SCIENTIFIC AND TECHNICAL JOURNAL
Namangan Institute of Engineering and Technology

«CARRYING OUT THEORETICAL STUDIES OF THE COTTON REGENATOR»

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Namangan Institute of Engineering and Technology

https://doi.org/10.5281/zenodo.7952007

ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 8
Issue 1
2023

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CARRYING OUT THEORETICAL STUDIES OF THE COTTON REGENATOR

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Abstract: In this paper, it was determined the strength of a newly installed slatted drum shaft by improving the design of the regenerator and conducting experiments on it. Based on the research, it was determined that the minimum value of the strength reserve coefficient is equal to 166, and it was concluded that this shaft fully meets the specified requirement for the device.

Keywords. Cotton raw material, impurities, regeneration, regenerator, colostrum grid, drum, drum shaft, planks, torque, weight

Introduction. In the technological processes of many cotton-ginning enterprises in the world, one of the main tasks is to clean cotton raw materials from various scalping, impurities based on highly efficient technological processes and at the same time preserve its natural properties. In the United States of America, Australia, China, India, and some Central Asian countries, special attention is being paid to the creation of efficient technologies for the cleaning of cotton raw materials, to increase the amount and efficiency of cotton fiber production, to create resource-saving technologies, to modernize technological processes, and to increase the competitiveness of the fiber. Many researchers are engaged in the cleaning of cotton raw materials from foreign impurities, the introduction of various innovative developments in technological processes, the application of technology and systems for mechanical and air cleaning of small and large impurities. One of the important tasks is to create an intensive automated system for cleaning cotton raw materials from various scalping, develop new methods and directions of cleaning technology, including increasing the number of cleanings in order to increase the cleaning efficiency of the machine. The analysis of the research conducted in this direction to solve the mentioned tasks confirms the relevance of the topic of this article.

Today, the increase of the amount of cotton pieces in the waste, which is separated from the technological equipment for cleaning cotton from large impurities in cotton ginning enterprises, causes them to disappear with the waste. In order to prevent this problem, 1RX cotton regenerator is installed in enterprises for each cleaning system [1-2].

One of the main disadvantages of existing regenerators in enterprises is the low productivity and cleaning efficiency of separated cotton pieces, and it was observed that waste and pieces of cotton passed between the columns as a result of hitting the columns when entering from the middle pipe of the waste cotton supply with air. Due to the extreme dirtiness of the cotton coming out of the regenerator, if it is mixed to the cotton coming to the cleaning system, the negative effect on the overall quality indicators of the received fiber will increase [3]. It is necessary to strengthen the cleaning of separated cottons in the regenerator, taking into account the need to bring the level of contamination to the same state in order to add the piece of cotton separated from the regenerator to the cotton in the flow.

Brushes are replaced several times in a season due to wear of the brushes of the separating brush drums of the 1RX cotton regenerator. In addition, wear varies between brushes, causing the brushes to become less efficient at removing cotton from sawing drum saws. Therefore, using a drum with a rubber plate instead of a brush drum to separate the cotton from the saw teeth is considered a solution to the problem of constantly changing the brushes. The separating drum of the 2RX-M cotton regenerator, developed by the "Pakhtasanoat Scientific Center" JSC, was made with a rubber plate, and this drum regenerator was introduced to the "Baghdod" cotton ginning enterprise in 2019 and has been used without repair until today. It was recommended to replace the separating brush drums of 1RX cotton regenerators with rubber-plate drums [4, 5]. Based on these recommendations, some changes were made to the construction of the unit to increase the efficiency of cleaning and separation of 1RX type cotton regenerators, which are used in cotton ginning enterprises. It was observed that the 1RX regenerator was fed from both ends of the waste cotton sawdust drum, and air was drawn from the middle, resulting in a reduction of cotton pieces in the waste. In this case, when the waste cotton is divided into two parts during its movement in the air duct, it is easier to

clean it by dividing it into small pieces towards the saw drum. Our next change is that the slats of the drum with the separator plate are installed at an oblique angle along the axis to the center of the drum, so that the cotton is removed from the saw tooth and directed towards the center and then relearning takes place. In order to reduce the amount of cotton pieces from the regeneration drum to the waste, the distance between the columns of the lower column grid is reduced [6].

