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STUDY OF THE BENDING OF THE SAW GIN MACHINE BLADE*

ИССЛЕДОВАНИЯ ИЗГИБА ПИЛЬНОГО ДИСКА ВОЛОКНООТДЕЛИТЕЛЯ

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The article presents the results of the study of the deflection of saw blades of the 4DP-130 fiber separating machine. The deflection of the saw blade occurs when the saw touches the grate, which occurs due to errors in the assembly of the saw cylinder and changes in the tightening force of the saw package. The work studied the effect of the design of inter-saw pads on the deflection of saw blades mounted on the saw shaft. The experiment compared serial pads obtained by casting from AK5M2 alloy and experimental pads obtained by welding from sheet steel St.3.The research found that when using steel inter-saw pads, the deflection of saw blades can be reduced by 15%, which allows extending the service life of saws and reducing accidents in gin shops of cotton ginning plants.

В статье приведены результаты исследования прогиба пильных дисков волокноотделительной машины 4ДП-130. Прогиб пильного диска возникает при касании пилы с колосником из-за погрешностей сборки пильного цилиндра и изменения силы затяжки пакета пил. В работе изучалось влияние конструкции междупильных прокладок на прогиб пильных дисков, смонтированных на пильном вале. В эксперименте сравнивались серийные прокладки, получаемые литьем из сплава АК5М2, и экспериментальные прокладки, получаемые сваркой из листовой стали Ст.3. В результате исследований установлено, что при использовании стальных междупильных прокладок прогиб пильных дисков можно снизить на 15%, что позволяет продлить

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срок службы пил и снизить аварийность в джинных цехах хлопкоочистительных заводов.

Keywords: fiber-separating machine, saw cylinder, saw blade, inter-saw spacer, aluminum alloy AK5M2, steel St3, bending, bending force.

Ключевые слова: волокноотделительная машина, пильный цилиндр, пильный диск, междупильная прокладка, алюминиевый сплав АК5М2, сталь Ст3, изгиб, изгибающая сила.

Introduction

Currently, domestically produced fiber-separating machines utilize disc saws with a thickness of 0.95 mm, an outer diameter of 320 mm, and an inner diameter of 100 mm [1].

Research organizations in Uzbekistan are actively conducting research aimed at increasing the service life of linter grates and fiber separation machines.

To increase the durability of grates, it is necessary to install saw blades in the central part of the grate gap, otherwise contact between the saw teeth and grates will damage them, as well as damage the fiber and seeds.

In the article by A. Djuraev et al. [2] it is established that during the ginning process the saw cylinder shaft experiences the force of distributed pressure from the raw material roller with a pronounced variable character, which is transmitted to the frame and other supporting and bearing elements of the gin. This pressure causes additional bending of the saw shaft and, as a consequence, changes in the gaps between the saws and the grate bars.

K.M. Islamkulov [3] conducted an analysis of disc saw heat treatment methods used in Russia, the United States, and Germany. Based on this analysis, a new technology for enhancing the strength and wear resistance of toothed disc saws used in linting and fiber-separating machines was proposed, utilizing high-frequency induction heating (HFH). The influence of the saw surface nanostructure on the wear resistance of the teeth has been established. The stresses arising during the heat treatment of circular saws have been determined by calculation. The calculations have shown an increase in the wear resistance of circular saws by 2-3 times compared to existing technologies. Furthermore, the study recommended replacing tool steel U8G with high-carbon steel 65G for manufacturing disc saws.

In the article by S. Isroilov [4] the paper provides information on experimental verification and practical use of the theoretical provisions obtained above. The studies were carried out on a special experimental stand, on which the most characteristic batch working body, the DP-80 gin saw cylinder, was installed.

In the article [5] N.M. Safarov et al. developed a mathematical model of the technological process of heat treatment of saw teeth using a laser beam and recommended a modern and highly efficient technological process for processing saw teeth using a laser beam, which allows preserving the natural quality of products. As a result of the increased strength of the saw teeth using the new laser processing technology, the service life of saw blades has increased, the cost, productivity and efficiency of the saw cylinder has increased.

The article [6] by A. Dzhuraev et al. presents a constructive diagram of a new saw cylinder and the results of a study of the bending of a gin saw cylinder, determining how to find the deflection and technological gaps, especially between the saw and grates. The process of bending vibrations of a gin saw cylinder, having a package of working steel saws and aluminum gaskets between them, compressed by the longitudinal compression force communicated by the central shaft, is considered.

