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# Physical Essence and Process of Laser Hardening of Circular Saw of a Saw Cylinder

**Akbar Abrorov, MasturaGapparova, Azamat Temirov, NodiraMirzakulova.**

Senior lecturer of department "Technological machines and equipment" , Bukhara Engineering and Technology Institute, Bukhara, Uzbekistan
Assistant teacher of department "Technological machines and equipment" , Bukhara Engineering and Technology Institute, Bukhara, Uzbekistan
Assistant teacher of department "Technological machines and equipment" , Bukhara Engineering and Technology Institute, Bukhara, Uzbekistan
Assistant teacher of department "Technological machines and equipment" , Bukhara Engineering and Technology Institute, Bukhara, Uzbekistan

**ABSTRACT.** In this paper, the reasons for reducing the reliability and durability of the saw cylinder Assembly, the choice of material of disc saws, the physical nature and process of laser hardening of the disc saw of fiber separation machines are given. Advantages and method of laser hardening of circular saw of fiber separating machines.

**KEYWORDS***:* laser hardening, steel, circular saw, heat treatment, reliability, fiber separation, cotton, saw cylinder.

## I.INTRODUCTION

Processing of raw cotton is carried out on technological machines and equipment, mainly manufactured in the United States, China and Uzbekistan. An important factor in ensuring the stability of the volume of growing the cotton crop and increasing the competitiveness of raw materials on the world market is to obtain high-quality cotton fiber.
Large-scale activities are being carried out in our Republic, and certain results have been obtained on the development of highly effective techniques and technologies for the primary processing of raw cotton, which ensure the production of high quality products. In this regard, we can note the development of techniques and technologies that ensure the preservation of the quality of produced cotton products at cotton gins, which make it possible to reduce the consumption of raw materials and energy.

In the world, the actual tasks are to create new samples of technology and technology of saw fiber separation and seeds from cotton flyers. The implementation of targeted scientific research on the development of high-performance designs main working bodies of technological machines of the cotton mills saw volunatarily machines, the development of methods of calculation parameters and modes of movement, allowing to achieve a significant increase in performance of cars at high humidity of raw cotton for producing high-quality cotton fiber, is considered one of the urgent problems of the industry [1-7].

At the moment, cotton processing plants operate serial fiber separation machines of the DP type, equipped with a saw cylinder Assembly with low reliability (Fig.1). It is known that the service life of the existing structures of the saw cylinder of fiber separation machines is only 48 hours, then it is necessary to sharpen the teeth, which creates a simple machine. The process of restoring the teeth of the saws is repeated twice for 96 hours, after which the life of the saws ends.

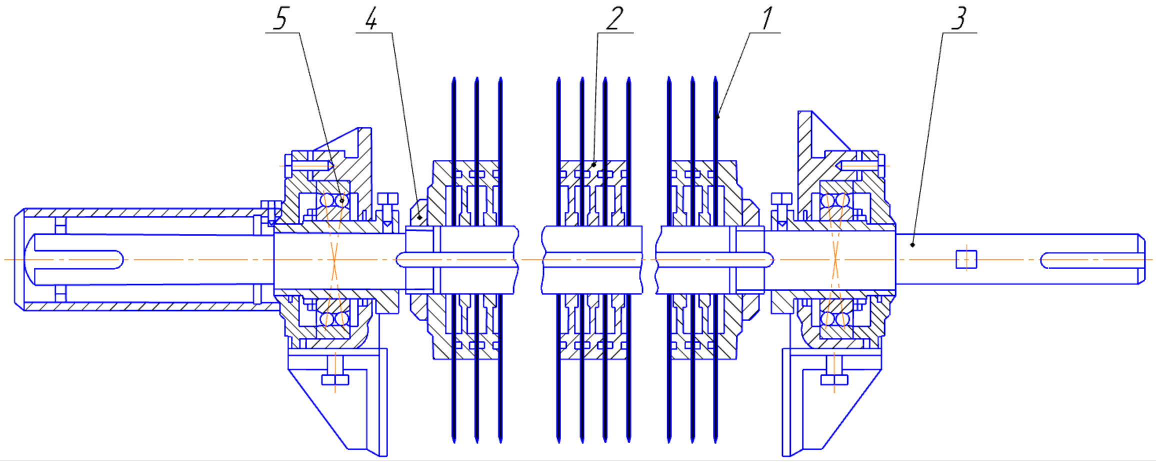


**Fig.1. Construction of the saw cylinder Assembly of the fiber separation machine.**
*1-disk saw; 2-gasket; 3-saw shaft; 4-nut; 5-node support saw cylinder.*

At present, cotton gin disc saws are made of cold-rolled steel U8G with a surface hardness of h=20 microns 374-388 HV 0.05 kgf/mm2 and at a depth of h=100-500 microns 438 HV 0.05 kgf/mm2, which corresponds to the structure of deformed perlite with a high degree of deformation.

When exposed to the metal surface, part of the laser radiation stream is reflected, the remaining part is absorbed. The energy of the absorbed laser radiation is converted into thermal energy, called effective thermal power.
The process of laser hardening of steel consists in heating the local surface layer at a speed of more than 102 -103 0S/s and cooling by the mechanism of thermal conductivity deep into the metal, without the use of cooling media. The cooling rate during laser quenching of steel depends on the intensity of the laser beam energy supply, the mass of the part, and can reach values of 103-104 0C/s. high-Speed cooling of the surface layer significantly exceeds the critical speed of quenching on martensite[8].

