Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 47 No. 01 (2026)

Increasing the Quality of the Side Surfaces of the Teeth of Saw Cylinder Discs Using Abrasive Blast Treatment

Zokhir Shodmonkulov[1], Normurod Mirzakabilov[2], Ravshan Mirzakabilov[3], Alisher Abdusamatov[4]

[1]PhD., Associate Professor, Department of Engineering Mechanics, Tashkent Institute of Textile and Light Industry, Tashkent, 100100, Uzbekistan
[2]PhD., Associate Professor, Department of General technical sciences, Jizzakh Polytechnic Institute, Jizzakh, 130100, Uzbekistan
[3]PhD., Associate Professor, Department of General technical sciences, Jizzakh State Pedagogical University, Jizzakh, 130100, Uzbekistan
[4]PhD., assistant, Department of Engineering Mechanics, Tashkent Institute of Textile and Light Industry, Tashkent, 100100, Uzbekistan
E-mail: zohirshod@gmail.com ORCID: 0000-0002-8132-8096

Abstract. The article presents materials on the effective use of abrasive blasting of the side surfaces of the teeth of saw blades in order to activate them during lightering. The scraping action and cutting of short fibers from seeds is enhanced by microroughnesses of the formed micro profile after impact interaction of an abrasive particle with a metal surface. Using atomic force microscopy, we obtained the height and step parameters of the roughness of the machined tooth surface, which are compared with the transverse dimensions of the cotton fibers, and thus a model for the intensification of the littering process is proposed.

It is shown that when modeling a single interaction of an abrasive particle with the surface of a part in the process of collision under air (liquid) pressure, it is necessary to take into account the specifics of impact-abrasive wear, when the separation of a wear particle is preceded by metal destruction. In the process of schematization of the contact interaction during abrasive blasting, some commonality with the shot blasting process and a number of assumptions typical for grinding, when micro cutting with a single abrasive grain is considered, are taken into account.

Abrasive blasting of the side surfaces of saw blade teeth with a cotton-processing machine particle made of black silicon carbide is proposed. The achieved required processing quality makes it possible to achieve microrelief on the treated surface.

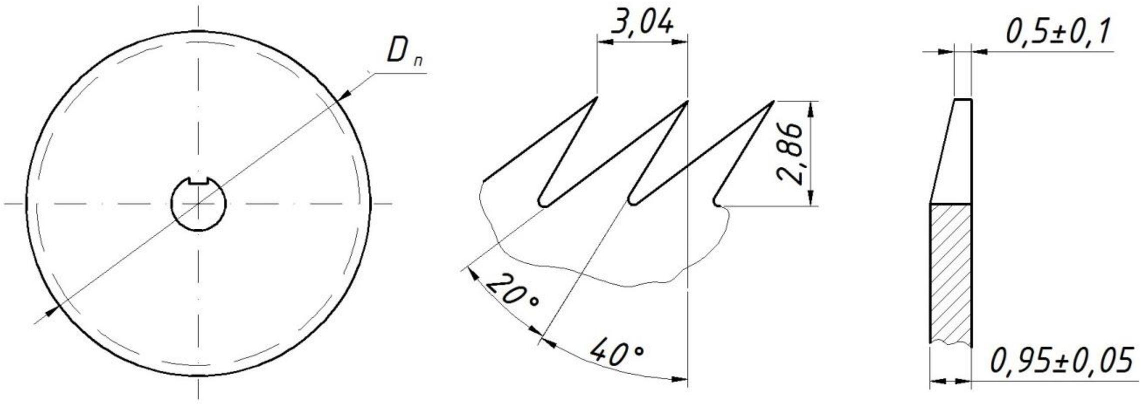
Keywords: saw blade, abrasive blasting, fiber separation, roughness, pressure, angle of attack, fiber.

Introduction. Hardening treatment is used to improve the quality of working surfaces of machine parts. Abrasive blasting is used if the workpiece has low rigidity, a complex profile with many transition surfaces and hard-to-reach places, small thickness, sharp edges, etc. For effective use in finishing processing, including processing by surface-plastic deformation, it is important to calculate and determine the main indicators of the quality of the processed surface. Based on the calculated quality indicators (residual stresses, depth and degree of hardening, roughness) of the surface layer of the machined part, provided that they are within the range of acceptable values obtained experimentally, it is possible to predict the performance and durability of machine components.

