DEPENDENCE OF THE SELECTOR DRUM ANGULAR VELOCITY AND LOAD ON THE TORQUE OF RESISTANCE FORCES FROM THE WINDING WIRE AND THE MOMENT OF INERTIA OF THE DRUM IN SECTION SELECTING

https://doi.org/10.5281/zenodo.20603789

G. N. Valiev[1], M. Turdiev[1], Oripov[1], A. J. Juraev[2]
[1]*Ferghana State Technical University (Uzbekistan, Ferghana)*
[2]*Tashkent Institute of Textile and Light Industry (Uzbekistan, Tashkent)*

Abstract

The analysis of the quality of winding on twisting machines has been carried out, the reasons for the formation and ways of eliminating winding defects and reducing the waste of raw materials during the processing of crepe yarns of natural silk have been established. Developed resource-saving technology for reducing silk thread winding defectiveness on twisting machines.

Keywords

winding, packing, silk, thread, density, twisting machine, winding defect, quality, waste raw materials, resource-saving technology.

INTRODUCTION

Improving the technological capabilities of warping machines installed at natural silk fabric production enterprises worldwide is considered a priority area of research for manufacturing knitted fabrics with high quality indicators and low raw material consumption. Extensive annual and long-term measures are being implemented to achieve these goals. In particular, the “Uzbekistan – 2030” Strategy outlines key objectives such as “efficient utilization of the local raw material base and development of industry based on advanced technologies” as well as “developing ‘driver’ sectors of industry and fully activating the industrial potential of regions.” In fulfilling these tasks, it is important, among other things, to improve the technology for developing resource-efficient silk crepe fabrics and to determine the rational parameters of the roving preparation drum in roving warping machines, thereby ensuring the competitiveness of export-oriented products manufactured by natural silk fabric enterprises.

This research work serves to a certain extent in implementing the tasks set forth in Decree No. PF-5989 of the President of the Republic of Uzbekistan dated

International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers
ISSN: 2945-4492 (online) | (SJIF) = 8.09 Impact factor
Volume-14| Issue-6| 2026 Published: |22-06-2026|

May 5, 2020, "On Urgent Measures to Support the Textile and Garment-Knitwear Industry"; Decree No. PF-60 dated January 28, 2022, "On the Development Strategy of the New Uzbekistan for 2022–2026"; Decree No. PF-71 dated May 1, 2024, "On Measures to Take the Development of the Textile and Garment-Knitwear Industry to a New Stage"; Decree No. PF-6 dated January 16, 2025, "On Additional Measures for Developing the Processing Chain in the Textile and Garment-Knitwear Industry"; as well as other regulatory and legal documents related to this field [2].

In the modern era of market relations, the most pressing development challenges for the silk industry are improving the quality of silk fabrics and enhancing their competitiveness in domestic and global markets by introducing innovative developments and technologies that ensure the production of high-quality products.

Silk is highly valued for its luster, durability, and excellent hygienic and performance properties. The use of natural silk threads in fabrics imparts softness and a unique, pleasant, delicate sheen, as well as excellent performance, hygienic, and consumer properties [3-4]. In the silk industry, the quality of products meeting international standards is largely determined by the quality of the silk threads, which in turn depends on the quality and properties of the cocoons.

The aim of this work is to develop an improved, resource-saving technology for reducing defects in the winding of silk threads on twisting machines.

METHODOLOGY

In textile processing technology, twisting plays a significant role in the efficiency of subsequent production processes.

The quality of yarn preparation for weaving is largely determined by the quality of the packages and the conditions under which the process itself is carried out, including the formation and preparation of the warp and weft yarns. The selection of these conditions and the optimization of the processes determine equipment productivity, the quality of products and semi-finished goods, waste yield, and the consumption of raw materials and materials.

Wang and Shi studied the problems of recycling silk textile waste [5]. Yan, Z., Yuyue, C.H., and Hong, L. investigated the production of silk thread consisting of two single yarns with different twist directions, which is treated with a calcium nitrate solution at 95°C to form a 3-D corrugated structure [6].

