartheta}_1$ and $\vec{\vartheta}_7$) and point *B* (the end of vector $\vec{\vartheta}_7$). Then, draw a perpendicular from the end of vector $\vec{\vartheta}_1$ and define intersection points *P* and *D* on straight lines*OM* and *OB*. The leather semi-finished product will halt if we impose the velocity directed to the left and equal to $\vec{\vartheta}_1$ on the system.

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

Any point of the straightening roller blade will have a rotation velocity relative to point O and a transport velocity $\vec{\vartheta}_1$ withpoint O. Two velocities ϑ_p and $\vec{\vartheta}_1$ are applied to point P, equal in magnitude, but directed to the opposite sides. Therefore, the absolute velocity of point P is zero, and is the center of instant blade rotation relative to the leather semi-finished product. From the similarity of triangles OPD and OMB [see: figure 6], we have:

(1) $$\frac{\overline{OP}}{\overline{OM}} = \frac{\vartheta_1}{\vartheta_7} \Rightarrow \overline{OP} = \overline{OM}\,\frac{\vartheta_1}{\vartheta_7} = R_7\,\frac{\vartheta_1}{\vartheta_7} = const\,.$$

In this case, the moving centroid is a circle of radius r_7 (the corresponding area is shaded in figure 6).

The position of the point P relative to the processed leather semi-finished product is determined by the distance

(2) $$\overrightarrow{MP} = \overline{OM} - \overline{OP} = R_7 - r_7 = R_7\left(1 - \frac{\vartheta_1}{\vartheta_7}\right) = const.$$

Therefore, straight line*NN* is a fixed centroid.

As shown in figure 6, point M of the straightening roller blade located at radius R_7 outside the centroid will describe an elongated cycloid or so-called trochoid $MM_1M_2M_3$, which will be the trajectory ofblade point M relative to the surface being processed. The blade points located on the straightening roller will move along the same trajectories, therefore, the processed surface in the ideal case will be restricted by the arcs of the trochoid *aa*.

The length of chord *S* of each trochoid arc corresponds to the movement of the leather semi-finished product during its processing by one blade, i.e. the feeding on one blade, which is determined by the followingformula:

(3) $S = \dfrac{60\vartheta_2}{n_7 d_7}$ *mm/blade*,

where n_7 is the speed of a straightening roller per minute; d_7 is the number of blades on the roller.

The relationship between *h*[see: figure 6] and *S* can be established using the trochoid equation. If we direct the coordinate axes, as in figure 6 (the *x*-axis is directed along the axis of rotation of the straightening roller), then the trochoid equation in parametric form yields the following:

(4) $y = \vartheta_2 t - R_7 \sin(\omega_7 t)$ and $z = R_7\left(1 - \cos(\omega_7 t)\right)$,

where ω_7 — is the angular velocity of straightening shaft 7.

We determine velocities and accelerations of the cutter sides relative to the leather semi-finished product for a straightening roller with a constant pitch of screw cutters, for cases when the directions of linear velocities of the cutter shaft and the leather semi-finished product coincide.

(5) $\vartheta_x = a_1 \cdot \dfrac{\omega_7}{2\pi}$; $\vartheta_y = \vartheta_2 - R_7\omega_7 \cdot \cos(\omega_7 t)$; $\vartheta_z = R_7\omega_7 \cdot \sin(\omega_7 t)$

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

(6) $$\vartheta_7 = \sqrt{\vartheta_2^2 - 2\vartheta_2 R_7 \cdot \omega_7 \cos(\omega_7 t) + R_7^2 \cdot \omega_7^2 + \frac{a_1^2}{4\pi^2} \cdot \omega_7^2},$$

(7) $a_x = 0$; $a_y = R_7 \cdot \omega_7^2 \cdot \sin(\omega_7 \cdot t)$; $a_z = R_7 \cdot \omega_7^2 \cdot \cos(\omega_7 \cdot t)$; $a = R_7 \cdot \omega^2$

The course of the screw line (the distance between adjacent turns of the screw line, measured along the generatrix of the cylinder) is determined by the following formula (Maisel et al 1950):

(8) $$h = \pi \cdot D \cdot tg\beta,$$

where β is the angle of ascent of the screw line.

For a screw shaft with a variable pitch ofscrew cutters 8 [see: figure 3 for screw cutters], the law of motion of the contact surface of the cutter face with a semi-finished product has the following form (Polomoshnykh et al 2013):

(9) $$x = \frac{2a_1}{k_0}\left[(k_0+1)^{\frac{\omega t}{2\pi}} - 1\right],$$

where a_1 is the first motion of the screw blades of the straightening roller with a variable pitch from the middle to its edges; k_0 is the coefficient that takes into account the sliding of the screw blade on the semi-finished product.