D.M. Mukhammadiev and I.O. Ergashev [7] investigated the change in the linear velocity of particles in the composition of the raw material roller. It was found that the linear velocity in the tangential direction changes by 23.5%. The main changes in velocity occur in

the vicinity of the saw and the cotton input zone of the working chamber.

The article [8] presents the results of a study of the bending of saw blades of the 5LP linter machine under the action of a lint layer in the gap between the saw and the grate. It was found that with an increase in bending forces from 9.8 to 49 N, the deflection of the disk in the saw shaft with aluminum gaskets changes by 4.5 mm, and when using steel gaskets by 3.5 mm, which reduces the likelihood of the saw touching the grate during machine operation.

Methods

In this paper, the bending process of the saw blade of the 4DP-130 fiber separator was studied. At present, these machines use gaskets obtained by casting from the aluminum alloy AK5M2 (Fig. 1- Inter-saw spacers of the saw gin machine: a – AK5M2; b – Steel 3). Gaskets with a thickness of 17.05 mm are installed along the entire length of the shaft between saw blades with a thickness of 0.95 mm with a pitch of 18 mm. A total of 129 gaskets are installed on the saw shaft, which should be located between the grate gaps [9]. The existing design of the saw-and-grate system elements of the fiber separation machine does not allow achieving the specified accuracy of their assembly, both of the saw cylinder separately and of the grate, which leads to contact between the saws and the grates.

The size chains of grate bars and saw cylinders depend on the assembly method, as well as on the manufacturing accuracy of saw blades, grate bars and inter-saw spacers. Therefore, inaccurate placement of saw blades in inter-grate gaps leads to bending of saw blades, which contributes to wear of the working areas of grate bars and saw blades [9].

a) b)

Fig. 1

It has been established that the reliability of the working areas of the grate bars and saw blades depends on the manufacturing accuracy of the saw blades, grate bars and inter-saw pads, as well as on the rigidity of the saw package on the saw shaft. The weak link in this package is the inter-saw pads, which are made of aluminum alloy AK5M2. Therefore, to eliminate one of the above-mentioned shortcomings, a new design of inter-saw pads for the fiber separation machine is recommended (Fig. 1, b) [10].

To study the bending of saw blades of a fiber separation machine, an installation (Fig. 2- Photograph of the experimental setup for studying the bending behavior of saw blades in a fiber-separating machine) was manufactured based on the proposed scheme (Fig. 3- Schematic of the experimental setup for studying the bending behavior of saw blades in a gin machine: 1 – Saw blade, 2 – Inter-saw spacers, 3 – Mechanical clamp, 4 – Dial indicators (ICh-10 0.01 model), 5 – Load-bearing rod, 6 – Weight, 7 – Sectorial angles (-45°, -30°, -15°, 0°, 15°, 30°, 45°). The aim of the experimental study is to investigate the deflection of saw blades from contact with the grate. For this purpose, both standard aluminum alloy AK5M2 spacers and newly recommended steel St3 spacers have been used in the fiber-separating machine.

Fig. 2

To create conditions similar to those for fastening the saw blades on the shaft of the fiber separator saw cylinder, i.e. the corresponding tightening force, a screw mechanical press was used. During the experiment, the tightening was set at the following levels - 9611; 19223; 28834; 38446; 48058 N. After tightening the gaskets and the saw blade, the readings

of the dial indicators of the ICh-10 0.01 brand were recorded (Fig. 2 and 3). After that, a load weighing 0.7; 1.4; 2.1; 2.8; 3.6 and 4.4 kg was suspended on the maximum diameter of the saw blade. The bending force in this case was 6.9; 13.7; 20.6; 27.5; 35.3 and 43.1 N.

