Methods founding construction and parameters of longitudinal screw pawl-creating device

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Abstract. This article outlines the results of the theoretical research based on the parameters of the working organs of the parameters of the construction of longitudinal pawl-creating device between cotton rows.

1. Introduction

Today, a considerable part of cotton production is organized by irrigated farming [1, 2, 3]. Not considering that in irrigated farming there is used more expenses of labor base than other types, fertileness is considered to be preferable [4]. In some parts of the country, for example, in the Republic of Karakalpakstan, Bukhara, Khorezm, Kashkadarya, and Navai regions the Republic of Uzbekistan, depending on the relief of the cultivated areas and the rough foams will contribute to irrigate the cotton plants using longitudinal and transverse pawls [5]. This will help to decrease water consumption in the uneven fields and increase cotton fertileness by full watering. In this process, the longitudinal and transverse pawls are formed before primary irrigation. The fact that the longitudinal is preserved for use till the end of the sowing period, it is considered to be high quality and should consider all agrotechnical requirements. To date, some farmers still have this process based on manual labor. As a solution to this technological process of mechanization problem, scientists from the Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (Uzbekistan) (BB TIIAME UZB) are carrying out scientific research work on the creation of an active cranked longitudinally shaped Pawling device between the cotton rows [6, 7, 8, 9].

2. Materials and methods

The proposed device is effective with many of its advantages, particularly it has not got a negative impact on cotton and it has energy efficiency, pawl-creating, and other advantages.

The scheme of the coil conveying pawl device is shown in the 1st figure. The technological process, using the pawl-creating device, is as follows: at the beginning, when transported through the tie-closer device (1), the soil transported when the particles are assembled on a special bunker (6) at the front of the pipe (3) (2). The crankcase carries through the tractor power take-off valve (PTV) via chain extensions (4) and extends the soil along the saddle pads and reaches the cone-shaped forwarding bunker (5) at the end of the pipe. In this process, the soil is sown with the cotton cord, leading to the formation of soil. As a result, a threshold is formed of a set of soil flakes along the row. It is important to determine the height of the floor, the minimum operating temperature of the appliance, the diameter of the slab, the number of strokes and angles, and the horizontal angle of the horizontally adjusted soil when the soil is raised with a certain amount of soil moisture [10].
3. Results and discussion

Using the diagram shown in 2nd figure, we measure the height of the pawl relative to the top of the row arcs. According to this

$$h_n = \frac{A}{2} \tan \varphi_m$$

(1)

Where $h_n$ is the height of the pawls between the cotton pumps and the upper part of their arcs; $A$ is the width of the cotton row ($A = 60$ sm) $\varphi_m$ is the natural shedding of the soil.

According to the data given [11, 12] in the literature, if we accept $\varphi_m = 35$-40°, (1) the height of the pawl can be no higher than 25.2 sm.

Now we will determine the face of the transverse pawl. It consists of the sum of two surfaces

$$S_{con} = S_n + S_e$$

(2)

Where $S_{con}$ is the surface of the upper triangle; $S_e$ is the face of the bottom flank.

According to the scheme in the 2nd figure

$$S_e = \frac{Ah_n}{2}$$

(3)

or considering (1)
Depending on the transformation of the cross-sectional view of the cotton rows into the law
\[ z = \frac{h_z}{2} \left( 1 - \sin \frac{2\pi x}{m} \right), \]
we determine \( S_z \) by the following expression
\[ S_z = \frac{1}{2} \int_0^A \frac{h_z}{2} \left( 1 - \sin \frac{2\pi x}{m} \right) dx = \frac{h_z}{2} A \]
(5)
where \( h_z \) is the depth of the row of cotton, m

(4) and (5), the expression (2) has the following appearance:
\[ S_{gen} = \frac{A^2}{4} \tan \phi_m + \frac{h_z}{2} A = \frac{A}{2} \left( \frac{A}{2} \tan \phi_m + h_z \right) \]
(6)

The calculations made by formula (6) show that the width of the cotton rows is 0.6 m and the depth of the furrow is 0.12 m, and the surface of the cross-section of the longitudinal cross-section constitutes the sum = 0.099 m² (990 cm²).