Time$t$ is determined from equality (9):

(10) $$t = \frac{2\pi \cdot \ell n\left|\frac{k_0 x}{2a_1} + 1\right|}{\omega_7 \cdot \ell n(k_0 + 1)}$$

Entering its valueto equations (1) and (2), we obtain the equation for the screw blade face trajectoryin sections 3–7:

(11) $$y_7 = \vartheta_2 \frac{\ell n\left|\frac{k_0 x}{2a_1} + 1\right|}{\omega_7} \cdot b_1 - R_7 \sin\left[b_1 \cdot \ell n\left|\frac{k_0 x}{2a_1} + 1\right|\right]$$

(12) $$z_7 = R_7 \cdot \left[1 - \cos\left(b_1 \cdot \ell n \frac{k_0 x}{2a_1} + 1\right)\right]$$

Where: $b_1 = \dfrac{2\pi}{\ell n|k_0 x + 1|}$.

Taking derivatives on both sides of equations (9), (11) and (12), we determine the components of the vector velocity of the blade face of the straightening rollers for sections 3-7 as follows:

(13) $$\vartheta_{7x} = b_1 \cdot \omega_7 \cdot (k_0 + 1)^{\frac{\omega_7 t}{2\pi}},$$

(14) $$\vartheta_{7y} = \vartheta_2 - R_7 \cdot \omega_7 \cdot \cos(\omega_7 t)$$

(15) $$\vartheta_{7z} = R_7 \cdot \omega_7 \cdot \sin(\omega_7 t),$$

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

Where: $b_1 = \dfrac{a_1 \ell n|k_0 x + 1|}{k_0 \cdot \pi}$.

Then the velocity ϑ_7 may be determined by:

(16) $$\vartheta_7 = \sqrt{b_1^2 \cdot \omega_7^2 (k_0 + 1)^{\frac{\omega_7 \cdot t}{2\pi}} + \vartheta_2^2 + R_7^2 \cdot \omega_7^2 - 2R_7 \cdot \omega_7 \cdot \vartheta_2 \cos(\omega_7 t)},$$

Similarly, the accelerations of the screw blade face of the straightening rollers are determined for sections 3-7 as follows:

(17) $$a_{7x} = b_2 \cdot \omega_7^2 \cdot (k_0 + 1)^{\frac{\omega_7 \cdot t}{2\pi}};\ a_{7y} = R_7 \cdot \omega_7^2 \cdot \sin(\omega_7 \cdot t);\ a_{7z} = R_7 \cdot \omega_7^2 \cdot \cos(\omega_7 \cdot t)$$

(18) $$a_7 = \omega_7^2 \cdot \sqrt{R_7^2 + b_2^2 \cdot (k_0 + 1)^{\frac{\omega_7 \cdot t}{2\pi}}}.$$

Where: $b_2 = \dfrac{b_2 \cdot \ell n|k_0 x + 1|}{k_0 \cdot \pi} = \dfrac{a_1 \cdot \ell n^2 |k_0 x + 1|}{2k_0 \cdot \pi^2}$.

III. RESULTS AND DISCUSSION

It is known,at moisture content 60-65% of the leather semi-finished product,the value of the straightening coefficient is $k_0 = 0{,}2$ (Bakhadirov 2000); for the completestraightening ofcreases of the leather semi-finished product, the straightening roller must make$\xi = \frac{K}{k_0}$revolutions ($k_0 << K.$)

To plot thevelocitycurves $\vec{\vartheta}_7$, the MS Excel program was used

Table 1. The values of $\vec{\vartheta}_7$ for different angular velocities (ω) and time (t)

t	V7(a),ω=6,3	V7(b), ω=6,3	V7(a), ω=8,4	V7(b), ω=8,4	V7(a), ω=10,5	V7(b), ω=10,5
0	0,551	0,514	0,791	0,746	1,031	0,977
1	0,551	0,515	1,063	0,979	1,295	0,979
2	0,551	0,516	1,054	0,982	1,306	0,982
3	0,551	0,517	0,791	0,988	1,031	0,988
4	0,551	0,519	1,072	0,998	1,282	0,998
5	0,552	0,522	1,044	1,017	1,317	1,017
6	0,552	0,525	0,792	1,051	1,034	1,051
7	0,552	0,531	1,080	1,111	1,270	1,111
8	0,553	0,538	1,034	1,213	1,327	1,213
9	0,553	0,549	0,795	1,381	1,037	1,381
10	0,554	0,564	1,088	1,646	1,256	1,646