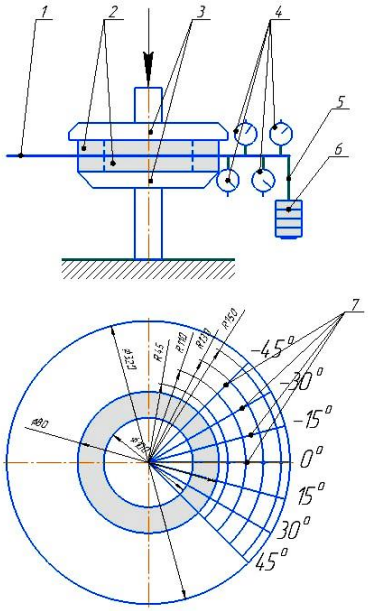

Fig. 3

To create conditions similar to those for fastening the saw blades on the shaft of the fiber separator saw cylinder, i.e. the corresponding tightening force, a screw mechanical press was used. During the experiment, the tightening was set at the following levels - 9611; 19223; 28834; 38446; 48058 N. After tightening the gaskets and the saw blade, the readings of the dial indicators of the ICh-10 0.01 brand were recorded (Fig. 2 and 3). After that, a load weighing 0.7; 1.4; 2.1; 2.8; 3.6 and 4.4 kg was suspended on the maximum diameter of the saw blade. The bending force in this case was 6.9; 13.7; 20.6; 27.5; 35.3 and 43.1 N.

The deflection was measured in saw blade radii of 90; 110; 130; 150 mm. In this case, the bending force was applied at a point 155 mm from the saw center at the radius from which the angular coordinate was counted, i.e. 0o (Fig. 3). For this purpose, a hole was made in the saw blade, where a rod for hanging loads was installed (Fig. 2 and 3).

Results

The results of the experimental study (Fig. 4 – Variation in the bending of the fiber-separating machine's saw blade depending on the clamping force of the saws, with spacers made of aluminum alloy AK5M2 and Steel St3) showed a decrease in the saw blade deflection from 4.65 to 3.06 mm with an aluminum liner and from 3.15 to 2.74 mm with a steel liner, as the saw clamping forces increased from 9611 to 48058 N and a fixed bending force of 43.1 N, which is 15.0%.

The findings also indicate that as the bending force increased from 6.9 N to 43.1 N, the deflection of the saw blade with an aluminum spacer reached 4.65 mm, while with a steel spacer, it reached 3.15 mm at a clamping force of 9611.61 N. When the clamping force was increased to 48058.07 N, the deflection of the saw blade decreased to 3.06 mm with an aluminum spacer and to 2.74 mm with a steel spacer (Fig. 5 – Variation in the bending of the fiber-separating machine's saw blade depending on the bending force at a clamping force of 48058.07 N).