The structure and shape of the winding largely determine the strength of the package, the weight and length of the wound thread, the ability of the package itself to retain its shape and structure, as well as the conditions for winding the yarns in subsequent processing processes [7].

International Journal of Education, Social Science & Humanities.
Finland Academic Research Science Publishers
ISSN: 2945-4492 (online) | (SJIF) = 8.09 Impact factor
Volume-14| Issue-6| 2026 Published: |22-06-2026|

EXPERIMENTAL PART AND RESULTS

On some types of twisting machines, the winding layers are periodically not wound enough to the inner edge of the coil flange, resulting in a package with bevels at the coil flanges [8].

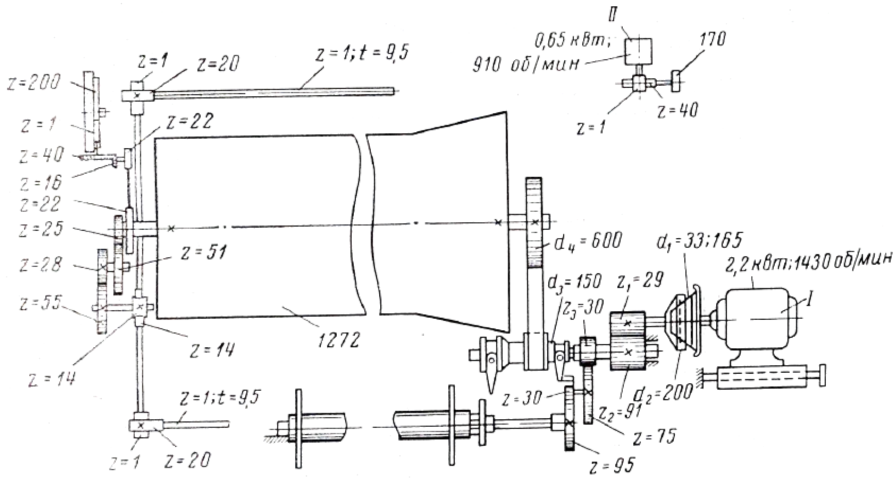


Figure 1. The kinematic scheme of the folding machine

Based on the kinematic scheme presented in Figure 1, the equipment parameters are obtained as follows:

- electric drive (engine): n = 1430 min-1, N = 2.2 kW;
- reducer (variator): d1 = 33 mm, d2 = 200 mm;
- gear: Z1 = 29 teeth, Z2 = 91 teeth;
- belt extension: d3 = 150 mm, d4 = 600 mm;

+- frequency of rotations of the drum: n = 18.8 min-1;

- perimeter of the drum: P = 4.0 m;
- winding speed V = 75 m/min (the speed increases partially as the diameter of the winding in the drum increases).

The length of the thread winding on the drum is from 1000 m to 1500 m (it can be less than 1000 m, but it is not recommended in terms of productivity, efficiency. Usually 1000 - 1200 m).

Resistance to drum rotation: number of yarns wound from the selection frame onto the drum (number of yarns in one skein) ml = 600 (The number of skeins depends on the assortment). In the existing technology, the linear density of the selected yarn (1 layer) is 2.33 tex, the tension of 1 yarn (1 layer) is 7-8 sN. In the new technology, the linear density of the selected yarn (4 layers) is (2.33 x 4) tex, the tension of 1 yarn (4 layers) is 15-16 sN.

The number of single (2.33 tex) yarns wound onto the selection drum is the same for one type of assortment and in the new technology, it is the same for one

International Journal of Education, Social Science & Humanities. Finland Academic Research Science Publishers
ISSN: 2945-4492 (online) | (SJIF) = 8.09 Impact factor
Volume-14| Issue-6| 2026 Published: |22-06-2026|

type of assortment. In the new technology, since the number of single threads selected at the same time is increased by 4 times (4 layers), the productivity also increases by 4 times, and the number of wicks is 4 times less.

By wicks and when grouping them, the change in mass is taken into account when calculating the value of the moment of inertia of the drum.

