# DETERMINING THE INITIAL BELT TENSION AND SLIP COEFFICIENT IN A VARIABLE RATIO BELT TRANSMISSION.

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***Abstract.*** *The article presents the proposed scheme and principle of operation of a variable ratio belt transmission. Formulas for calculating the initial tension and slip coefficient of the transmission belt are determined by analytical methods. Ways to reduce slip are identified.*

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

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 webbing. 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 webbing and webbing are made wavy (Fig. 1) [1,2,3].

To ensure the necessary absorption of complex values of torques and angular velocities of the shafts of the driving and driven pulleys in the transmission of the cotton gin, and thereby to ensure the required oscillations of the angular velocities of the pulley shafts with the required amplitude and frequency, eccentrics are used. For this purpose, the belt transmission consists of driving and driven pulleys, a belt surrounding them, and an eccentric tension roller located under it, and the driving and driven pulleys are made up of bearings, flexible elements and seals. The actual design of the belt transmission consists of driving and driven pulleys and a belt covering them. The disadvantage of the design is that it does not provide a sufficient reduction in the amplitude values of the oscillations of the torques on the pulley shafts of the transmission. The disadvantage of this design is that it cannot sufficiently reduce the torques and angular velocity fluctuations of the driven pulley shaft connected to the working bodies of technological machines and the driven pulley shaft connected directly to the drive motor shaft. This leads to disruption of the technological process and variable engine load. In addition, the existing design makes it difficult to obtain the necessary changes in the angular velocities of the pulley shafts to intensify technological processes, for example, cotton ginning. The main task of the design is to ensure sufficient absorption of the torques and angular velocities of the driving and driven pulleys of the transmission. In this case, the required vibrations of the pulley shafts with the required amplitude and frequency are ensured. The task is solved by improving the design of the belt transmission. In this case, peak loads on the pulley shafts are achieved by selecting the thickness of the belt elements of the transmission pulleys in accordance with the value of the eccentricity of the tensioning roller. The essence of the design is that the belt transmission consists of pulleys with a belt element in the form of a groove and a groove and a rubber bushing installed between them, where the thickness of the rubber bushing is taken such that the difference in the thickness of the rubber bushings of the leading and driven pulleys is chosen equal to the value of the eccentricity of the tensioning roller. The proposed belt transmission sufficiently ensures uneven rotation of the shafts of the pulleys of technological machines.

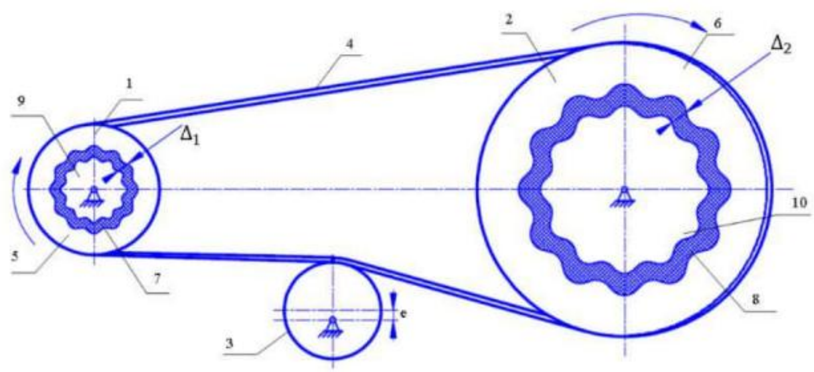


**Figure 1. Belt drive diagram with integral pulleys and an eccentric tension roller**

The belt drive (Fig. 1) works as follows; the drive pulley 1 transmits the rotational motion from the drive motor (not shown) to the driven pulley 2 and the tension roller 3 by means of a belt 4. The driven pulley 2 is directly connected to the working body of the technological machine (not shown in the figure). When the technological process is performed, a variable load (resistance) can be transmitted to the driven pulley 2. The eccentric execution of the tension roller causes the shaft and the ball screw 10 connected to it to vibrate, causing the shaft to vibrate at a certain angular velocity. The peak value of the moment of vibration of the ball screw 10 is absorbed by the elastic element 8 and the pulley 2 rotates at the required unevenness. Some of the technological load on the rotation of the pulley 2 is absorbed by the belt 4 due to the variability of the eccentricity of the tensioning roller, and the pulley 1 rotates with the required unevenness on the shaft 5. Then the vibration of the pulley 1 with an angular velocity of 5 ω1 and the torque of the drive is absorbed by the additional elastic element 7 and the hub 9, along with the drive shafts and the electric drive rotor, rotates with the required unevenness. In this case, the choice of the ratio $\varepsilon=\Delta_2-\Delta_1$ ensures the required uneven rotation of the pulleys 1 and 2. In this case, the greater the torque, the greater the deformation of the elastic element. This explains the choice of the thicknesses of the elastic elements 7 and 8 $\Delta_1$ and $\Delta_2$. In this case, the absorption of the peak values of the vibration values of the loads is ensured due to the large deformation of the elastic element 8 of the driven pulley 2, and, accordingly, the absorption of the peak loads due to the small deformation of the elastic element 7 of the pulley 1 is less. But their difference is equal to the eccentricity value. We define it from the following expressions:

$$e = \Delta_2-\Delta_1 \qquad (1)$$

In this case, the required frequency and amplitude of oscillation of the angular velocities and torques of the transmission pulleys are provided.

The number of gears of this belt transmission moving with a variable angular velocity is determined by the following expression [4]:

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

where, $r_1$ and $r_2$ are the radii of the pulleys, a is the eccentricity of the tension roller, the angles of engagement of the tension roller with the belt, $r_3$ is the radius of the tension roller.

Determination of the slip coefficient and the initial tension of the belt. It is known that in existing belt mechanisms, the initial tension of the belt and the slip coefficient have a basically constant value [5,6]. However, in belt transmissions with a variable gear ratio, the initial tension of the belt and the slip coefficient vary around the average value. Therefore, it is important to determine the initial tension and slip coefficient for the proposed belt transmission.

The transmission ratio of belt transmissions is also determined by the following expression, taking into account the slip coefficient of the belt [5].

$$u_{12} = \frac{D_1}{D_2(1-\xi)}. \qquad (3)$$

Taking into account the expression (2) for finding the transmission ratio determined analytically for the belt transmission under consideration, we can find the belt slip coefficient.

$$\xi = 1 - \frac{a\cos\varphi_3' + \sqrt{r_3^2 - a^2\sin^2\varphi_3'}}{a\cos\varphi_3 + \sqrt{r_3^2 - a^2\sin^2\varphi_3}}. \quad (4)$$

Also according to [5]

$$S_1 - S_2 = S_0(e^{\mu\beta} - 1) = \xi EF, \quad (5)$$

here: $S_1, S_2, S_0$- The initial tension of the belt in the belt transmission lines is determined based on the given equations (4) and (5).

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

Analysis of the obtained expression (4) shows that if the eccentricity of the tension roller is zero, the slip coefficient is also zero. When we calculate using the given values, the slip coefficient varies in the range of 0.015÷0.030. For example, when the eccentricity of the tension roller is 4.0 mm, the slip coefficient varies in the range of 0.020÷0.030. Similarly, the value of the initial tension also varies depending on the eccentricity of the tension roller.

## Conclusion.

A belt drive design with a combination of eccentric tension rollers and elastic element pulleys is proposed. Formulas for calculating the initial belt tension and slip coefficient using an analytical method are proposed.

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