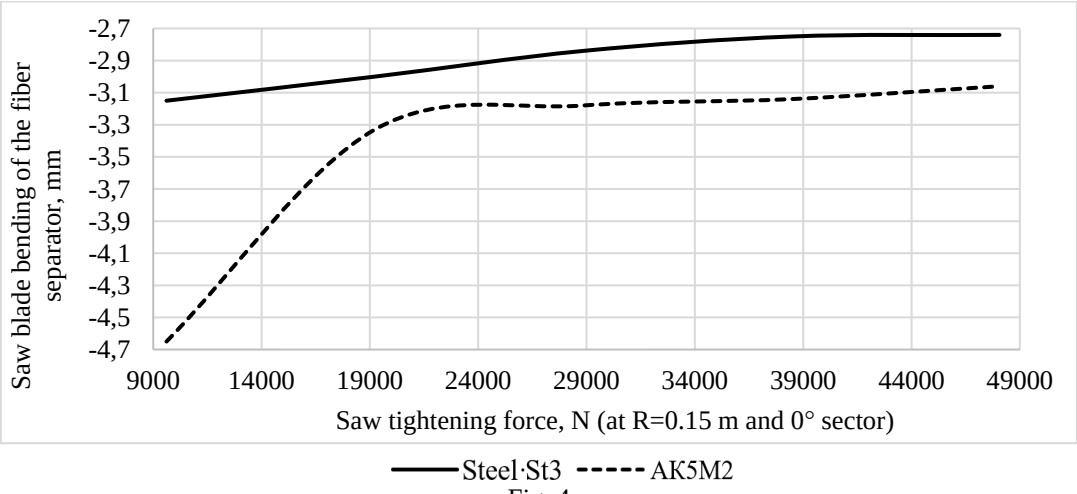

Fig. 4

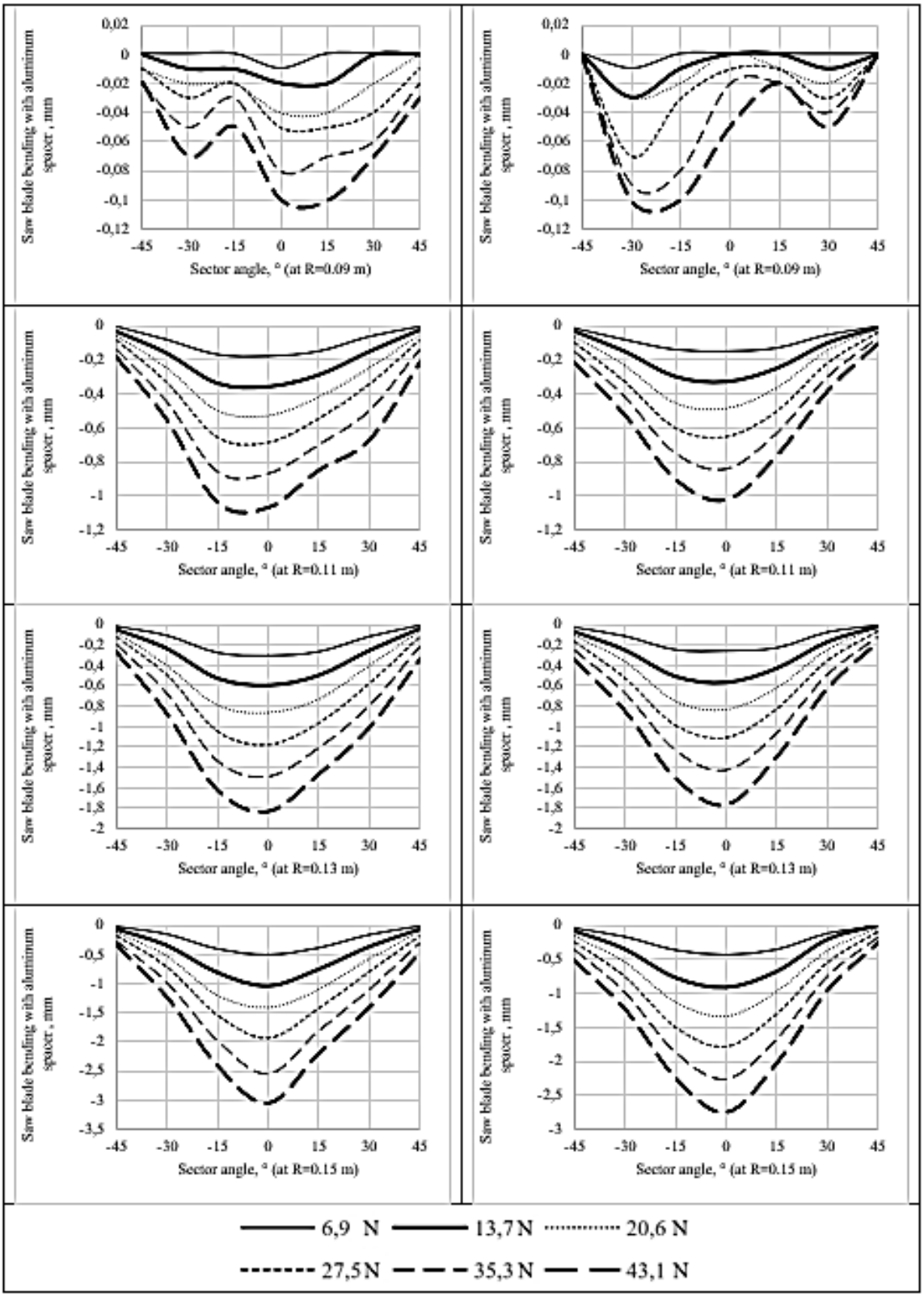

Fig. 5

Conclusions

1. Analysis of the results of the experimental study on the deflection of the saw blades of the fiber separator showed a decrease in deflection from 4.65 to 3.06 mm for a saw blade with an aluminum gasket and from 3.15 to 2.74 mm with a steel gasket, that is, on average by 15.15% with an increase in the tightening forces of the saws from 9611 to 48058 N with a bending force of 43.1 N.

2. Overall, the study established that as the bending force increases from 6.9 N to 43.1 N,

the deflection of the saw blade with an aluminum spacer reaches 4.65 mm, whereas with a steel spacer, it reaches 3.15 mm—a reduction of 32.25% at a clamping force of 9611.61 N. At a higher clamping force of 48058.07 N, the deflection decreases to 3.06 mm with an aluminum spacer and 2.74 mm with a steel spacer—a 10.45% reduction.

3. The above results indicate an increase in the resistance of saw blades to bending by an average of 15% when using steel inter-saw pads compared to serial ones and AK5M2 alloy, which allows to extend the service life of saws and reduce accidents in gin shops of cotton ginning plants.

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