A multiple increase in the heating and cooling rate during laser quenching does not lead to the formation of new phases and structures. In laser thermal hardening, steel has the same phases and structures as in traditional furnace quenching: martensite, cementite (carbides), and residual austenite. However, the high rate of cooling leads to the fact that after cooling, more highly dispersed structures are formed, the resulting martensite is more dispersed than during normal quenching. For example, in u8g steel, after volumetric quenching, the length of martensite needles is 7-10 microns, and after laser quenching-only 2-3 microns.

All these features lead to the fact that the microhardness of the surface layer of steels after laser quenching is higher than after bulk types of quenching [9].

As a result of exposure to the laser beam, structural and phase changes occur in the surface layer, and a fine-grained quenching structure of increased hardness and wear resistance is formed, with high tribotechnical properties that are unattainable with traditional steel hardening technologies.

Grinding grains has a positive effect on the properties of steel, and, above all, it is possible to achieve the most optimal combination of strength and plasticity (Fig.2). Grain grinding has a particularly strong effect on increasing the creep resistance, since the grain boundaries effectively prevent the plastic flow of the metal at elevated temperatures.

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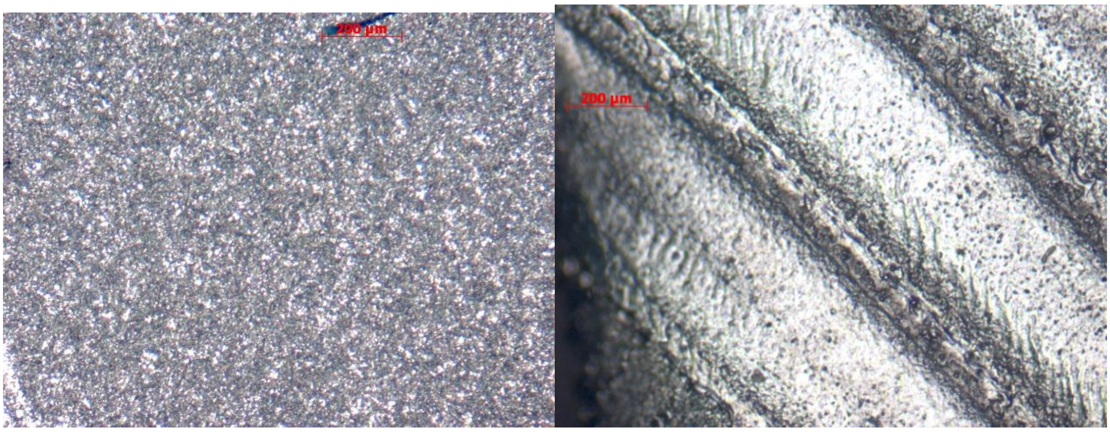


а) б)

**Fig.2. Fragments of u8g tool steel after laser quenching under a light microscope:**

*a) before the laser annealing b) after laser annealing*

The effect of laser thermal hardening depends on the initial heat treatment of steel, chemical composition and carbon content. Annealed and normalized steels have the smallest thermal influence zone. The greatest depth of the zone of thermal influence is observed on pre-hardened and low-or medium-tempered steels. In this case, the values of micro-hardness are aligned along the cross-section of the hardened layer. As the carbon content of steel increases, the depth of the hardened layer and the microhardness increase [10].

The essence of the method chosen by us for this work is that a highly concentrated energy source-a laser beam as a source of local thermal hardening (quenching) has significant technological and technical and economic advantages in comparison with traditional technologies of bulk or furnace thermal and chemical heat treatment.

Considering this method from a scientific point of view, laser surface hardening largely eliminates the disadvantages inherent in bulk thermal quenching, chemical-heat treatment, and at the same time opens up new potential technological opportunities in strengthening the surface layers of machine parts and mechanisms [11].

The modern level of development of laser technology and laser technologies allows us to consider lasers as a convenient, economical and reliable tool for surface thermal hardening of a wide range of machine parts.

The effect of the laser beam on the surface of steel leads to a complex improvement of physical, chemical, mechanical properties of the surface layer, which are manifested in a higher dispersion and isotropy of the structure of the hardened surface layer, increasing microhardness, heat resistance, corrosion resistance and wear resistance [12].

The advantages of laser quenching can be classified into several types: technological, energy, operational, environmental.

The method of laser thermal hardening (hardening) of surface layers has a number of technological advantages in comparison with traditional heat treatment technologies.

**Based on the above we can draw the following conclusion:**

1. After the laser hardening does not require technological operations of the home;
2. No or minimal residual deformations;
3. Keeping the geometric dimensions of the part within the tolerance field during laser quenching;
4. Increasing the hardness of the hardened layer;
5. Increased wear resistance;
6. Minimum heat input to the workpiece;
7. Local impact on the surface to be hardened;
8. No cooling fluids;
9. Easy to automate and robotize;
10. The duration of the thermal quenching cycle is reduced.

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