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

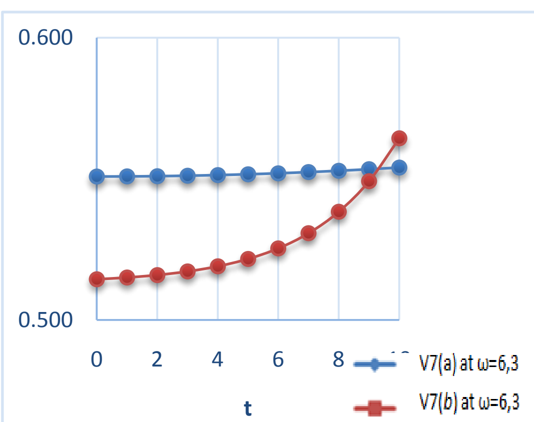
Where V7 (a) at a constant pitch; and V7 (b) at a variable pitch. Here$V_2 = 0.18, R_7 = 0.11, a_1 = 0.2, k_0 = 0.2, and\ b_1 = 0.006$.

Table 2. The values of $\vec{\vartheta}_7$ for different angular velocities (ω) and time (t) continuation

t	V7(a) ω=12,6	V7(b) ω=12,6	V7at ω=16,8	V7(b) ω=16,8	V7(a) ω=20	V7(b) ω=20
0	1,271	1,208	1,752	1,671	2,118	2,024
1	1,271	1,211	2,010	1,676	2,226	2,031
2	1,271	1,216	2,029	1,689	2,410	2,056
3	1,272	1,227	1,753	1,724	2,456	2,133
4	1,273	1,249	1,989	1,812	2,316	2,361
5	1,274	1,294	2,046	2,028	2,144	2,976
6	1,275	1,384	1,758	2,512	2,152	4,395
7	1,276	1,552	1,968	3,484	2,331	7,261
8	1,278	1,854	2,061	5,252	2,460	12,624
9	1,280	2,362	1,767	8,278	2,398	22,356
10	1,282	3,166	1,945	13,308	2,212	39,832

The same applies for table 2 as table 1.

Below we plot the velocity curves with the information provided in the tables above:



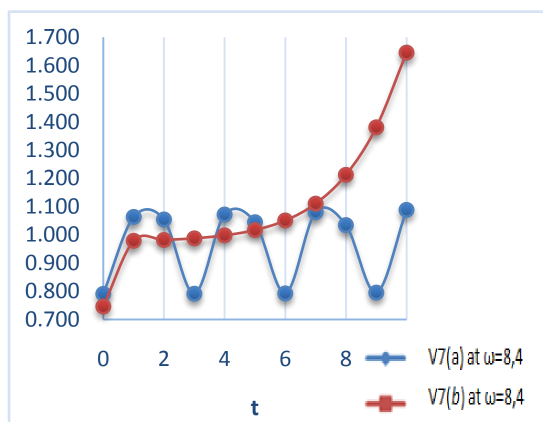


Figure 7 and 8. Velocity curves with the angular velocities (ω) of 6.3 and 8.4

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

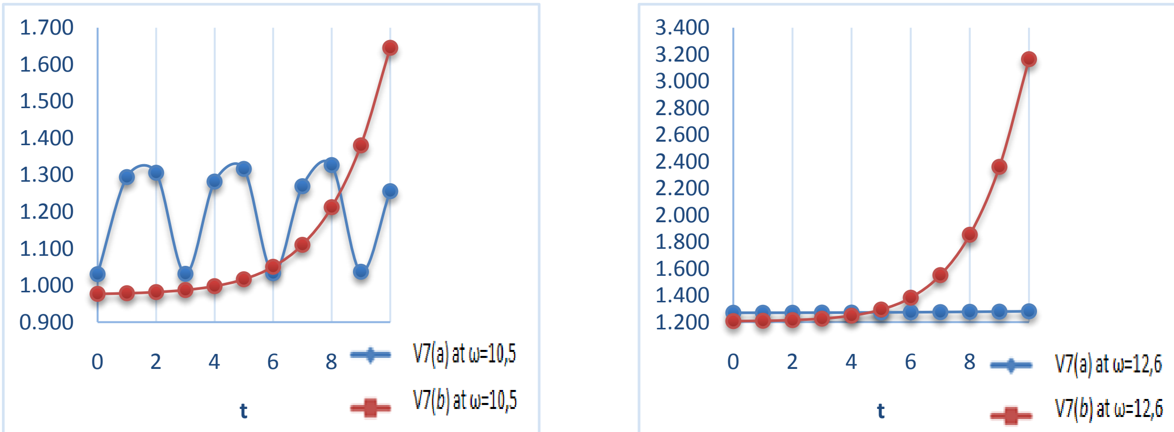


Figure 9 and 10. Velocity curves with the angular velocities (ω) of 10.5 and 12.6

