The Evaluation of Spinning Chambers of Pneumo-mechanical Spinning Machines

Sherzod Korabayev	PhD, Namangan Institute of Engineering and Technology, Namangan, Uzbekistan E-mail: sherzod.korabayev@gmail.com
Orif Alimov	PhD, Jizzakh Polytechnic Institute, Jizzakh, Uzbekistan
Guzal Jabborova	Student, Namangan Institute of Engineering and Technology, Namangan, Uzbekistan

ABSTRACT

In the article analysed the corrosion of the rotors of pneumomechanical spinning machines in industrial conditions.

Keywords: spinning machine, rotor, chamber, decay.

Introduction

The main component [1, 2] of every open-end spinning machine based on the chamber spinning process is the rotor as the most important element. According to the research of Stanisław Płonka, several years of observations of pneumomechanical spinning machines of type PW12 manufactured by BEFAMA (Poland) in industrial enterprises showed that the camera is the most durable element of the machine [3].

The internal surfaces of the chamber must have a low friction coefficient in contact with the thread, which mainly depends on the surface topography and the manufacturing method. It should not create a static charge and not electrostatically load the thread. It must be very resistant to the high velocity of the moving solid particles and the wear caused by the reaction of the thread and any accidental dynamic loads.

To fulfil the above conditions, it is necessary to use the appropriate materials, types of processing and methods that guarantee obtaining the correct surface layer from a technological and operational point of view. The material should have a low density, and high unit strength that provides small forces and moments of inertia. The dielectric properties of the thread, high wear resistance and low viscosity are also of great importance. At the same time, the production technology must guarantee to obtain such a surface structure that ensures high quality, low friction and proper wear resistance of the produced thread; resulting in increased efficiency and durability. Well-known manufacturers of pneumatic spinning machines produce chambers from special steel or aluminium alloys (Fig. 1).

Materials and methods

Figure 1. Chamber of the pneumatic spinning machine.

Steel chambers are subjected to a hardening operation or a layer of diamond or boron is applied to its inner surface. Aluminium alloy cameras use a diamond layer or diamond and nickel [2] layers.

Several years of observation of chambers in open spinning machines operating in industrial conditions have shown that mainly the inner surface of the chamber: the cone C and the collecting rod undergo a decay process (Fig. 1). Erosion testing of the chambers of open-ended spinning machines is limited only to the inner surfaces of the collecting trough, R_{cg}, because the intensity of erosion of these surfaces is several hundred times greater than the conical inner surface C of the chamber. Chambers made of aluminium alloys without a hard layer on their internal surfaces are subject to corrosion, as the chamber splits into two parts on the collector rod [4-10].

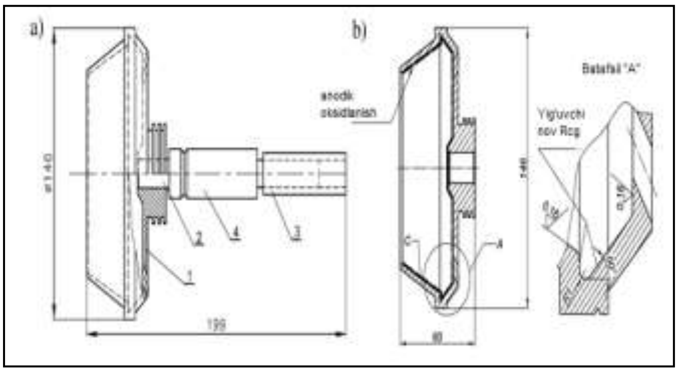

Figure 2. The chamber of the PW-12 open-end spinning machine: a) the complete chamber with the drive pulley of the belt and bearing: 1 – chamber, 2 – cylindrical needle, 3 – spindle cover (drive pulley), 4 – bearing SKF-18CN-AA 74077; b) a chamber with a defined profile of the collector shaft.

During the operation of the chamber spinning machine, a part of the solid impurities of the fibre tuft is deposited in the collecting tube of the chamber under the influence of centrifugal force (Fig. 3), which worsens the control of yarn formation and reduces the tenacity of the yarn. Rapid erosion of the chambers is caused by non-uniform thinning of the peripheral wall of the collecting rod (Fig. 3). This process creates "cracks" and, as a result, the cutting of the chamber cone (Fig. 3b). The geometric structure of the conical surface C undergoes significant changes.

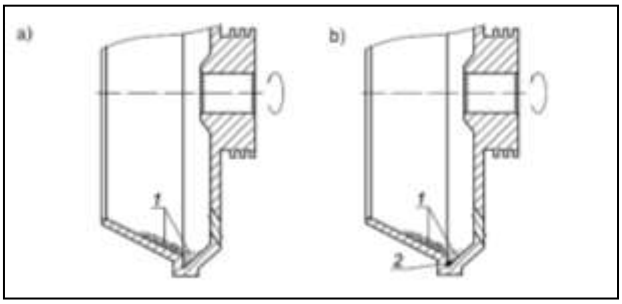

Figure 3. Impurities accumulated in the collecting tube of the camera: a) the camera at the beginning of work; b) the camera after the operation (some tens of hours); 1 - fibres, 2 - impurities.

Erosion occurs due to the process of opening the rod in the form of many cavities with a width of several micrometres to tens of micrometres. As a result, an eight-fold increase in the maximum surface peaks is accompanied by a five-fold increase in the maximum height of the surface topography. A long service life of up to about 6,000 operating hours causes significant material removal from the entire periphery of the chamber and, in critical cases, the formation of "cracks" in the collector tube. The operation of hard anodic oxidation leads to a significant increase in surface roughness. As a result of the initial period of the operation, the smoothing of the surface unevenness occurs.

Conclusion

The height of the unevenness of the oxide layer shows a clear increase. For example, there is a three-fold increase in the maximum surface peak height Sp and an approximately 1.88-fold increase in the height of the maximum surface topography St. The collecting beam of the cameras leads to a significant decrease in the decay intensity, which is reflected in the low intensity of the growth of the surface roughness. As a result, after about 9000 hours of operation, there is a total removal of about 50 mm thick oxide layer and about 60 µm thick substrate layer on the surface of about 260 to 310 mm along the periphery area of the entire chamber. At the periphery of the chamber, the decay in the form of a rod of variable width is not placed at the point of the largest internal diameter but slightly shifted to the conical surface bent at an angle of 50°. This is explained by the direction of the two generated forces, i.e. centrifugal, and they affect the moving thread and the impurity pressed on the surface of the collecting rod due to intensive wear.

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