In addition, it is necessary to determine the strength of the newly installed plate drum in order to improve the design of the regenerator and carry out experiments on it. The body providing this stability is considered to be the drum shaft, and in this work, the strength of this shaft was checked using a special program.

Calculation of cotton regenerator slatted drum shaft.

The slatted drum shaft in the improved RX regenerator is subjected to external loads due to high speeds. Inadequate strength and uniformity of plank drum details, as well as vibrations can lead to deterioration of the process of separating cotton from the saw drum, deterioration of cotton quality, and premature failure of the details without uniform bending. Therefore, it is very important to perform strength calculations of the drum shaft, plates, drum shell, flange (disc) and other parts [7-8].

Fig. 1 shows the planar drum shaft and the calculation scheme of the loads acting on it. External loads affecting the shaft include:

- Evenly distributed load acting on the shaft between the supports (we do not take into account the effect of the weight of the separated cotton, due to its smallness)

$$q_1 = \frac{G_{вал} + G_{гар} + G_{коб} + G_{пл.}}{l_0} \qquad (1),$$

here:

$G_{вал}$ – shaft weight between supports, kg;

$G_{гар}$ – weight of flanges, kg;

$G_{коб}$ – weight of shells, kg;

$G_{пл}$ – plank weight, kg;

- evenly distributed load on the cantilever part of the shaft q_2;
- pulley mass $G_{шк}$;
- torque of the electric motor $M_{бур}$

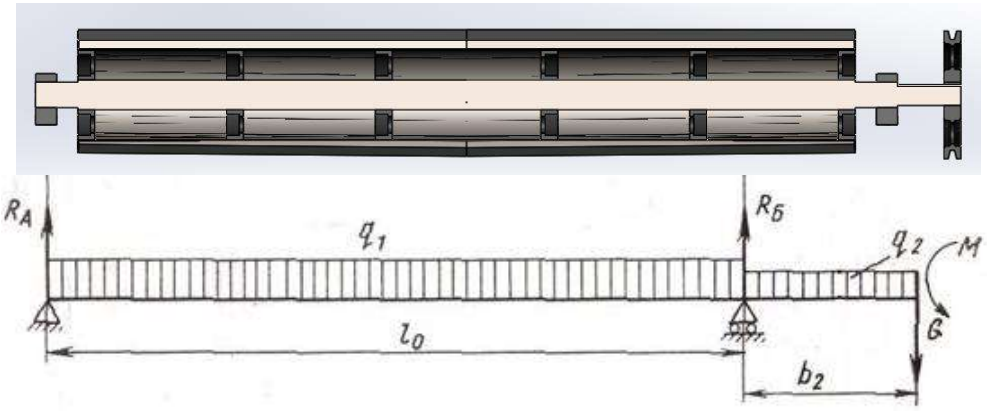


Figure 1. Calculation scheme of the loads acting on the shaft of the slatted drum