We determine the minimum operating efficiency of the coil conveyor making device [13]
\[ Q_{min} \geq 1000 S_{gen} S_{tp} \] m³/hour
(7)
or
\[ Q_{min} \geq 1000 S_{gen} S_{tp} \rho \] kilo/hour
(8)
where \( S_{tp} \) is the speed of the tractor, km/hour
\( \rho \) is the soil density, kg/m³

\( S_{gen} = 0.099 \) m², \( S_{tp} = 4.26 \) km/hour. [14] and \( \rho = 1200 \) [15] the minimum operating efficiency of the coil conveyor making device is \( Q_{min} = 421.7 \) m³/hour or \( Q_{min} = 506 \) t/hour. Based on this value, you can define the parameters of the coil conveyed the worker unit.

The work of a clay working device through the cotton rows is similar to that of the coil conveyed carrier, which is edged at a certain angle. It is a core element in the coil conveyed the worker unit.

It is widely used in the transportation of materials with friable or viscous materials and is used to transport the soil to a horizontal angle at the formation of a longitudinal thrust between the pallets of cotton rows, one of which is highly effective.

The diameter and step of the coil conveyor are determined according to the standard, taking into account working conditions. Tables 1 and 2 show the standard values of the diameter (\( D_{sh} \)) and the step (t) corresponding to the angle (\( \alpha \)) of relative to the horizon [12].

**Table 1.** The standard diameter and step of the coil conveyor setting angle \( \alpha = 0 \) regarding horizon

| Diameter of coil conveyor \( D_{sh} \), mm | 100 | 125 | 160 | 200 | 250 | 320 | 400 | 500 |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Step of coil conveyor \( t \), mm        | 100 | 125 | 160 | 200 | 250 | 320 | 400 | 500 |

**Table 2.** The standard diameter and step of the coil conveyors when the mounted angle relatively \( \alpha > 0 \) regarding horizon

| Diameter of coil conveyor \( D_{sh} \), mm | 100 | 125 | 160 | 200 | 250 | 320 | 400 | 500 |
|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Step of coil conveyor \( t \), mm        | 80  | 100 | 125 | 160 | 200 | 250 | 320 | 400 |
that there are certain protective zones that will ensure that plants are not damaged by the cotton rows. Accordingly, the external diameter of the coil conveyor pipe is determined by the following inequality

$$D_{km} \leq A - 2a$$

(9)

in which: $D_{km}$ is the external diameter of the coil conveyor pipe, in m; $A$ is the width of line spacing, in m; $a$ is the width of the protective zone in m.

Knowing the external diameter of the pipe, we determine the internal diameter of the pipe according to the following expression.

$$D_{iu} \leq A - 2a - 2\delta$$

(10)

Where $\delta$ is the thickness of the wall of the coil conveyor pipe ($\delta = 3$ mm).

The diameter of the coil conveyor (10) is calculated as follows

$$D_{iu} \leq A - 2(a + \delta + \lambda)$$

(11)

Where $\lambda$ is the radial interval between the coil conveyor and the pipe ($\lambda = 8$-12 mm).

The external and internal diameter of the coil conveyor pipe between the width 600 mm and the width of the cotton wave (9) to (10), taking into account the aforesaid values $\delta$ and $\lambda$, according to the observed observations $a = 80$ mm, and (11) diameter should be no larger than 418, 434 and 440 mm.

Based on the data given in Table 2 and State Standard 20295-85 [16], the diameter of the coil conveyor is 400 mm, step 320 mm, the internal diameter of the coil conveyor pipe is 420 mm and the external diameter is 426 mm.

This parameter is determined by the fact that the actual sample of the device's coil conveyor workflow of work is minimal or equal to that required because otherwise the soil will be heaped behind the coil conveyor. Taking into consideration the fact that the device is equipped with two coil conveyors, the condition is written as [19]:

$$Q_{sat} \geq 0.5Q_{min}$$

(12)

Where, $Q_{sat}$ is a real workflow of one unit of the device.