The operational properties of machine parts significantly depend on the state of the surface layer [1, 2]. The parameters of the friction process, and therefore the wear process, are largely determined by the roughness parameters of the mating surfaces, and therefore depend on the heights and shapes of the irregularities of the contacting surfaces, as well as on the direction of micro-irregularities (marks) formed as a result of processing. The roughness parameters of mating surfaces affect the mating accuracy, which is determined by the gap. The strength of press joints also depends on roughness, which decreases with increasing height of irregularities. Of particular importance is the surface roughness of parts operating under conditions of cyclic and alternating loads, it affects the fatigue strength of the part, since cavities of irregularities and risks are stress concentrators and can become sources of submicroscopic discontinuities in the surface layer as a result of the occurrence of stresses that do not even exceed the tensile strength metal. This leads to the formation of fatigue microcracks that can develop into a main crack, which will cause the destruction of the part.

Surface roughness and microrelief parameters such as the direction of scratches, the shape and pitch of irregularities, the dimensions of the supporting surface, determine the performance properties of machine parts: impact strength, contact rigidity, corrosion resistance, heat transfer coefficient, etc.

Machines used in the cotton processing industry are subject to special requirements for the roughness of the surfaces of the working parts. In fiber separation machines (gins and linters), the working body is a saw cylinder, consisting of disks with a diameter of 320 mm and a thickness of 0.95 mm (Fig. 1, a) and made of carbon tool steel U8G (tensile strength $\sigma = 1150$ N/mm^2 , hardness 67÷70 HRA, relative elongation $\delta = 6\%$) by cold cutting of teeth (Fig. 1, b) on a special sawing machine [3].



a) b)

Fig. 1. Linter saw with diameter Dn (a) and tooth profile with dimensions of geometric parameters (b)

The main operation of processing raw cotton, consisting of seeds and fibers covering the seeds, is fiber separation. The first stage of fiber separation is carried out in gins (the process is called ginning), where mechanical separation (separation) of fiber occurs in the working chamber as a result of the action of the teeth of saw blades on raw cotton, which, together with the inter-saw spacers, constitute the working body of the machine, i.e. the saw cylinder.

The operational properties of critical machine parts that make up the working element of technological machines largely depend on the condition of their surface layers. The condition of the surface layer of machine parts is assessed using quality parameters that are subdivided into geometric and physical-mechanical.

As a result of mechanical processing of machine parts, the physical and mechanical state of their surface layers (microhardness, residual stresses, dislocation density) changes significantly. The quantitative and qualitative picture of the change in the state of the surface layer of parts depends on many factors, but, above all, on the ratio of the force and temperature components of the mechanical processing process. If the force factor prevails, the consequence is strain hardening (work hardening - an increase in microhardness), compressive residual stresses. With the predominance of the temperature factor, the processed surface layer is characterized by softening (decrease in microhardness), the formation of tensile residual stresses that initiate the appearance of microcracks and, accordingly, a decrease in the durability and fatigue strength of machine parts.

Abrasive blasting of the side surfaces of the teeth of linter saws consists of the process of microcutting (scratching), which occurs when an abrasive particle hits the surface at a certain angle. Since microcutting is carried out due to plastic deformation of the contact layers of metal, the effect of strain hardening should be expected, i.e. an increase in microhardness in a thin surface layer. Hardening is also facilitated by the impact nature of the contact interaction of an abrasive particle made of black silicon carbide with the surface of the tooth of the saw blade.

Microhardness tests are carried out in cases where, according to technical specifications, it is impossible to measure hardness using macromethods. They are recommended for determining the microhardness of individual structural components of alloys; thin surface layers, coatings, thin sheet materials; for determining the heterogeneity of microhardness in individual sections of parts, for testing small parts and microsamples.

Microhardness tests differ from conventional hardness measurements by the magnitude of the indentation loads and, accordingly, the small size of the imprint (the diagonal of the imprint d is measured in μm). The depth of the imprint h depends on the shape of the indenter – the hard tip. In the practice of microhardness measurements, the most widely used is a diamond square pyramid with an angle at the top of 136^0, which gives an imprint of depth h=d/7.

Methods. The working surfaces of the saw blade teeth that come into force contact with the raw material roller formed in the chamber must have a roughness of at least 1.25÷0.63 microns. With a rougher surface, when separated from the seeds, the fibers can receive mechanical damage in the form of microscopic cuts, which sharply worsen the spinning properties of the fiber.

The second stage of fiber separation - linting (linter is a fibrous material 6 mm or more long, remaining on cotton seeds after ginning) is characterized by the fact that the mechanical method of removing linters from cotton seeds consists of scraping and cutting the fibers with the top of the teeth and their edges on the front and side surfaces. In linters, the number of saw blades reaches up to 160, and in gins, depending on the design, 90 and 130. The durability of saw blades and the condition of the teeth determine the performance of gins and linters, as well as the quality of the resulting cotton fibers, linters and seeds.

