International Journal of Advanced Science and Technology
Vol. 29, No. 8s, (2020), pp. 453-460

Improvement of the Construction and Justification of Parameters of the Fibrous Material Regenerator

Djuraev Anvar
Doctor of science, professor,
Department of Engineering and Service, Tashkent institute of textile and light industry
Kuliev Tokhir Mamarajapovich
Doctor of philosophy,
Director GeneralJSC "Pakhtasanoat Ilmiy Markazi" (Cotton Industry Science Center)
Tashkent, Uzbekistan

Abstract

The article presents the constructional scheme and operation principle of the fibrous material regenerator. Based on the numeral solution of the problem of the dynamics of regenerator machine units, taking into account the mechanical dynamic characteristics of the engine, inertia, elastic – dissipative properties of elastic gears, technological loads from the regenerated material, the laws of movement of working parts are obtained and their main parameters are justified. Based on the tests of the regenerator, high technological indicators of the machine were obtained.
Keywords: *fibrous material, regenerator, dynamics, machine unit, engine, belt drive, stiffness, dissipation, moment of inertia, load span, oscillation, law of motion, test , regeneration effect.*

Regeneration state of fibrous materials and its analysis.

In the process of cleaning fibrous materials from large litter, a significant amount of the cleaned fibrous material, in particular, raw cotton fiberglass, falls into the waste [1,2]. In the giving technology, the cotton fiberglass regenerator [3], containing a feeding pipe, saw drum, grates alternating with guides, removing the brush drum and trays. The most important drawback of this regenerator is the high content in the regenerated mass, also to the captured under-engineered fiberglass, seeds with strands of fiber and free fiber, as well as seeds with normal residual pubescence reaching 30%.The reason for this is the insufficient multiplicity and low efficiency of the impact of the grate on the seeds transported by the saw drum. Insufficient multiplicity of the impact of grate is due to the feeding of seeds to the saw drum only once, and the low efficiency of the impact is a result of the installation of guides between the grate grates, which help to catch fiberglass and seeds with strands of fiber, however, at the same time prevent the release of seeds with normal residual pubescence. A part from it, the low efficiency of grates for the excretion of seeds with normal pubescence is due to the fact that their parameters are optimized mainly for the trapping effect. Another disadvantage of the RNS regenerator is the low overall regenerative effect on volatiles, seeds with strands of fiber and free fiber - up to 31%, which is mainly due to the lack of an additional regenerative drum in the regenerator, as well as the supply of seeds to the saw drum in bulk.

Regenerator of fiberglass from impurities of raw cotton cleaners 1RX-M [4] contains several parts consisting of the front and back walls, sidewalls, a trough with trays and a cover of a semi-cylindrical shape, called a pneumatic feeder, with one input and two output holes. The main and regenerative gripping saw drums, fixing brushes and grates, removing the brush drum and the screw conveyor, which is sealed by the end protruding from the parts are located in the housing. This regenerator has a regenerative effect of up to 95%. Its main disadvantages are low cleaning effects: for large litter - up to 70%, small litter - up to 50%, uluk - up to 30% and limited productivity - up to 1 t/h.

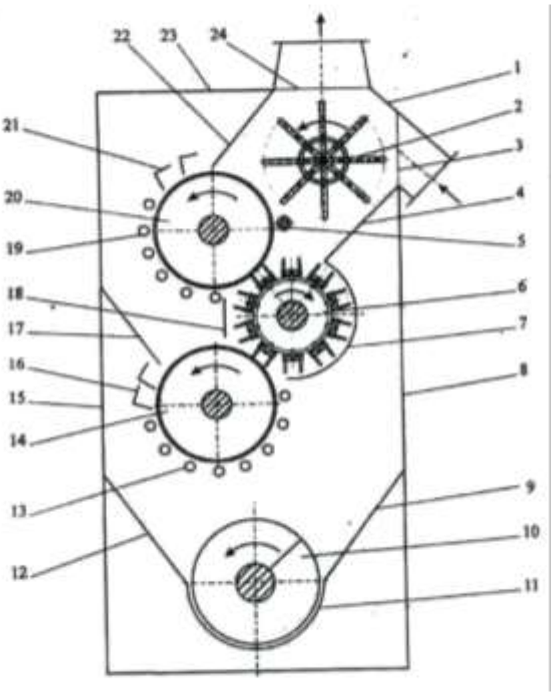
Low levels of cleaning effects are explained by insufficient multiplicity of cleaning of regenerated fiberglass, and for fine litter and uluk-to a greater extent their transit through the pneumatic feeder under the influence of air flows from the inlet to the opening holes without getting to the main gripping saw drum, as a result of which these small specks and uluks in the output pipes are mixed with regenerated raw cotton fiberglass and clog them. Insufficient frequency of cleaning due to the fact that the distance between the input hole located in the middle part of the pneumatic feeder and exit located at its ends, less than half the length of the working parts, as a result, the frequency of capture of recoverable briefing, and accordingly the frequency of their cleaning on the grate does not exceed 3-4 times that at high infestation of recoverable briefing is insufficient for their effective cleaning.