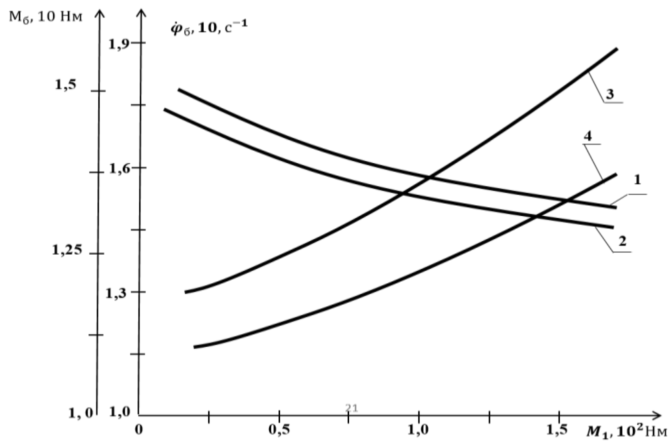
In this case, the drum, the motor rotor and other rotating masses are taken into account on the drum shaft and rotor.

It should be noted that with an increase in the coefficient of friction of the belt transmission transmitting movement to the wicking drum, the values of the coefficient of unevenness of its angular velocity decrease (Fig. 2). Here:

$$\delta_б = \frac{\dot{\varphi}_{б\, max} - \dot{\varphi}_{б\, min}}{\dot{\varphi}_{б\, ўрт}} = \frac{2(\dot{\varphi}_{б\, max} - \dot{\varphi}_{б\, min})}{\dot{\varphi}_{б\, max} + \dot{\varphi}_{б\, min}} \quad (1)$$

where $\dot{\varphi}_{б\, max}$, $\dot{\varphi}_{б\, min}$– maximum and minimum values of the angular velocity of the pick drum.

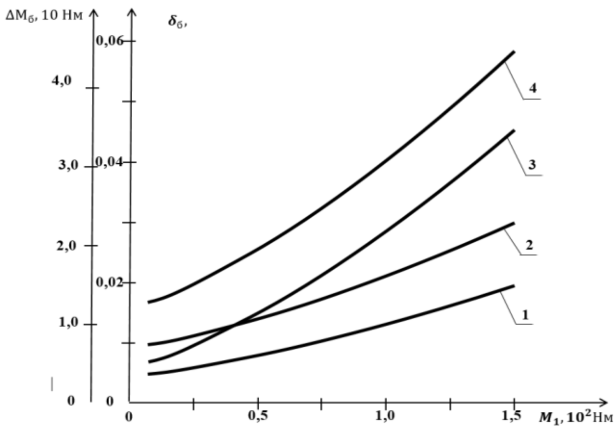
As a result of the obtained law of motion and processing of loads, the dependence graphs of the parameters were constructed. In particular, Figure 5 shows the dependence graphs of the angular velocity of the selector drum and the load on the moment of resistance forces coming from the winding yarn and the moment of inertia of the drum. According to the analysis of the graphs, when the technological resistance M1 values are increased from 0.25 * 102Nm to 1.5 * 102Nm and Ib = 2.5 kgm2, the angular velocity of the drum decreases in a linear fashion from 18.2s-1 to 14.9s-1, while the values of the turning torque decrease in a linear fashion from 1.12 * 102Nm to 1.358 * 102Nm. That is, as the resistance increases, the turning torque increases correspondingly, but the angular velocity decreases. Accordingly, as Ib = 3.5 kgm2 increases, the values of φ ̇_(b) decrease from 17.21 s-1 to 13.92s-1 in the nonlinear coupling, and the values of Mb increase from 1.17*102Nm to 1.56*102Nm.



1,2-$\dot{\varphi}_б = f(M_1)$;3,4-$M_б = f(M_1)$;1,4-$I_б = 2{,}5\ kgm^2$; 2,3-$I_б = 2{,}5\ kgm^2$;

Figure 2. Graphs of the dependence of the angular speed and loading of the pick drum on the torque of the resistance forces coming from the winding thread and the moment of inertia of the drum

Accordingly, Figure 3 shows the dependence of the angular velocity of the selection drum on the unevenness coefficient and the torque of the screwdriver on the moment of resistance from the winding thread. The analysis shows that when the M1 values increase to 1.5 * 102Nm and Ct = 450 Nm / rad, the angular velocity of the selection drum increases from 0.0045 to 0.021 in a linear manner, while the torque of the screwdriver increases from 5.1 Nm to 31.3 Nm. Accordingly, when the unevenness coefficient is 250 Nm / rad, the values of δ_b increase from 0.009 to 0.032. In this case, the values of ΔM_b reach 44.3 Nm. Therefore, it is recommended not to exceed the technological resistance values (1.0 - 1.2)102Nm in order to reduce the fluctuation of the angular speed of the drum and to ensure that the torque does not exceed.