Considering the value of lint as a raw material and its great demand in various industries (textile, chemical, printing, etc.), intensification of the linting process remains relevant. The efficiency of this process can be increased by ensuring the participation of the side surfaces of the teeth in the general process of scraping the linters, i.e., activating the side surfaces of the saw teeth by creating an appropriate microrelief on their working surfaces, which, at a certain height and pitch of irregularities, will ensure the capture of the remaining short fibers on the seeds at rotation of the saw blades relative to the formed seed roller.

To increase the capture of short fibers by the side surfaces of the teeth of the saw blades, abrasive blasting was performed to form a microrelief. In view of the widespread use of this type of processing in various industries, abrasive blasting chambers have been developed that have a multifunctional purpose: surface cleaning, deburring and rust removal, polishing, obtaining the required roughness, strain hardening.

The experiments were carried out in an experimental abrasive blast chamber (ASC) installed in the mechanical workshop of GAUCH LLC (NPO Tekhnolog).

Technical characteristics of ASK

Overall dimensions of the working area, mm. . . . . 1070×1350×1100
Working pressure, MPa. . . . . 0.2÷0.4
Compressed air consumption, m3/min. . . . . 0.6÷1.5
Abrasive hopper volume, l. 50
Transporting the abrasive to the nozzle. . . . . .Ejector
Productivity, m2/h. . . . . 5÷20

The effectiveness of this treatment can be adjusted by changing the operating pressure and the size of the abrasive particles, as well as by the correct choice of abrasive material. The air-abrasive mixture is supplied under pressure to a rigidly fixed part. Small abrasive particles accelerated by air flow perform micro-cutting. By changing the angle of attack α of abrasive particles, it is possible to process even hard-to-reach areas of the workpiece, which improves the quality of processing of non-rigid parts with complex configurations.

Black silicon carbide (BC) with a grain size of 40 was chosen as the abrasive material, since this material has high cutting ability and is the most common and accessible in industry. According to GOST, the main fraction is

45%, which corresponds to the grain size range of 200÷12. This abrasive is classified as grinding grain. The experiments were performed at processing modes: p = 0.1÷0.4 MPa, α = 15÷60°.

To determine the dependence of the roughness parameter of the machined surface of linter saw teeth on the processing mode, experimental studies were carried out using the mathematical method of experiment planning [4].

Results and discussion. Pressure p and angle α of attack of the abrasive are taken as input parameters (factors). The processing time was constant t = 2 min. The output parameter is the height H of the roughness of the treated surface. The choice of the experimental area, i.e. the levels and intervals of variation of the studied parameters (table) was made based on the results of preliminary studies of abrasive blasting and analysis of a priori information.

Factor (designation)	Step variations	Level (designation)		
		upper (+1)	basic (0)	lower (-1)
p (x_1)	0,1	0,4	0,3	0,2
α (x_2)	15	45	30	15

As a result of processing the experimental data, a regression equation with coded variables was obtained:

$$y = 1{,}85 + 0{,}15x_1 + 0{,}3x_2 + 0{,}25x_1x_2. \quad (1)$$

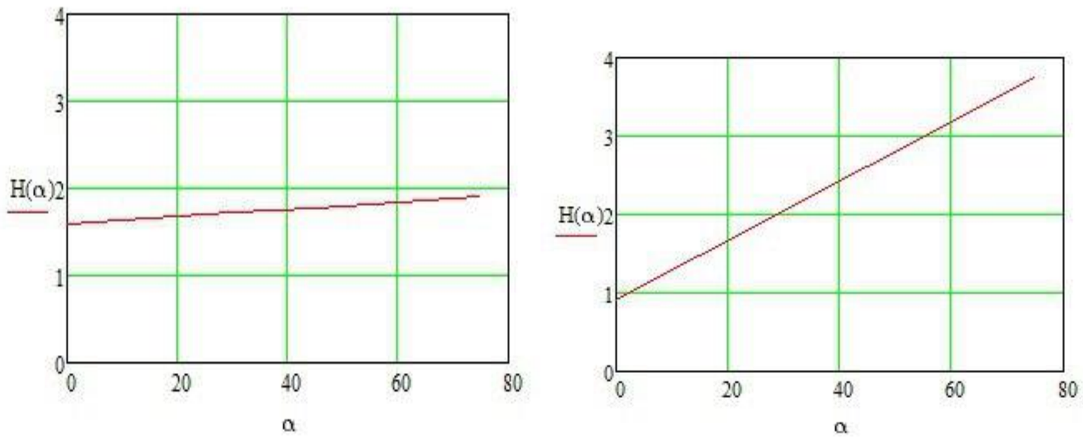
According to the resulting model, the output parameter y increases with increasing factors x_1 and x_2. The statistical significance of the coefficients of the regression equation (1) is confirmed by comparing the absolute value of the coefficients with the confidence interval in accordance with the Student's test. Testing the hypothesis of model adequacy using the Fisher F test indicates that the linear model represented by equation (1) is adequate.