Torque acting on the slatted drum shaft $M_{бур}$

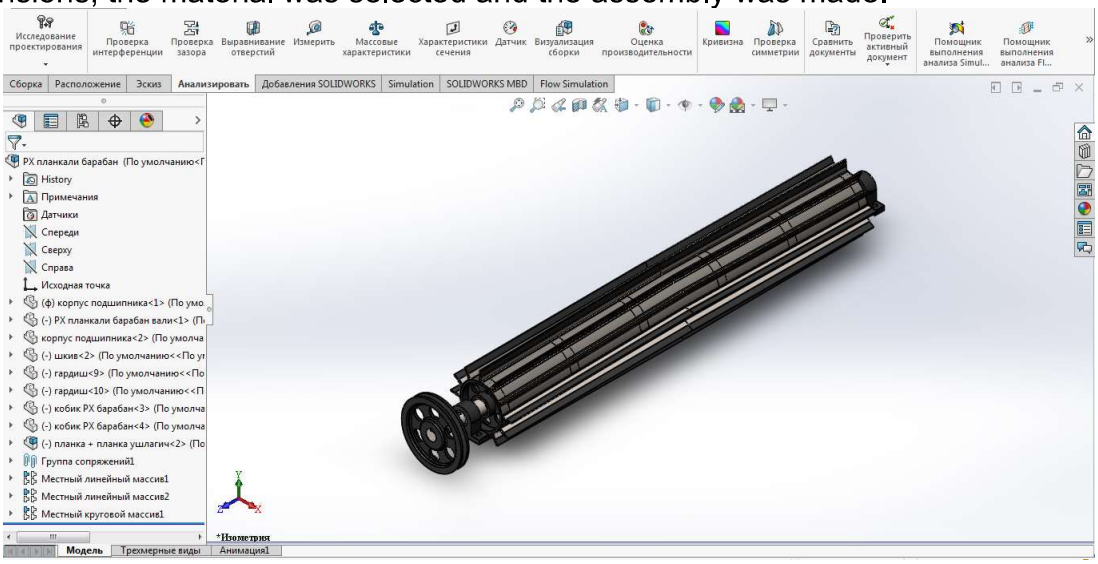
$$M_{бур} = 9550 \cdot \frac{N}{n} \qquad Nyuton \cdot m\,,$$

where: N – power transmitted to the flat drum ($N = 3{,}0\ kVt$);

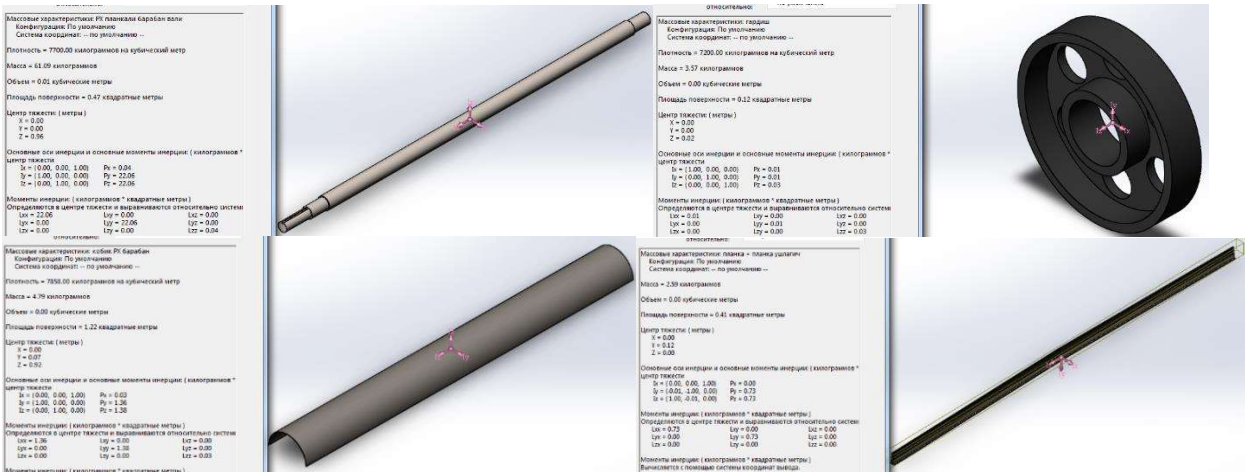
n – Rotational speed of the slatted drum ($n = 1000\ ayl/\min$).

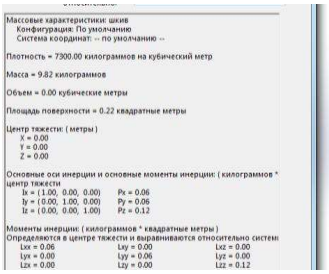
$$M_{бур} = 9550 \cdot \frac{3{,}0}{1000} = 28{,}65 \quad Nyuton \cdot m\,.$$

We use the Simulation package of the SolidWorks program for the calculation. For this purpose, the slatted drum was drawn separately in 3D according to the detailed dimensions, the material was selected and the assembly was made.



To find q_1 q_2, $G_{шк}$, we determined the mass of the details using the SolidWorks Analysis function, and found the mass using Mass characteristic.





