

Determination of the Parameters of the Working Bodies of the Drum of a Horizontal Spindle Cotton Harvesting Apparatus

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Abstract: This paper presents the development of an innovative technology for producing a lightweight composite material utilizing recycled aluminum and mineralized wood waste. The primary objective is to create an environmentally sustainable material that offers significant weight reduction and enhanced mechanical properties for various industrial applications. The process involves the amalgamation of aluminum, reclaimed from post-consumer products, with wood waste that has undergone mineralization to improve its durability and compatibility with metal matrices. Key aspects of the development include optimizing the mineralization process, ensuring uniform dispersion of wood particles within the aluminum matrix, and achieving strong interfacial bonding. Preliminary results demonstrate that the new composite exhibits superior strength-to-weight ratios and thermal stability compared to traditional materials. This advancement holds potential for widespread applications in automotive, aerospace, and construction industries, promoting both resource efficiency and environmental conservation

1 INTRODUCTION

In recent years, in our republic, at the Tashkent Tractor Plant JSC (Agrotech cluster), the high-performance company "Djon-Dir" has been producing cotton picking machines (CPM) with a horizontal spindle (HS) equipped with picking devices, and until now, hundreds of machines have been delivered to clusters and farms. It is known that the HS CHM was produced in the USA and is mainly adapted to the soil-climate conditions and agronomy of this country. Currently, more than 30 types of cotton varieties are regionalized in our country, of which early varieties, mid-ripening and promising varieties are considered, in addition, it is recommended to plant new varieties. In our republic, cotton varieties are now planted at 60, 76 and 90 cm between rows (Matchanov, 2023).

The analysis of the work efficiency of HS and vertical spindle (VS) CHM in the conditions of

Uzbekistan showed that the ATCs of HS machines are on average 6...9% higher than those of VS, and the work efficiency is almost twice as large. Based on the results of experiments, analysis and calculations of experts, HS CHM yield is higher than 30 t/ha, especially in fields with high yield (43...51 t/ha) and the degree of furrow opening is high (90% and above), reliability indicators are also showed that it will be high. It was shown that these HS CHMs are not fully adapted to the conditions of Uzbekistan (Glushenko et al., 2004; Abdazimov et al., 2014; Abdazimov et al., 2019).

In order to eliminate the above-mentioned shortcomings, in-depth study of the technological process of picking this GS CHM, especially the research of the process of pulling and wrapping the cotton in the groin of GSh, and establishing the dimensions and modes of the cotton picking apparatus (CHA) suitable for the conditions of our republic, carrying out constructive and technological

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adaptation works based on the suitability criteria requires going.

2 MATERIALS AND METHODS

In our ongoing research work, the number of spindles in the drum, spindle location parameters, spindle material and tooth sizes were studied based on the type of regionalized and promising varieties, the size of cotton branches, structure and bolls, yield, planting scheme, which are considered the main working organs of HS CHM (Petre, 2015).

Cotton varieties have their own pattern of formation depending on the shape and type of bush, which pattern was determined based on the statistical processing of the results of experiments on each zoned cotton variety. Experiments were conducted on the dynamics of boll opening, arrangement and elasticity of boll elements (branches, bolls, leaves, etc.).

Usually, it is noted that the axis of the drum and separator should be 120-125 mm in the longitudinal direction and 220 mm in the transverse direction (Glushenko et al., 2004; Abdazimov et al., 2014). It is desirable for the disk separator to be located near the colosnik grid, that is, near the exit of the spindle from the working chamber, but it is difficult to turn the cassette with the spindle into the separation zone at a short distance and in a short time. This is achieved by choosing the most optimal variant of the guideway profile, in which it is necessary to take into account the increase in pressure on the guideway of the roller when the spindle cassette turns.

It is important that the drum of the cotton picker with horizontal spindles completely and qualitatively separates the cotton wrapped around the spindles, that is, it does not damage the cotton fibers and seeds. If even a small amount of cotton pieces remain on the spindle after passing through the disc separator, the cotton piece of the spindle at 3000-4125 rev/min will be wrapped in plaster and will be stuck to the cotton in the groin in the working chamber, and the quality of wrapping the cotton piece will be negatively affected. Spindles in each tier should pass under the separator disks at a distance of 0.1...1.0 mm, if this gap is larger than this, the cotton will be wrapped around the spindle (Omonov et al., 2021; Omonov & Tulaev, 2021).