Moving from the coded values of the factors x_1 and x_2 to the natural values p and α, we obtain the dependence of the indicator H on the pressure p and angle α:

$$H = 2{,}3 - 0{,}35p - 0{,}03\alpha + 0{,}017p\alpha. \quad (2)$$

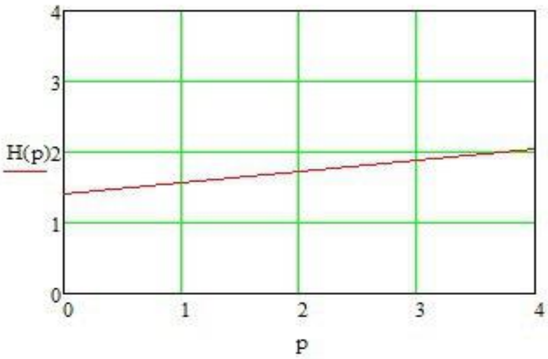
Equation (2) can be used as an interpolation formula to determine the height H of the surface roughness of linter saw teeth after abrasive processing.

In Figures 2 and 3 show the calculated dependences of the parameter H on pressure p and angle α during abrasive processing of the side surfaces of saw teeth.

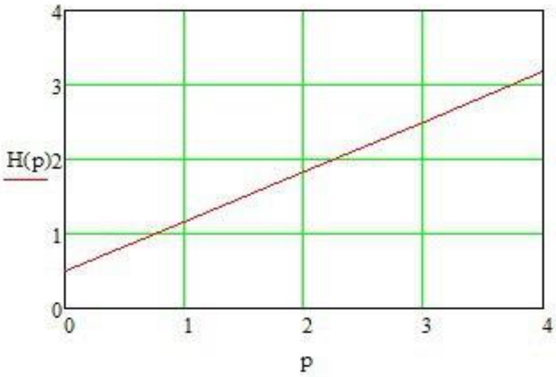


a) b)

Fig. 2. Dependence of the unevenness height H on the angle of attack α during abrasive blasting of the teeth of saw blades for linters:
a) air pressure p=2 atm; b) air pressure p=4 atm



a)



b)

Fig. 3. Dependence of the unevenness height H on air pressure p during abrasive blasting of linter saw teeth: a) angle of attack $\alpha=30^0$; b) angle of attack $\alpha=60^0$

The parameter H increases significantly (from 1.84 to 3.18 μm) when the pressure p changes from 0.2 to 0.4 MPa at α = 60° (see Fig. 3). At α = 30° the parameter H changes less (from 1.72 to 2.04 μm).

A similar pattern of changes in the height H of irregularities is observed when the angle α changes (see Fig. 2). When the angle α changes from 30 to 75°, the height of the irregularities at p = 0.2 MPa increases slightly (from 1.72 to 1.9 μm). With increasing pressure p, the height of the irregularities increases to 3.75 μm. Thus, the height H of the roughness of the treated surface increases as a result of an increase in the contact effect of the abrasive particle on the metal surface.

To improve the efficiency of saws, it is necessary to increase the height of the roughness of the treated surface. It is also important to form a surface topography with a significant step of irregularities so that several cotton fibers can be placed between them, which, as a result of rotation of the saw blade, will come off the seeds.

Experimental studies have found the optimal angle of attack of an abrasive jet α = 45° when processing articles with a hardness of 180÷575 HB and, in particular, for steels U7, U10 and U8G (67÷70 HRA).

However, diffraction methods based on the diffraction of X-rays, electrons and neutrons have their own characteristics, which are due to the type of radiation and the differences in its interaction with matter. Thus, the actual penetration depth of X-rays (wavelength 4·10-6 - 5·10-6 cm) depending on the wavelength, chemical composition of the material and geometric conditions of shooting is about 1…10 μm. The use of neutron rays, which have a very high penetrating ability (usually 1…10 μm), for diffraction research of the surface layer is impractical.

Depending on the method of recording the diffraction pattern, a distinction is made between X-ray structural analysis units for photographic recording and diffractometers for recording using X-ray quantum counters.