The productivity of the regenerator is limited by the fact that through the inlet pipe of the pneumatic feeder, waste is fed to the main gripping saw drum unevenly and undiscovered, that is, in the form of lumps, on a short arc of its surface before the fixing brush. As a result, when the productivity increases and the corresponding growth in the size of lumps and the intensity of their supply above certain values, the jamming lumps between the saw drum and the fixing brush with grates, so that the rotation of the drum slows down and stops, and the waste that continues to flow fills the surface of the saw drum. Therefore, to eliminate these shortcomings, the construction of the fibrous material regenerator has been improved and the method of dynamic analysis of machine aggregates has been developed.

The constructional scheme of the fiber material regenerator is developed.

The construction diagram of the regenerator is shown in Fig.1 [5]. The regenerator housing contains a leading bar drum 2, the main 20 and the regeneration 14 gripping saw cylinders with fixing bars 21, 16 and grates 19, 13, removing the bar drum 6 with a casing 7, a screw conveyor 10 equipped with a sealed end face 30 extending beyond the sidewall 29, trays 22, 1 and 4, a guide 5, a shield 18. In the upper part of the front wall 8 opposite the leading rod drum 2, the sidewall 29 has an inlet 3, to which the feed pipe 28 is attached, and in the cover 21 above the leading rod drum 2, the sidewall 25 has an outlet 24, to which the discharge pipe 26 is connected through a condenser to the fan (not shown in the diagram).

Trays 1, 4, 22, parts of the front wall 8 and cover 23 between the edges of trays 1, 4, 22, as well as the surfaces of the main gripping saw cylinder 20 and the removing slat drum 6, facing the lead bar drum 2, form an air duct 27 between the inlet 3 and outlet 24 holes. The leading bar drum 2 is located in the central part of the cross section of the air pipe 27.



View from above

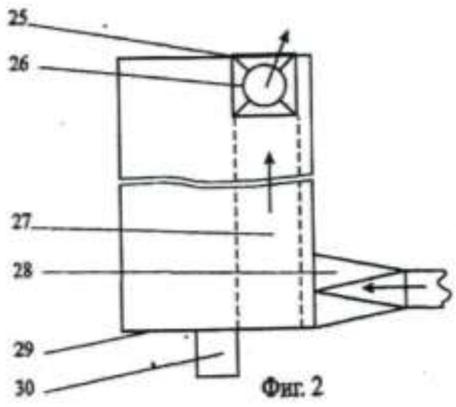


Fig.1. Diagram of a fibrous material regenerator

The regenerator works as follows. The waste is fed from the feed pipe 28 through the inlet 3 due to the rarefaction of air in the regenerator housing created by the fan (Fig. not shown) through the exit port 24. In this case, the air tends to move from the input 3 to the output 24 hole in the air duct 27 along the shortest path with the least aerodynamic resistance, that is, in the gap between the lead of the rod drum 2 and the tray 1. But the rotating rod drum 2 twists the air flows in the air duct 27 around itself, as a result of which they move mainly along screw trajectories. In this case, the air captured by the main saw cylinder 20 is ejected by it behind the grate 19 and distributed to other parts of the body, and then returned to the air duct 27 by a removing slat drum 6.

Impurities entering the regenerator through the inlet hole 3, moving by inertia in the direction of the branch pipe 28, falls under the influence of the bars of the lead drum 2, which reflect them to the tray 1, to the part of the cover 23 located above it, to the tray 22 and to the surface of the main gripping saw cylinder 20. Due to the impact of the rods and impacts on the lid and trays, the waste lumps are intensively loosened and thrown on the surface of the main gripping saw cylinder 20 in the area opposite the entrance hole 3 on the length of the arc from the lower edge of the tray 22 to the guide 5. Clumps of waste Pappus of raw cotton, uluk and foreign material are captured by the saw cylinder 20, spread on the surface of the fixing bars 21, after which are not related to the briefing of raw cotton trash and uluk separated from the saw cylinder 20 under the action of centrifugal forces and turbulence and the associated briefing are separated from their collisions with the grate 19 [6,7,8].

