Construction of experimental inter-operational conveying device

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Abstract. The results of the construction of inter-operational conveying devices for the creation of an automatic line for the mechanical processing of a leather semi-finished product between several technological machines for leather processing are considered in the article. At the same time, on this line, all processing machines must be fed through ones. The dimensions and principles of operation of the mechanism of conveying devices are shown. The main mechanisms of this conveyor are string conveyors, cutting and pressure rollers. The results of the experiments are presented. The task of this proposed conveying device is to increase labor productivity by automating the process of transportation and partial straightening of the sheet material during transportation, as well as communicating the desired speed to the sheet material after partial straightening. It is shown that with the wrong choice of the diameter of the work rolls, the design of the machine, changes in the angular speed of the spreader shaft affect the quality of the extraction and straightening of the folds of the leather semi-finished product.

1 Introduction

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2 Materials and methods
Machines must be feed-through (i.e., on such a machine, the leather is processed once: it enters from the front and exits from the back). The frame is mounted on scissor lifts (elements 14 and 15 of the device, Fig. 1), which provide the ability to adjust the height of receiving and transporting sheet material.

The endless strings of the conveyor consist of two groups that alternately go around the support shaft of the straightening block and provide the ability to control the difference in velocities when the sheet material enters and exits the processing zone. The device contains a transport conveyor, a straightening unit and a control system.

The inter-operational transporting device contains a string transporting conveyor, consisting of two groups (1 and 2), straightening block I, and control system II (elements 1-18 of the device, described in the text). The strings of the first group 1 envelope the grooves of transporting roll 3 and support roll 4 of straightening block I. The strings of the second group 2 envelope the grooves of transporting roll 5. Rings 6, freely installed in the grooves of support roll 4 of straightening block I. In the section of the strings of the second group 2, above support roll 5, pressure roll 10 is installed (Fig. 1), [16, 17].

Fig. 1. Scheme of the inter-operational conveying device (side view)

Moreover, the infinite strings of the first 1 and second 2 groups alternately envelope support roll 4 of straightening block I. Support rolls 3, 4, 5 and 8 are mounted on frame 11. On the section of the strings of the first group 1 in front of the support roll, roller conveyor 12 is attached to frame 11. In the section of strings of the second group 2, behind support roll 5, roller conveyor 13 is attached to frame 11 (Fig. 1).

As seen in Fig. 1, an experimental inter-operational conveying device was built to remove fluid and bring the semi-finished leather product in the straightened form to the second technological machine. The task of the conveying device proposed (a conveyor) is to increase labor productivity by automating the process of transportation and partial straightening of the sheet material during transportation and adjusting the desired feed rate to the sheet material after partial straightening.
3 Discussion and results

To perform an experimental determination of the quality and expansion of the surface area of the skin, and the supply of a semi-finished leather product to the next stage of processing in a straightened form, we use the new conveying device. First, we determine the straightening factor, which is the increase in the area of the semi-finished leather product, i.e. the difference between its areas in the straightened and unstraightened positions, referred to the area of the semi-finished leather product in the unstraightened position \[K = \frac{H_1 - H_2}{H_2}\]

where \(K\) is the coefficient of straightening of the folds of the leather semi-finished product; \(H_1, H_2\) - are the areas of the leather semi-finished product in the straightened and unstraightened positions, respectively. As is known, in order to perform various mechanical operations for processing a semi-finished leather product (fleshing, squeezing, straightening, splitting, planing, etc.), a certain moisture content of the processed leather semi-finished product is required.

To conduct experimental studies to determine the moisture content and straightening of the leather semi-finished product, we use a new inter-operational conveying device for transporting and feeding the semi-finished leather product to the processing zone, prepared with the following technical characteristics based on Fig. 1:

- Diameters in cm:
  - of straightening pressure roll: 20
  - of upper squeezing roll without moisture-wicking material (monshon): 16.6
  - of 1 and 2 conveying rolls: 16
  - Distance between axles of 1 and 2 conveyor rolls: 1.150
  - Groove pitch: of the 1st conveying roll: 2.5, of the 2nd conveying roll: 2.5
  - Number of grooves: in the 1st conveying roll: 26, in the 2nd conveying roll: 26
  - Working width: of the 1st conveying roll: 65, of the 2nd conveying roll: 65
  - Groove depth of the 1st and 2nd conveying rolls: 2x3
  - Spring stiffness, \(N/m\): 29400
  - Electric motor power, kW:
    - straightening roll pressure rolls: 1.5
    - Number of strings in the conveyor: 5

Note: Support roll 4 was replaced with a plate 65x8 fixed to the support.
Since the leather semi-finished product, processed in the mode of operation of the squeezing machine with a free upper working roll and straightening roll, in addition to compression, experiences a slight stretch. Apparently, as in other mechanical operations (for example, planing, straightening, stacking, etc.), the fibers are displaced and oriented in the force field due to the friction force transmitted through the driving roll. The coefficient of mutual friction of the fibers of a wet leather semi-finished product is negligible.

When squeezing without forced rotation of one of the working rolls, the fibers of the leather semi-finished product are shifted. As fluid is removed from the wet leather semi-finished product with squeezing and straightening rolls (Fig. 2), the coefficient of mutual friction of the fibers of the leather semi-finished product increases, and hence the tension between the fibers. This leads to an increase in the area of the skins, breaking load and a decrease in tensile elongation, which makes it possible to reduce the pressing force between the working rolls, providing the necessary residual moisture content of the processed leather semi-finished product.

To assess the significance of individual factors in folding form, in relation to the design and requirements of the leather industry, a straightening roll was added. To ensure the required pressure of the pressing and straightening rolls on the leather material and to reduce vibration during straightening, springs are installed.[19–22]

The percentage of straightening and expansion of the semi-finished leather product was determined as follows: first, the coefficient of straightening of the semi-finished leather product was determined. After squeezing and straightening the wet leather semi-finished product, on the specified conveyors, without changing the conditions of the leather semi-finished products, their masses and areas were measured at the exit from the conveyor zone, and all the results were recorded in the table.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig2.png}
\caption{Laboratory installation of inter-operational conveying device: a) an inter-operational conveying device with a straightening roll; c) straightening the leather semi-finished product at the exit; d) pressing and straightening rolls (side view).}
\end{figure}

The results of experimental studies have shown that the percentage of straightening of the semi-finished leather product and the change in the percentage of moisture content depend on its area and the design of the technological machine. The test object was chrome-tanned ox hide.
In the process of removing fluid from a wet semi-finished leather product, its moisture content and physical and mechanical properties, and hence the quality, change significantly. At the same time, the quality of the finished product is formed, which, in particular, determines its grade. This occurs after liquid operations in the process of removing fluid from a wet semi-finished leather product.

<table>
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<th>Table 1. Results of experimental studies</th>
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4 Conclusions
References