X-ray structural analysis is being widely introduced into the mechanical engineering industry and, thanks to penetrating radiation, allows one to determine the degree of perfection of crystals, their preferred orientation, and study in detail the structural changes that occur in steels and alloys during their thermal and mechanical processing, as well as during the operation of machine parts.

The structure of the treated surfaces was studied in the laboratory of the Institute of Chemistry and Physics of Polymers of the Academy of Sciences of the Republic of Uzbekistan using an Agilient-5500 scanning probe microscope [6, 7].

Atomic force microscopy (AFM) is a type of probe microscopy based on the force interaction of atoms. At distances of about one angstrom between the sample atoms and the probe (cantilever) atom (from the English cantilever - console) repulsive forces arise, and at greater distances - attractive forces.

Special probe sensors – cantilevers are an elastic console (elastic micro-beam) with a sharp probe at the end (Fig. 4).

Elastic V- or I-shaped cantilevers are made mainly from thin layers of doped silicon SiO_2 or Si_3N_4 by photolithography and etching from silicon wafers. One end of the cantilever (Fig. 4) is rigidly fixed to a silicon base - holder. At the other end of the cantilever there is the probe itself in the form of a sharp needle. The radius of curvature in modern AFM probes is 1 ... 5 nm depending on the type of probes and the technology of their manufacture. Obviously, with a decrease in the radius of curvature of the tip of the needle, the microscope allows obtaining images with higher resolution. The angle at the top of the probe (needle) also affects the image quality and in different cantilevers varies within 10 ... 200. Cantilevers have an elastic constant k = 0.03 ... 1 N / m. The force F acting on the probe from the surface under study leads to bending x of the cantilever and is determined by Hooke's law:

$$F = -kx, \quad (3)$$

where k is the cantilever stiffness (elastic constant).

The bending value is usually recorded using an optical system (Fig. 4) consisting of a semiconductor laser and a four-section (square) photodiode. The AFM optical system is adjusted so that the laser radiation is focused on the end of the cantilever, and the reflected beam hits the center of the photodetector. Under the action of contact forces, the cantilever bends and the laser beam reflected from it shifts relative to the center of the photodetector. Consequently, the cantilever deflection can be determined by the relative change in the illumination of the upper and lower halves of the photodetector. In this work, silicon cantilevers with a stiffness of 9.5 N/m^2 with a frequency of 145 kHz were used. The maximum scanning area on the atomic force microscope in X and Y is 5x5 μm^2, in Z – 1 µm..

Fig. 4 show the probe sensor device and the structural diagram of the atomic force microscope, respectively. A special piezoelectric scanning device moves the control sample under the needle (probe) or the needle over the sample in a raster pattern.

In Figure 4 shows a diagram of a probe sensor. A piezoelectric scanning device moves the sample under study under the probe.

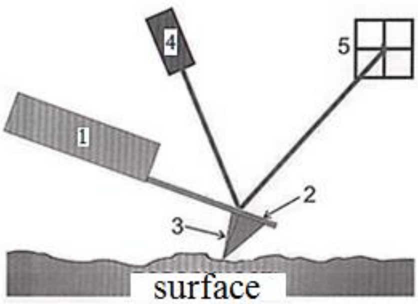


Fig. 4. Atomic force microscope probe sensor:
1 – chip (base); 2 – beam; 3 – probe; 4 – laser detection system; 5 – photodiode; 6 – surface layer of the processed part

The detection system includes a laser and a photodiode. The feedback system controls the vertical movement of the scanning device. Computer control of the movement of the scanning device, collection, visualization and analysis of experimental data are provided. The advantages of this equipment: high resolution, accurate reproduction of the surface profile, visualization of the result on the monitor.

We examined samples (Fig. 5) cut from a saw blade.

Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 47 No. 01 (2026)