The raw cotton flakes that have been cleaned and regenerated and that have not been released through the grate 19 and 13, impurities and uluk are removed from the saw cylinders 14 and 20 by a removing slat drum 6, which directs them to the air duct 27, where they fall under the influence of the bar drum 2 and the screw air flows moving around and along it. As a result, the regenerated fiberglass and non-isolated impurity admixtures and uluk are moved in the direction of the outlet 24 and re-fed by the rod drum 2 to the main gripping saw cylinder 20, after which the processes of cleaning the regenerated fiberglass on the main and regenerative gripping cylinders 20, 14 and the release of impurity admixtures and uluk between the grates 19, 13 are repeated. Then the regenerated fiberglass are repeatedly removed from the saw cylinders 14, 20 by a slat drum 6, which directs them to the air duct 27 under the influence of the rod drum 2 and screw air flows.

The above-described process of regeneration and cleaning of raw cotton fiberglass from impurities is repeated until the regenerated fiberglass, fed by the removing slat drum 6 to the air duct 27, reach the area under the outlet 24, through which they under the influence of the sucked air will get into the exhaust pipe 26, and then in the condenser (not shown in the diagram) will be separated from the air transporting them. Allocated through the gaps between the grate 13, impurity impurities and uluk on trays 12 and 9 will get into the trough 11, along which they will be removed from the regenerator by a screw conveyor through the sealed end 30. The multiplicity of cleaning regenerated raw cotton fiberglass on saw cylinders 20, 14 can be adjusted by changing the rotation speed of the lead bar drum 2, as well as the volume and speed of air sucked through the 24. It is assumed to ensure the multiplicity of waste and regenerated fiberglass feeding to the exciting saw cylinders 20, 14 and, respectively, the multiplicity of their cleaning by grate grates 19 and 13 is about 6-8 times, which is 2 times more than in the prototype. The performance of the proposed waste regenerator at an air flow rate of 2 m^3/s (including suckers up to 0,5 m/s) will be up to 4 t/h, while the regeneration effect will be 95-98 %, the cleaning effect for large litter 98-99 %, for small litter 80-90 %, for uluk 60-80 %.

Analysis of kinematic schemes of machine PX-2 shows that the working parts and the driving gears are identical with the third engine unit cleaner PT-10 except that the amount of wiper blade reels one more, the other engine unit is dual-mass and mechanics of such systems is studied quite well [6]. Therefore, its specific features are given while studying the dynamics of gear units of the 2RKH-M regenerator, only its specific features.

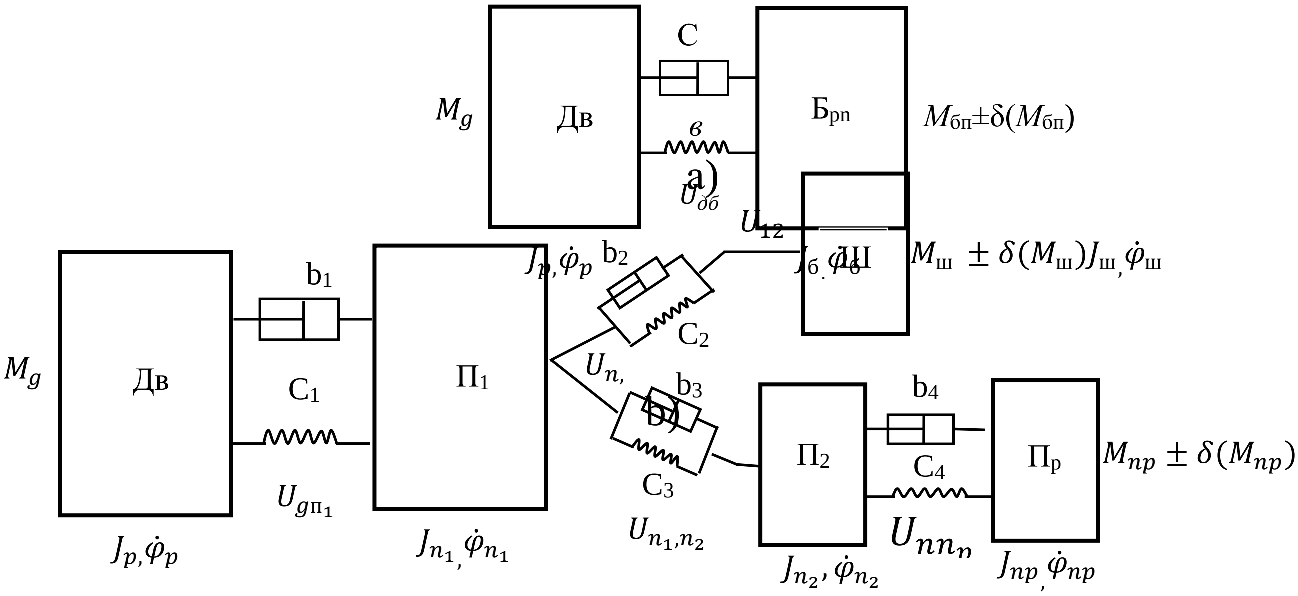


Fig. 2. Dynamic models of machine units with drive mechanisms of a rubber-slatted drum (a), saw bars and drums, as well as a impurity auger (b).