The actual work efficiency of the coil conveyor carrier driven under certain angles to the horizon can be determined by the following expression [13. 12th p].

$$Q = 3600S_{iu} \delta_m \rho C_{\alpha}$$

(13)

In which $S_{iu}$ is the surface of the transverse section of the material transported on the coil conveyor pipe, in m$^2$; $\delta_m$ is the material transporting speed, m/s; $\rho$ is the density of the transported material, kg/m$^3$. $C_{\alpha}$ is the coefficient that takes into account the effect of the workflow on the horizons in terms of their working angle.

The value of $C_{\alpha}$ is based on Table 3.3 which is given below [12].

Table 3. The installed position of the angle $\alpha^\circ$ relatively to the horizon is given by the values of the coefficient

| $\alpha^\circ$ | 0  | 5  | 10 | 15 | 20  | 30  | 40  | 50  | 60  | 70  | 80  | 90  |
|-------------|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| $C_{\alpha}$ | 1.0 | 0.9 | 0.8 | 0.7 | 0.65 | 0.58 | 0.52 | 0.48 | 0.44 | 0.4  | 0.34 | 0.3 |

The face of the transverse section of the material transported on the coil conveyor pipe and speed of transportation are determined by the following expression

$$S_{iu} = \frac{\pi D_{iu}^2}{4}$$

(14)

$$v_{iu} = \frac{m_{iu}}{60}$$

(15)
Where, $\psi$ is the coil conveyor’s filling coefficient,

$N_{sh}$ is the number of coil conveyor’s rotations, rounds/min

The value of $\psi$ is 0.25 for small fractional material (soil, sand, sandy gravel, etc.) with a density of 800-1600 kg/m$^3$ [13]. It is suggested that the tractor speed of the tractor is in the direction of saturation of the coil conveyor carrier and the grounding hinge on the front of the coil conveyor carrier can be used to obtain this coefficient at $\psi$ = 0.5-0.6 [12].

Considering the expressions (14) and (15), expressions (13) have the following view:

$$Q_{sh_x} \geq 15\pi D_{sh}^2 \psi t n_{sh} \rho C_{\alpha}$$

We denote this expression and the value of the expression (16) of $Q_{min}$ (12).

$$15\pi D_{sh}^2 \psi t n_{sh} \rho C_{\alpha} \geq 0.5 \cdot 1000 S_{sh} \vartheta_{tr} \rho$$

We resolve this with regard to $n_{sh}$ and we get the following expression

$$n_{sh} \geq \frac{100 S_{gen} \vartheta_{tr}}{3\pi D_{sh}^2 \psi t C_{\alpha}}$$

In this statement, putting the values of the $S_{gen}$, $D_{sh}$, $t$ defined above and $\psi$, $C_{\alpha}$, $\vartheta_{tr}$ are set at the above values, we determine that the number of rotations of the coil conveyor should be at least 301 round/min.

Regarding a coil conveyed horizon, we define the angle of installation as follows

$$\alpha < \varphi$$

Where, $\varphi$ is the angle of friction on the coil conveyor pipe.

When the term (18) is done, the soil particles at the top of the coil conveyor pipe do not affect the soil particles beneath it. As a result, the technological process is carried out with low energy consumption, and no deterioration is observed.

According to the given information in the literature, $\varphi$ should be lower than 30-35 °. Thus, the angle of installation of the vortex to the horizon should not exceed 30° [6].

Thus, according to the research, it is desirable to use the only incoming intact coil conveyor on the pawl-creating device between cotton rows, to avoid damaging the seedlings, to maintain the required level of performance, and the low consumption of energy to the technological process, with the coil conveyor, its internal and external diameters have to be corresponding to 400 mm, 420 mm and 426 mm, the step of the coil conveyor 320 mm, the number of rotations 301 round/min and above and the angle of installation till 30° horizontally.

The number of rotation cycles required for the coil conveyor generator, which is the working body of the pawl-creating device, is based on the required power consumption for the unit, and the number of transmissions in the device is adjusted by a chain extension.

**Conclusion**

The results of the above theoretical research enable to define the parameters of the coil conveyed device used for the longitudinal pawls between the cotton rows.

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