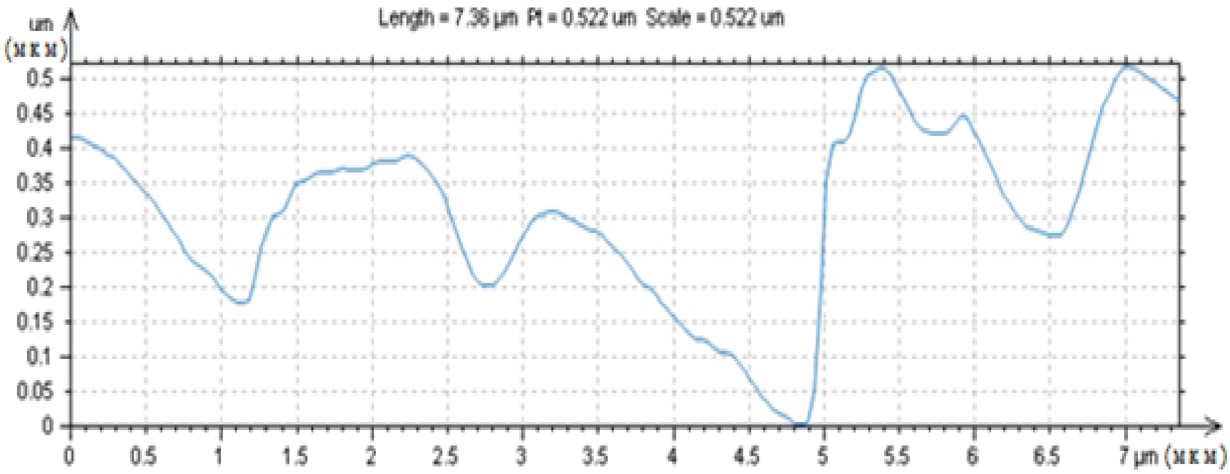
Fig. 5. Sample for atomic force microscopy from a saw blade after abrasive treatment

This is explained by the fact that when constructing a microprofile using a needle probe, depending on its radius of curvature and the place of contact, under-probing or missing of the controlled surface area may occur, which does not happen with X-ray diffraction microscopy. Therefore, profilograms obtained by the latter method more realistically display the actual surface with its microroughness.

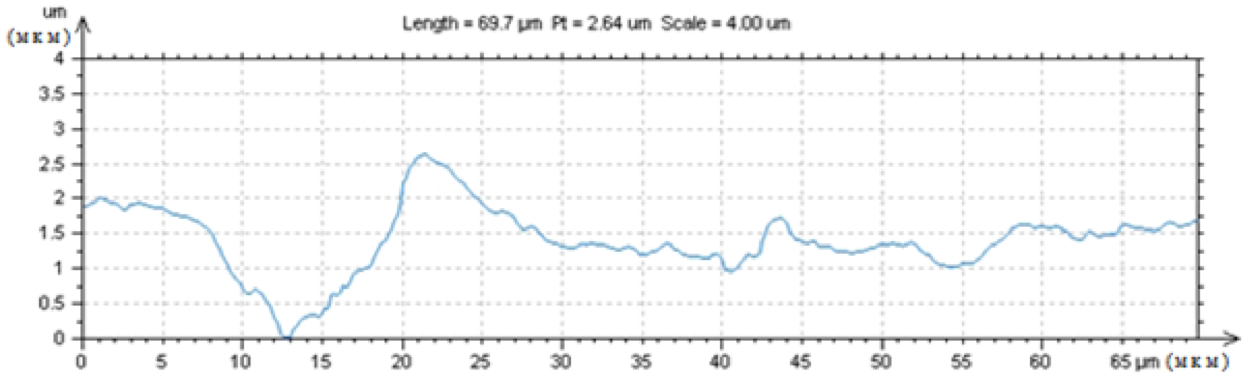
However, in mechanical engineering practice, the applied standardized parameters of surface roughness (three height, two step and one structural), obtained on profilometers-profilographs, are sufficiently informative and necessary for solving many technological problems: studying the wear process and predicting the degree of wear of contact surfaces of parts; the effect of roughness on the fatigue strength of machine parts; ensuring the strength and accuracy of centering of a cylindrical connection depending on surface irregularities; the effect of surface irregularities on corrosion resistance, contact rigidity, vibration resistance, etc.

In Fig. 6, a shows the microprofile of the lateral untreated surface of the teeth. The maximum height of the unevenness was H = 0.143 µm, the average step of the unevenness along the vertices was S = 9 µm. Such a surface during linting does not provide additional cutting of the remaining fibers, since local contacts are not commensurate with the transverse size of the cotton fibers (calculated fiber diameter d = 11.3÷17.7 µm), i.e. the fiber diameters are greater than the pitch of irregularities on the tooth surface saws (S/d < 1).