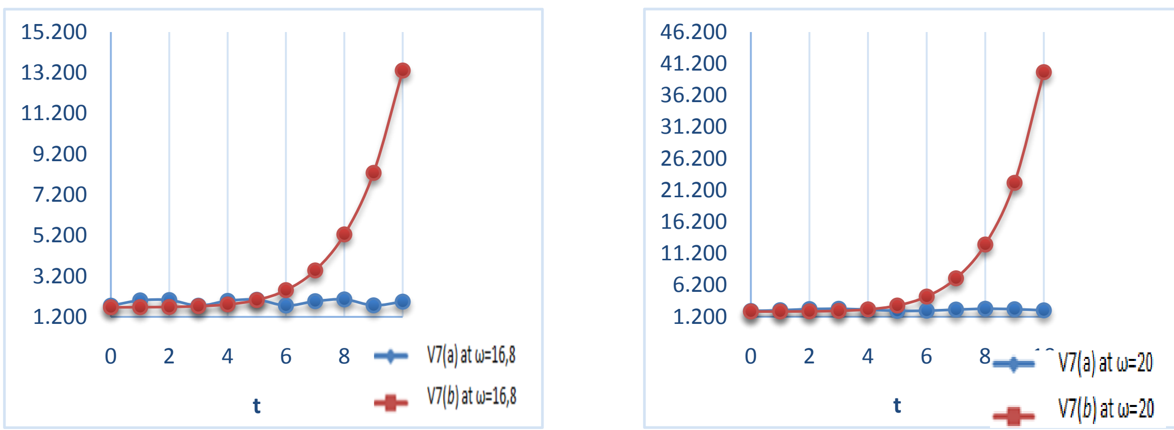


Figure 11 and 12. Velocity curves with the angular velocities (ω) of 10.5 and 12.6

Velocity changes of straightening roller 7 for variousvalues of the angular velocity of the straightening roller: V7 (a) denotesvelocity changes of the straightening roller 7 at a constant pitch, whileV7 (*b*) denotes velocity changes of the straightening roller 7 at a variable pitch

From the curves, it follows that with a change in the angular velocity of the screw shaft, the blade points' velocities of the screw shaft change. When the angular velocities of the screw shaft at a constant pitchare:$\omega = 6.3$ *rad/s*, $\omega = 12.6$ *rad/s and* $\omega = 20$ *rad/s*, the curves will be straight. Here, the acceleration of thecontact point of the screw shaft blade with a leather semi-finished product has one component – centripetal acceleration. In this case, only centrifugal inertia forces act on the blades of the screw shaft. Therefore, the friction force with the contact point of the leather semi-finished product and the points of the shaft blade will be the least. The resistance forces of the rolling friction torque arising due to the rolling friction coefficient will also be the least.

When the screw shaft has a variable pitch, in all the graphs after 6–8 seconds, theblade speed increases sharply.As a result, the acceleration of the blade points of the screw shaft consists of two components –tangent and normal ones; so, the inertia force has two components. At the same time, at the point of contact of the leather semi-finished product with the shaft blades, the friction forces and the modulus of resistance will be thegreatest.For the device in question, it is recommended to choose a screw shaft with a constant pitch.

IV. CONCLUSIONS

The proposed conveyor, without stopping the technological cycle ofthe sheet material processing ensures stable operation of the automatic line consisting of “the first mechanical processing machine – transportation – the second mechanical processing machine” during the leather semi-finished product processing. On this line, the first and second processing machines must be the through passage ones.

In accordance with the findings, in three cases – when the angular velocities (ω) equal 6.3, 12.6, and 20 – velocity changes of straightening roller 7 are constant for all the values of t from 1 to 10. In other cases, these changes vary with respect to time.

If the screw shaft holds a variable pitch, a steep increase in the speed of the blade is observed in 6 to 8 seconds depending on the value of the angular velocity.