That is, $G_{вал} = 61{,}09$ kg; $G_{гар} = 3{,}57 \times 6 = 21{,}42$ kg; $G_{коб} = 4{,}79 \times 2 = 9{,}58$ kg; $G_{пл} = 2{,}59 \times 12 = 31{,}08$ кг; $G_{шк} = 9{,}82$ кг; $q_2 = 2{,}21$ кг.*

We put the obtained values in equation (1).

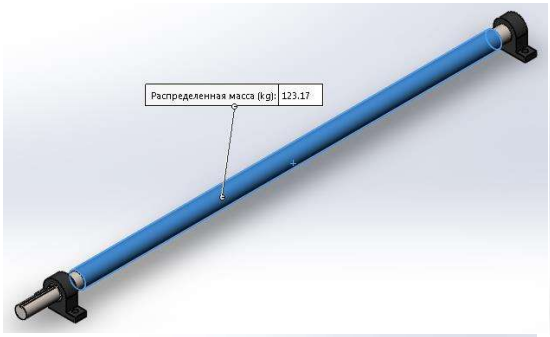
$q_1 = 61{,}09 + 21{,}42 + 9{,}58 + 31{,}08 = 123{,}17$ кг.*

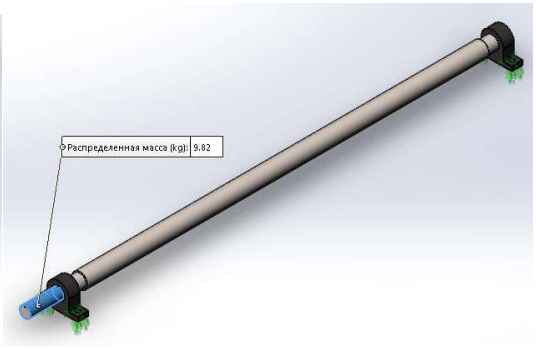
Note: the program itself calculates the equalty of distribution of weight to length.

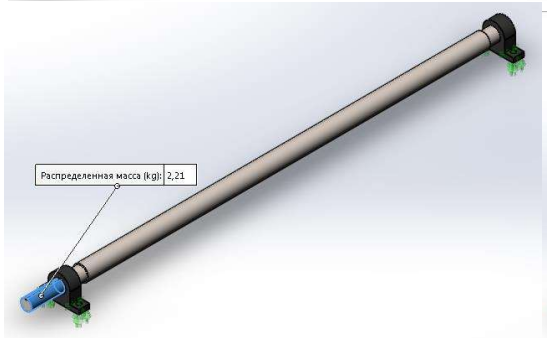
All the data for the static calculation of the slatted drum shaft are ready. To simplify the calculation, we use q_1 instead of the shaft between the supports, flanges, shells, plank, q_2 instead of the pulley base of the shaft, and $G_{шк}$ instead of the pulley.

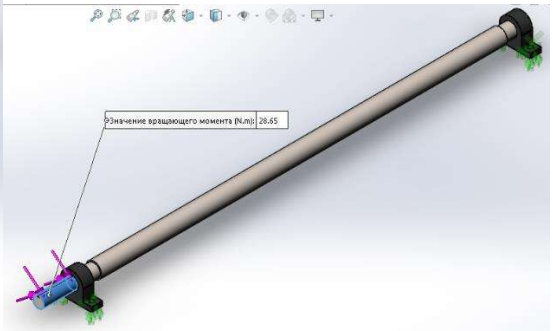
We select the working part of the shaft and select $q_1 = 123{,}17$ kg, the part of the pulley base of the shaft and we select $q_2 = 5{,}45$ kg, the part of the pulley base of the shaft and we select $G_{шк} = 9{,}82$ kg, the part of the pulley base of the shaft, and the torque we insert $M_{бур} = 28{,}65\ N \cdot m$. (2 picture).

To make the calculation more accurate, we also take into account the centrifugal force and write 1000 rpm (Figure 2).