In Fig. 6, b shows the microprofile of the processed saw surface. The maximum height of irregularities was 2.68 µm, which is an order of magnitude greater than the H parameter for an untreated saw. But the main result of processing the teeth of linter saws is a significant pitch of irregularities (S > 20 µm), which is comparable to the diameter of cotton fibers, i.e. S/d > 1. At least two fibers can be located and held between the irregularities.



a)



b)

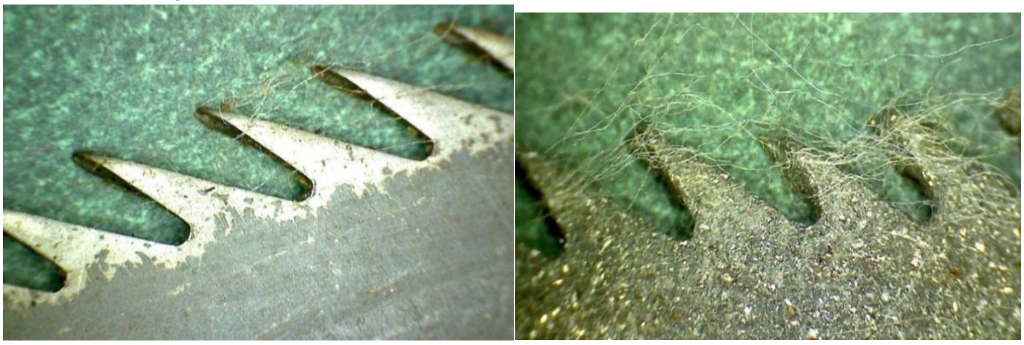
Fig. 6. Parameters of the profiles of the side surfaces of saw teeth without treatment *(a)* and after abrasive treatment at p = 0.3 MPa and α = 45° *(b)*

Depending on the ratio of the linear density T and the density δ of the cotton fiber for the given ranges of their values, the calculated fiber diameter is in the range of 11.3 ... 17.7 μm. If we compare the values of the average step along the peaks of the irregularities and the fiber diameter, we can note that at least two fibers are placed in the space between the irregularities. Getting into the space between the irregularities and being held in it due to the irregularities during the continuous rotational movement of the saw blade, there is a high probability of cutting the fibers. The next fibers of cotton seeds get into the vacated space and the cutting process is repeated.

Thus, abrasive blasting of the teeth of saw blades for linters creates good prerequisites for enhancing the gripping ability of the fibers by the irregularities formed and their subsequent cutting. This is proven by the photo in Fig. 7, which shows the fixation and concentration of fibers on the teeth of linter saws after local and single lapping with a mass of cotton seeds.

On untreated teeth (Fig. 7,a), the fibers, as expected, are concentrated mainly on the tooth tip. On teeth after abrasive blasting (Fig. 7,b), a large number of fibers are fixed on the side surfaces, which convincingly confirms the fact of activation of these surfaces by the formed irregularities of the tooth microprofile.

In Fig. 7, a, b show fragments of saw blades with untreated and treated teeth with cotton fibers.



a) *b*)

Fig. 7. Gripping with saw blades with untreated teeth *(a)* and abrasive teeth *(b)*

Thus, processing saw blades with black silicon carbide abrasive creates the required relief on the side surfaces.

Conclusion. Taking into account the unity of the nature and mechanism of impact contact interaction of solids in the process of abrasive blasting and wear of steels and alloys in the air flow of abrasive particles, their angle of attack α = 45^0 was selected, ensuring maximum absolute wear of normalized carbon tool steels.

Using the method of mathematical planning of an experiment, a regression equation was obtained for the height of the unevenness with coded variables $y = 1{,}85 + 0{,}15x_1 + 0{,}3x_2 + 0{,}25x_1x_2$, which, after testing the hypothesis of the adequacy of the model, was transformed by transferring the coded values of factors x_1 and x_2 to natural values (p – air pressure; α – angle of attack): H=2.3-0.35p-0.031α+0.017pα, μm

Using the obtained equation of the roughness height as an interpolation formula, the values of H were calculated for different abrasive blasting modes and the corresponding graphical dependencies were obtained. Thus, the intensity of the roughness height growth H from the attack angle α significantly depends on the compressed air pressure: at p = 2 atm, H = 1.72 ... 1.9 μm (an increase of 10.5%); at p = 4 atm, H = 2.04 ... 3.75 μm (an increase of 83.8%). A similar pattern was revealed for the dependence of the roughness height H on the pressure p: at $\alpha = 30^0$, H = 1.72 ... 2.04 μm (an increase of 18.6%); at $\alpha = 60^0$, H = 1.84 ... 3.18 μm (72.8%).

The method of atomic force microscopy was used to study the scanned profiles of the side surface of the teeth and it was found that for saw blades without processing the maximum height of the unevenness is equal to H=0.143 μm, and the average step of the micro-irregularities along the vertices does not exceed S=8…9 μm at a scanning length of 49.8 μm. At a scanning length of 7.36 μm, the specified parameters take the values H=0.132…0.522 μm, S=1…2.5 μm, respectively.

