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# THE EFFECT OF VARIABLE GEAR RATIO ON ENERGY EFFICIENCY OF COTTON GINNING

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**Abstract**

The article presents the proposed scheme of a variable speed belt and the principle of its operation. Formulas for calculating the initial tension of the drive belt and the slip coefficient are analytically determined. Ways to reduce slippage have been identified.

**Keywords:** belt drive, pulley, tension roller, eccentric, elastic element, gear ratio, speed, tension, slip coefficient.

Eccentrics are used to ensure the necessary absorption of complex values of torques and angular velocities of the driving and driven pulley shafts in the transmission of the cotton ginning machine, and thereby ensure the required oscillations of the pulley shafts with the required amplitude and frequency of angular velocities.

Taking into account the increasing cost of electricity used in processing raw materials in cotton gins, reducing its productivity is one of the main issues today.

17 kW of electric energy is consumed in each section of the UXK unit, which is used for cleaning cotton from impurities, and it can be seen that its power consumption is disproportionate. It is recommended to distribute the power of its electric motors in order to reduce the power consumed by the UXK unit and ensure its proportionality (Fig. 1).

Also, in order to eliminate the load on the working bodies of the unit during cotton cleaning, a device with a tension roller is used to determine the initial tension in the belt transmission with a variable transmission ratio.

The belt drive consists of a driving and driven pulley, a belt surrounding them, and an eccentric tension roller located under it. The driving and driven pulleys are made of flexible elements and bushings. The flexible elements are made of different thicknesses, where the difference between the thickness of the flexible element on the driving pulley and the thickness of the flexible element on the driven pulley is equal to the value of the eccentricity of the tension roller, and the surfaces of the flexible elements and the corresponding surfaces of the bushings and bushings are made wavy (Fig. 1) [1,2,3].

The main task of the structure is to ensure adequate absorption of torques and angular velocities on the drive and driven pulleys of the transmission. In this case, the required oscillations of the shafts of the pulleys at the required amplitude and frequency are provided. The task is solved by improving the design of the belt drive. In this case, the peak loads on the pulley shafts are carried out by choosing the thickness of the belt elements of the transmission pulleys according to the value of the eccentricity of the tensioning roller.

The distribution of the power consumed in the UXK aggregate in the recommended amount was selected based on the load on the working bodies of the aggregate.

Fig 2 shows the kinematic diagram of the UXK unit and the electric motors installed on it.

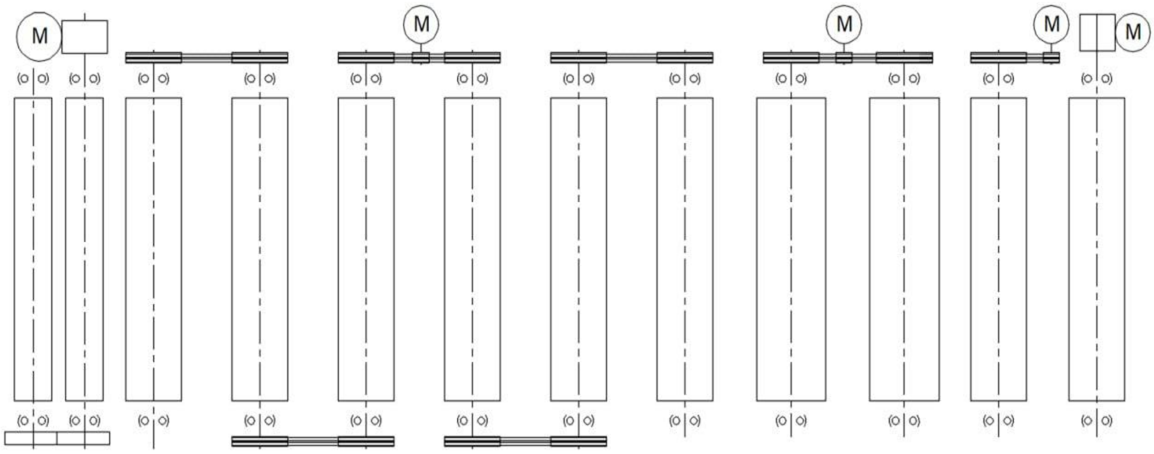


Figure 2. Kinematic scheme of the UXK unit

The total capacity of the UXK unit for cleaning cotton from small and large impurities is 19 kW. The installed capacity of the proposed (Fig. 2) cleaning unit is 13 kW. Also, a belt transmission with a tension roller and an eccentric tension roller was developed.

The number of gears of this belt drive moving at a variable angular velocity is determined by the following expression, according to [4].

$$\bar{u}_{12} = \frac{r_2}{r_1} \cdot \frac{a \cdot \cos\varphi_3 + \sqrt{r_3^2 - a^2 \cdot \sin^2\varphi_3}}{a \cdot \cos\varphi_3' + \sqrt{r_3^2 - a^2 \cdot \sin^2\varphi_3'}}. \tag{2}$$

here, $r_1$ ва $r_2$ – pulley radii, a – tension roller eccentricity, $\varphi_3$, $\varphi_3'$ - Tension roller belt with coverage angles, $r_3$ – tension roller radius.

When we find the number of transmissions of the belt drive and after some changes in the formulas we find the initial speed of the belt.

$$S_0 = \frac{EF}{e^{\mu\beta} - 1}\left[1 - \frac{a\cos\varphi_3' + \sqrt{r_3^2 - a^2\sin^2\varphi_3'}}{a\cos\varphi_3 + \sqrt{r_3^2 - a^2\sin^2\varphi_3}}\right]. \tag{6}$$

The analysis of the obtained expression (6) shows that if the eccentricity of the tension roller is zero, the sliding coefficient is also zero. When we calculate the given values, the sliding coefficient varies between 0.015÷0.030. In particular, when the eccentricity of the tension roller is equal to 4.0 mm, the sliding coefficient changes in the range of 0.020÷0.030. Similarly, the value of the initial tension varies depending on the eccentricity of the tension roller.

**Conclusion**

The effect of variable transmission ratio on cotton ginning was determined.
A belt drive design with elastic element pulleys with an eccentric tension roller is recommended. Formulas for calculating the initial belt tension and slip coefficient are recommended in the analytical method.

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