It is known that the horizontal spindles are mounted on the curved-shaft cassette, and under the action of the curved-shaft cassette through the sliding bearing on the guideway, there are 4 complex kinematic movements, that is, advancement with the

machine, rotation along with the spindle drum, the curved-shaft cassette under the influence of the guideway and the spindle fixed to it according to a certain law around the axis of the cassette. turns and the spindle rotates around its axis. In this case, under the influence of the profile of the guideway, the spindles must enter and exit the working chamber in a forward-reciprocating motion perpendicular to the row of yarn, enter the disk separator sideways, and exit the separator zone at least 4 times completely, and the spindle must also complete one full revolution around its axis in the wetting washer zone. rotation conditions must be ensured and these conditions are achieved on the basis of the guideway profile and the curved cassette. The completeness of separation of cotton wrapped on the spindle depends on the structural and technological parameters of the picking apparatus, as well as on the physical and mechanical properties of the cotton crop (Abdazimov et al., 2022; Omonov et al., 2022; Rizaev et al., 2023).

In the study of high-quality and reliable separation of cotton wrapped from a horizontal spindle, first of all, development of the optimal design parameters of the disc separator by taking into account the direction of movement of the separator in relation to the spindle and speed indicators, the effect of the separator wrapped on the spindle on the cotton, as well as the factors determining the surface of the spindle on the working part and can be put into production. When determining the outer diameter of the disk, $L_0 - n + m$, where: L_0 is the length of the working part of the spindle processed by the separator, $L_0 - n$ is the length of the working part of the spindle in the separation zone, where the axis of the separator shaft intersects with the axis of the spindle; m is the distance from the end of the spindle to the separator shaft, mm (according to the research data of M.V. Sablikov, $m = 32...36$ mm was considered sufficient) (Glushenko et al., 2004).

3 RESULTS AND DISCUSSION

Work was carried out to determine the optimal technological and structural parameters of the guideway and the disk separator for the HS CHM sine dialing apparatus. In the picking chamber, the condition must be met that the spindles do not allow the yarn to bend in the direction of CHM movement, and for this it is necessary to achieve that the component of the speed of the spindle center in the picking zone in the direction of CHM movement speed $V_m = 0$ (Fig. 1). When determining the optimal diameter of the disk separator, first of all, the length

of the spindle working part (50-80 mm, the length of the working part of the CHM spindle used in our country is 52 mm) was taken into account, as well as the spindle and the separator to the mutual kinematic movement trajectory, which in turn is the spindle cassette curvature depends on the structural characteristics of the guideway profile. The arrangement scheme and dimensions of the guideway profile and disk separator on the spindle drum of the HS machine dialing apparatus are given in Fig. 1.

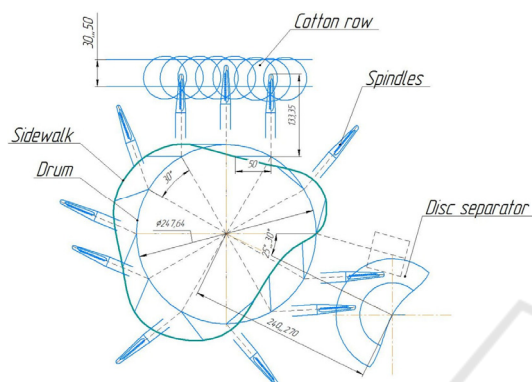


Figure 1: The layout and dimensions of the working bodies in the dialing apparatus.

A 3D model of the construction of the guideway of the spindle drum was developed in the Compass program, in which dynamic forces were applied to the walls of the guideway along the X, Y, Z coordinates, and the stability was checked (Fig. 2). In this case, the known spindle-cassette curve ship is forced to move along the profile of the guideway with the help of a sliding bearing, and dynamic forces are applied to the walls of the guideway.

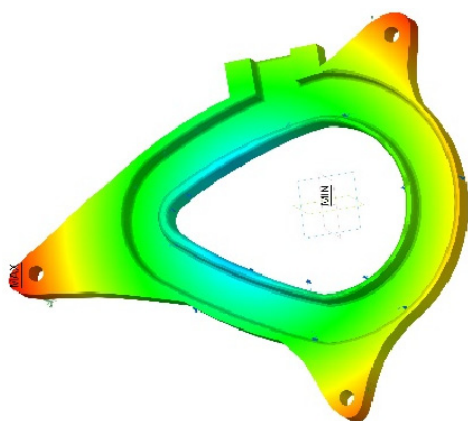


Figure 2: 3D model of a spindle drum guideway.