Within the same scanning lengths of 49.8 and 69.7 μm, the microprofile of the teeth after abrasive blasting is characterized by maximum values of the roughness height, respectively, equal to 2.68 and 2.64 μm (an order of magnitude greater than untreated teeth), and the roughness step along the tops is more than 20 μm, thereby creating sufficient conditions for intensifying the lintering process by activating the side surfaces of the teeth.

A technological condition (S≥ndp) was developed to activate the side surfaces of the teeth due to additional cutting of short fibers from the seeds by the microprofile irregularities formed during abrasive blasting. It was experimentally proven that on untreated saw blade teeth, the cut fibers from the seeds are mainly concentrated on the tooth top. On the teeth after abrasive blasting, a large number of fibers after their cutting are fixed on the side surfaces with the formed microroughnesses.

Since abrasive blasting is a finishing and strengthening type of mechanical treatment, in addition to forming a favorable surface microprofile, strain hardening of the surface layer of the teeth occurs. Experiments have shown that the microhardness Hμ measured by the "oblique cut" method on the PMT-3 device (microhardness meter) increased from Hμ=4020 to Hμ=4420 MPa, and the degree of work hardening was U=12.9…24.2%, the work hardening depth increased from h=0.13 to h=0.162 mm, the work hardening gradient was in the range of U=99.23…149.38% with an increase in compressed air pressure from p=2 to p=4 atm.

Production tests have shown that the productivity of linting machines has increased by an average of 20% due to the intensification of the technological process.

References

1. **Sulima A.M., Shulov V.A., Yagodkin Yu.D.** Surface layer and operational properties of machine parts. M.: Mechanical Engineering, 1988. 240 p.
2. **Suslov A.G**. Quality of the surface layer of machine parts. M.: Mechanical Engineering, 2000. 320 p.
3. **Maksudov I. T., Nuraliev A. N.** Handbook on primary processing of cotton. Tashkent: Mekhnat, 1995. 395 p.
4. **Spiridonov A. A.** Planning an experiment in the study of technological processes. M.: Mechanical Engineering, 1981.

   184 p.

5. **Vinogradov V. N., Sorokin G. M., Kolokolnikov M. G.** Abrasive wear. M.: Mechanical Engineering, 1990. 224 p.
6. **Nagornov Yu. S., Yasnikov I. S., Tyurkov M. N.** Methods for studying surfaces using atomic force and electron microscopy. Tolyatti: TSU, 2012. 58 p.
7. **Shodmonkulov Z. A., Shin I. G.** Atomic force microscopy of the surfaces of linter saw teeth after abrasive blasting // Scientific-practical. conf. "Current problems of innovative technologies in cotton ginning, textile, light industry, printing production in the conditions of integration of science, education, production and their solutions." 2019, May. Tashkent. 2019. pp. 138–141.

---

8. **Shodmonkulov Zohir Abdurakhimovich, Shin Illorion Georgievich, Iskandarova Nigora Kurvanbekovna,**
Akhmedhodjaev Hamid Tursunovich Investigation of the height parameter of roughness by the method of
mathematical planning of the experiment during abrasive blasting of saw blades // ISSN 2181-8622 Scientific and
technical journal of NamIET SCIENTIFIC AND TECHNICAL JOURNAL OF NAMANGAN INSTITUTE OF
ENGINEERING AND TECHNOLOGY VOL 5 – Issue (3) 2020 Pg.92-99.
9. **Illarion Shin, Zokhir Shodmonqulov, Sakhrobjon Nazarov and Nigora Iskandarova** Processing of teeth of saw
blades of cotton processing machines with a stream of compressed air with abrasive particles // E3S Web of Conferences 304, 03033 (2021) https://doi.org/10.1051/e3sconf/202130403033 ICECAE 2021.
10. **Ortikov Oybek, Shodmonkulov Zokhir, Shin Illarion, Shakhnoza Nurbekova** Abrasive blasting of the teeth of
linter saws with the aim of their activation // https://www.researchgate.net/publication/361390675), ISCMMSTIAI–
2022, Tashkent, Conference Paper, June 2022 c.337-344
https://www.scopus.com/authid/detail.uri?authorId=58258722500
11. **Shodmonkulov Zokhir, Ortikov Oybek, Karimbayev Djasurbek, Muminova Nargiza** Simulation of a single
interaction of an abrasive particle with the surface of a part during blasting // https: // www. researchgate. net/publication /361390675), ISCMMSTIAI–2022, Tashkent, Conference Paper, June 2022 c.345-350
https://www.scopus.com/authid/detail.uri?authorId=58258722500