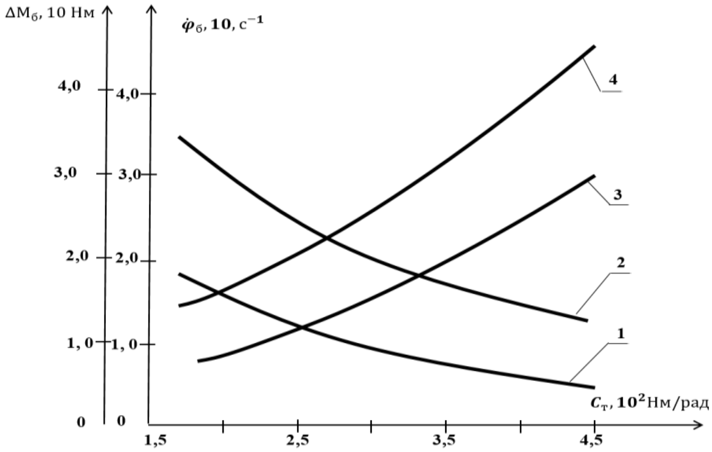
1,2-$\delta_6 = f(M_1)$; 3,4-$\Delta M_6 = f(M_1)$; 1,4-$C_т$=450 Nm/rad; 2,3-$C_т$=250 Nm/rad;

Figure 3. Graphs of the dependence of the angular velocity of the pick drum, the unevenness coefficient and the torsional torque vibration range on the torque of the resistance forces coming from the winding thread

Also shown in Figure 4 are graphs of the dependence of the angular velocity of the selection drum and the vibration range of the torque of the drill on the change in the belt transmission stiffness coefficient. According to the analysis, when the stiffness coefficient C of the belt mechanism transmitting motion to the selection drum increases from 0.8*102Nm/rad to 4.5*102Nm/rad and when M1=150Nm, the angular velocity vibration range decreases from 1.8s-1 to 0.38s-1, the ΔM_b values increase in a linear fashion to 44.6 Nm. Accordingly, when M1=120 Nm, the Δφ ̇_b values decrease from 3.32 s-1 to 1.22 s-1, and the ΔM_b values increase to 28 Nm.

International Journal of Education, Social Science & Humanities.
Finland Academic Research Science Publishers
ISSN: 2945-4492 (online) | (SJIF) = 8.09 Impact factor
Volume-14| Issue-6| 2026 Published: |22-06-2026|

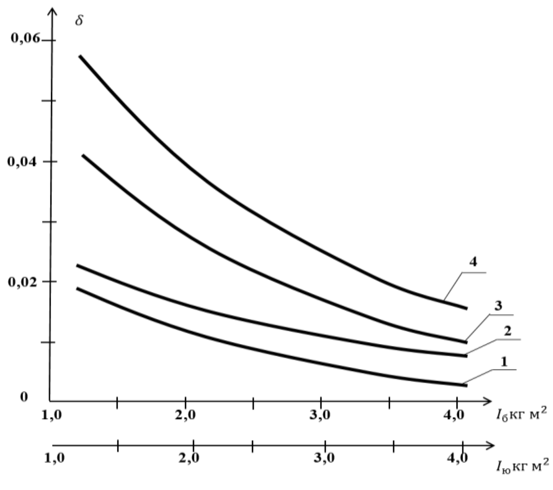
Therefore, to ensure smooth rotation of the body drum, the values of the belt drive friction coefficient are recommended to be in the range of Ct=(400-420) Nm/rad.