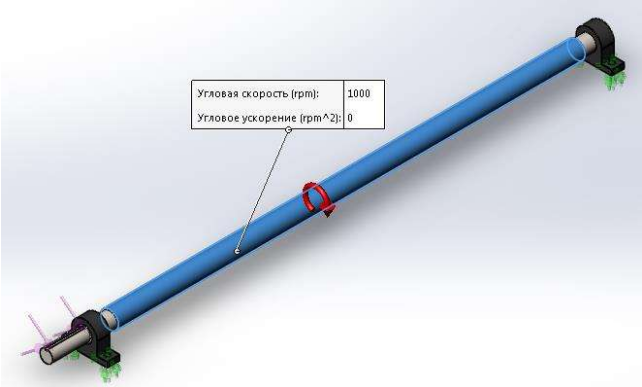
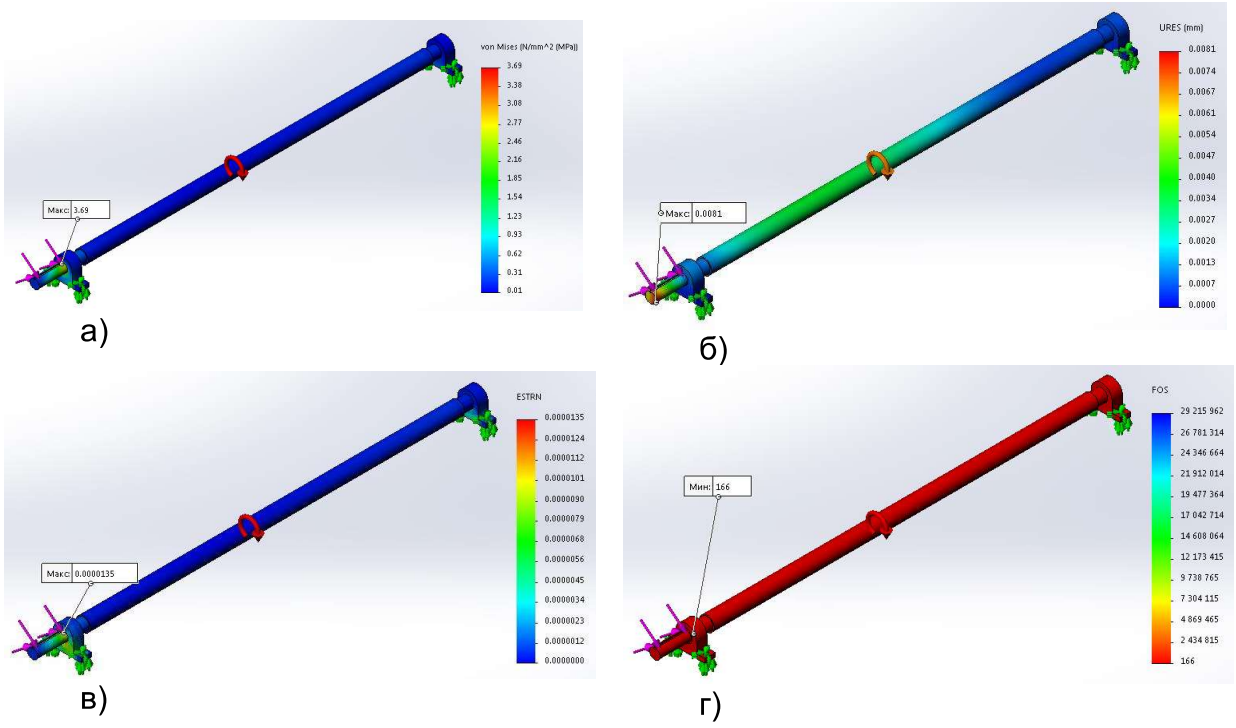


Figure 3 shows the obtained curves. So, the greatest stress in our shaft was ≈3.69 MPa and it occurred in the place painted in red (Fig. 3, a), the greatest displacement occurs in the cantilever part of the shaft and was 0.0081 mm (Fig. 3, b Fig.), the equivalent deformation of the shaft was 0.0000135 (Fig. 3, c) and the strength reserve factor was 166.



а) б) в) г)

Figure 3. Plank drum shaft epuratures

Concussion. As can be seen from Figure 3, the minimum value of the strength reserve factor is 166. For shafts, this coefficient should be $[k] \geq 1{,}5 \div 2{,}5$. So our shaft meets the demand.

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