At the point of convergence between the leather semi-finished product and the shaft blade, the forces of friction and the resistance modulus will be the greatest.

For the device in dispute, the author suggests that a screw shaft with a constant pitch should be chosen.

ACKNOWLEDGEMENTS

We appreciate the efforts of several of our colleagues who helped us in searching the data and sharing their ideas. We also acknowledge their kind interest in this publication, which gave us much incentive to research deeper and deeper. Equally important, in each of our step, our family members motivated us. Without their encouragements, we would not have been able to finish this paper as intended.

REFERENCES

[1] Polomoshnykh S.P., Radnaeva V.D., Titov O.P., Kalashnikova Y.M. 2013.Basics of mechanical technology for processing leather-fur semi-finished product in liquid operations. Newsletter of the Khmelnytsky National University, №3: 226-232.

[2] Bakhadirov G.A., Khusanov K.B. 2008. Problems of mechanization and automation of the machining processes of the leather semi-finished product. Technology and Automation Technique 2008. *In* Proceedings of the international scientific and technical conference dedicated to the 75th anniversary of the SIUA in Yerevan, 13-18 September 2008. SIUA-2008, Yerevan, pp. 164-168.

[3] Burmistrov A. G. 2006. Machines and apparatus for leather and fur manufacture. M.: Kolos, Ill: 102–184.

[4] Bakhadirov G.A. 2005.Operation analysis and classification of roller machines for leather manufacture. Problems of Mechanics, No 4: 45-50.

[5] Kaplin L.A. 1999. Scientific basis for improving the equipment for the mechanical processing of leather and fur materials in terms of improving product quality and production efficiency. M.Sc. thesis, Don State Service Academy, Moscow.

[6] Polomoshnykh S.P., Laidabon C.S., Kalashnikova Yu.M., Tumanova I.S., Lunin S.N. 2013. A device for the impregnation and lying of a leather and fur semi-finished product. Russian Federation patent No. 2472861.

[7] Polato A. 2009. The method of continuous stretching of leather and other similar materials and the line for its implementation.Russian Federation patent No. 2283871.

[8] Polato A. 2007. Method and device for continuous gradual stretching and drying of technical leathers and similar products. Russian Federation patent No. 2302468.

[9] Bakhadirov G.A. 2010. The mechanics of the squeezing roller pair. Fan, 15(5):166.

[10] Ainetdinov R.Sh., Kalyn I. Y., Zaitsev B.V. 2013.Putting out unit for the leather and fur semi-finished product. Russian Federation patent No.2400539.

[11] Image-Gallant 2019. Leather wiring. Available from www.perchatki.com.ua/main.php?pg [cited 10 August 2019]

[12] Leather Fur Lining 2019. Leather production. Available from http://koja-meh-podklad.ru/proizvodstvo-koji

DOI: 10.37200/IJPR/V24I4/PR201318
Received: 22 Sep 2019 | Revised: 13 Oct 2019 | Accepted: 15 Jan 2020

[13] Maisel M.M., Kvyatkevich I.K., L.G. Pin. 1950. Machines and devices for leather and fur production. M. Publishing house "Gizlegprom", 209 (1): 590.
[14] Bakhadirov G.A. 2000. Experimental determination of the coefficient of straightening of a leather semi-finished product. Uzbek Journal of the Problems of Mechanics,No 1: 91–94
[15] Cara dhaliwall, erinmacpherson, julie richardson (2015) effectiveness of telephone-delivered interventions for increasing physical activity levels in persons with type 2 diabetes or hypertension: a systematic review. Journal of Critical Reviews, 2 (4), 6-11.
[16] Sasikala,A., &Kumaresan,K. (2015). A Review of Secure Protocols on Wireless Network Technologies. International Journal of Communication and Computer Technologies, 3(2), 79-88.
[17] Monika,S., &Anand,C. (2015). A Study on Large-Scale Social Tagging Behavior of User in online Social Network. International Journal of Communication and Computer Technologies, 3(2), 89-97.
[18] Ural, G., Kaçar, F., Canan, S. Wavelet phase coherence estimation of EEG signals for neuromarketing studies (2019) NeuroQuantology, 17 (2), pp. 112-120.
[19] Awang, M.A., Zamri, N.N., Romli, M., Zakaria, M.N. Acoustic reflex latency (ARL) assessment in malaysian adults: The effects of age, gender and stimulus frequency (2019) NeuroQuantology, 17 (2), pp. 91-96.

LIST OF TABLES

LIST OF FIGURE CAPTIONS