1,2-$\dot{\varphi}_б = f(C_т)$;3,4-$\Delta M_{b} = f(C_т)$;1,4-$M_1 = 150\ Nm$;2,3-$M_1 = 150\ Nm$;

Figure 4. Graphs of the dependence of the angular speed of the selector drum and the vibration ranges of the screwdriver torque on the change of the coefficient of uniformity of the belt transmission

It should be noted that the heavier the selection drum, the higher the moment of inertia, the smoother it rotates. Figure 5 shows graphs of the angular velocities of the selection drum and the drive (motor) rotor shafts against the corresponding moments of inertia.



1,2-$\delta_{Yu} = f(I_ю)$; 3,4-$\delta_b = f(I_b)$; 1,3-$C_т$=450 Nm/rad; 2,4-$C_т$=250 Nm/rad;

Figure 5. Graphs of the dependence of the coefficients of unevenness of the angular velocities on the shafts of the selector drum and the rotor of the driver (engine) on the corresponding moments of inertia

According to the analysis of the constructed graphs (Fig. 5), when the moment of inertia of the masses applied to the driving rotor increases from 0.55 kgm2 to 0.8

kgm2, the values of δ_p decrease from 0.02 to 0.0034, and the values of δ_b decrease from 0.039 to 0.011 when the rotor angular velocity unevenness coefficient C1=450 Nm/rad. Accordingly, when the belt roughness coefficient is taken as 250 Nm/rad, the values of δ_p decrease from 0.024 to 0.01, and the values of the drum angular velocity unevenness coefficient δ_b decrease from 0.051 to 0.022 in a nonlinear relationship. Therefore, in order to reduce the values of δ_ρα and δ_β, and to ensure uniform rotation of the selection drum and the motor rotor, the recommended values of the moments of inertia are Ip= (0.5-0.6) kgm2; Iб= (3.0-3.5) kgm2.

CONCLUSION

Thus, based on the results of the work, the following conclusions can be drawn. The effect of technological resistance on the dynamic parameters of the selection drum in the pre-selection was studied. As a result of the dynamic analysis of the drum of the pre-selection machine, it was theoretically determined that with an increase in the resistance from the winding yarn, the vibration amplitude also increases, and it was proved that the vibration frequency corresponds to the vibration frequency of the moment of resistance forces. It was found that when the technological resistance values in the pre-selection machine are increased, the angular velocity of the selection drum decreases in a linear manner, while the values of the turning torque decrease in a linear manner.

REFERENCES:

1. https://www.factmr.com/report/2865/knitted-fabrics-market
2. Decree of the President of the Republic of Uzbekistan dated September 11, 2023 on "Uzbekistan - 2030 Strategy" No. PF-158
3. Valiev G. N., Oripov, J. I., Valiev N. G. The Investigation of the endurance of natural silk threads to multiple tensile deformations // International Journal of Advanced Research in Science, Engineering and Technology (IJARSET). Vol. 8, Issue 9, September - 2021. – pp. 18256-18260.
4. Valiev G. N., Khomidov V. O., Turdiev M. Устройство для испытания натяжных приборов текстильных машин // Design, technology and innovation in textile and textile industry (INNOVATsII-2018): collection of materials Mejdunarodnoy nauchno-technicheskoy conference (Moscow, November 15-16, 2018). Chast 1. – M.: FGBOU VO "RGU im. Kosygina", 2018. - 257 p., p. 89-92.

5. Wang, Shi. Advances in energy science and equipment engineering [Text] / Shi. Wang // International Conference on Energy Equipment Science and Engineering (ICEESE), May 30-31, 2015. – Guangzhou, Peoples r china, P. 875-879.

6. Yan, Z. Structural characterizations of three-dimensional crimped silk yarns [Text] / ZHANG Yan, CHEN Yuyue, LIN Hong // Thermal Science. - 2015, Vol. 19 Issue 4, P.1337-1340.

7. Valiev G. N., Khomidov V. O. Study of the Shape of a Balloon of Natural Silk Thread When Winding From a Fixed Packing // International Journal of Advanced Research in Science, Engineering and Technology (IJARSET). Vol. 7, Issue 8, August - 2020. – pp. 14733-14737.

8. Usenko V. A. Shelkokruchenie - M.: Legkaya industriya, 1969 - 320 p.