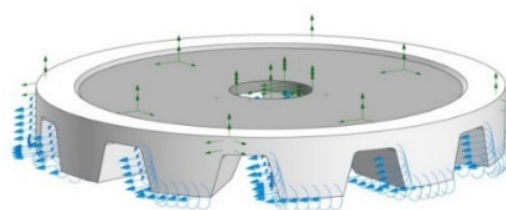


Figure 3: 3D model of a disc separator and the forces acting on it.

A 3D model of the disc separator was also developed and subjected to dynamic forces and tested for robustness. For reference, a disc separator consists mainly of two parts: a metal alloy and a polymer product (Figure 3).

4 CONCLUSIONS

The guide rail material is Steel 3 according to GOST R 52246-2016, the total mass is 6.64 kg. The coefficient of loss of stability of the newly designed guideway (coefficient zapasa poteri ustoychivosti) was 0.000305, the stability coefficient was $1.85 \dots 10$, the coefficient zapasa po predelu tekuchesti was $1.06 \dots 10$.

The diameter of the disk separator is $D=159$ mm, the total thickness is 24 mm, the diameter of the disk of the metal part is $d=137$ mm, the thickness is $S=4$ mm, the total mass is 525 grams. The composition of the disc separator metal alloy: Fe 96.87%, Si 1.6%, Mn 0.96%, Ti 0.35%, Cr 0.04%, V 0.03%, Sb 0.01%, Pb 0.01%, Sn 0.01%, P 0.01% and Niobium 0.01%.

It was found that the structure of guideway and disc separator in the new structure meets the requirements of stability and durability.

REFERENCES

- Abdazimov, A.D., Omonov, N.N., & Khudayorov, M.T., 2022. Justification of the parameters of the information model of the automatic guidance system of the cotton harvester. *IOP Conference Series: Earth and Environmental Science*, 1076, 012002. DOI: 10.1088/1755-1315/1076/1/012002.
- Abdazimov, A.D., Radjabov, S.S., & Omonov, N.N., 2019. Automation of agrotechnical assessment of cotton harvesting machines. *IOP Conference Series: Journal of Physics: Conference Series*, 1260(3), 032001. DOI: 10.1088/1742-6596/1260/3/032001.
- Abdazimov, A.D., Uljaev, E., Ubaidullaev, U.M., & Omonov, N.N., 2014. *Fundamentals of automation of*

- control and control of technological parameters of cotton harvesting machines*. TSTU (Technical University, Tashkent), 11–24.
- Glushenko, A.O., Matchanov, R.D., Rizaev, A.A., Toshboltaev, M.T., & Khudoykulov, R.R., 2004. *Simulation of dynamic processes in horizontal-spindle cotton pickers*. Science, 7–39.
- Matchanov, R.D., 2023. *Development of a cotton harvesting machine for selective cotton harvesting*. Science, Tashkent, 6–34.
- Omonov, N.N. & Tulaev, B.R., 2021. Evaluation of the degree of processing of the stalks on the basis of the analysis of the trajectory of the spindle of the horizontal spindle cotton harvesting machine. *IOP Conference Series: Earth and Environmental Science*, 868, 012072. DOI: 10.1088/1755-1315/868/1/012072.
- Omonov, N.N., Abdazimov, A.D., Shodiyev, J.G., & Atadjanova, M.M., 2021. Investigation of spindle activity of horizontal spindle cotton harvesting machine. *IOP Conference Series: Earth and Environmental Science*, 868, 012073. DOI: 10.1088/1755-1315/868/1/012073
- Omonov, N.N., Masharibov, A.R. & Atadjanova, M.M., 2022. Universal row-crop tractor with a variable base: calculation of the links of the tractor base change mechanism. *IOP Conference Series: Earth and Environmental Science*, 1076, 012006. DOI: 10.1088/1755-1315/1076/1/012006.
- Petre, M., 2015. Combine Harvesters: Theory, Modeling, and Design (USA), 4-55.
- Rizaev, A.A., Alimova, D.B., Omonov, N.N., & Mamatmurodov, I.A., 2023. About rational number of spindles on drums of cotton harvester. *E3S Web of Conferences*, 401, 04013. <https://doi.org/10.1051/e3sconf/202340104013>.