According to the dynamic models shown on fig.3. taking into account the above methodology for composing systems of differential levels of machine units of the regenerator 2RKH-M were obtained for a machine unit with a water gear of a rubber-slat drum:

$$\frac{dM_g}{dt} = 2M_K\omega_c - 2M_K P\frac{d\Delta\varphi_p}{dt} - \omega_c S_K M_g;$$
$$J_p\frac{d^2\varphi_p}{dt^2} = M_g - C\Delta\varphi - b\frac{d\Delta\varphi}{dt};$$
$$J_p\frac{d^2\varphi_б}{dt^2} = U_{gб}C\Delta\varphi + U_{gб}b\frac{d\Delta\varphi}{dt} - M_{бn} \pm \delta(M_{бn});$$
$$\Delta\varphi = \left(\varphi_p - U_{gб}\varphi_б\right);\ \frac{d\Delta\varphi_p}{dt} = \left(\frac{d\Delta\varphi_p}{dt} - U_{gб}\frac{d\varphi_б}{dt}\right); \qquad (1)$$

where, $\varphi_p, \varphi_б$ - are the angular displacements of the motor rotor and the rubber-slat drum; $J_p, J_б$ - are reduced moments of inertia of the motor rotor and the rubber-slat drum, $M_{б.п}$ - is the mathematical expectation of the moment of resistance from the cotton fiberglass to the rubber - slat drum [7,8,9].

Mathematical model of a machine unit with drive mechanisms for two saw and rod drums and a impurity auger of the 2RKH-M machine:

$$\frac{dM_g}{dt} = 2M_K\omega_c - 2M_K P\frac{d\Delta\varphi_p}{dt} - \omega_c S_K M_g;$$
$$J_p\frac{d^2\varphi_p}{dt^2} = M_g - C_1\Delta\varphi_{gn_1} - b_1\frac{d\Delta\varphi_{gn_1}}{dt};$$
$$J_{n_1}\frac{d^2\varphi_{n_1}}{dt^2} = U_{gn_1}C_1\Delta\varphi_{gn_1} + U_{gn_1}b_1\frac{d\Delta\varphi_{gn_1}}{dt} -$$

$$-C_2\Delta\varphi_{nш} - b_2\frac{d\Delta\varphi_{nш}}{dt} - C_3\Delta\varphi_{n_1n_2} - b_3\frac{d\Delta\varphi_{n_1n_2}}{dt} - M_{n_1};$$

$$J_ш\frac{d^2\varphi_ш}{dt^2} = U_{nш}C_2\Delta\varphi_{nш} + U_{nш}b_2\frac{d\Delta\varphi_{nш}}{dt} - M_ш \pm \delta(M_ш) \qquad (2)$$

$$J_{n_2}\frac{d^2\varphi_{n_2}}{dt^2} = U_{n_1n_2}C_3\Delta\varphi_{n_1n_2} + U_{n_1n_2}b_3\frac{d\Delta\varphi_{n_1n_2}}{dt} - C_4\Delta\varphi_{nnp} - b_4\frac{d\Delta\varphi_{nnp}}{dt} - M_{n_2};$$

$$J_{np}\frac{d^2\varphi_{np}}{dt^2} = U_{nnp}C_4\Delta\varphi_{nnp} + U_{nnp}b_4\frac{d\Delta\varphi_{nnp}}{dt} - M_{np} \pm \delta(M_{np});$$

where, $\Delta\varphi_{gn_1} = \left(\varphi_p - U_{gn_1}\varphi_{n_1}\right)$; $\frac{d\Delta\varphi_{gn_1}}{dt} = \left(\frac{d\Delta\varphi_{nnp}}{dt} - U_{gn_1}\frac{d\varphi_{n_1}}{dt}\right)$;

$\Delta\varphi_{nш} = \left(\varphi_{n_1} - U_{nш}\varphi_ш\right)$; $\frac{d\Delta\varphi_{nш}}{dt} = \left(\frac{d\Delta\varphi_{n_1}}{dt} - U_{nш}\frac{d\varphi_{n_1}}{dt}\right)$;

$\Delta\varphi_{nnp} = \left(\varphi_{n_2} - U_{nnp}\varphi_{np}\right)$; $\frac{d\Delta\varphi_{nnp}}{dt} = \left(\frac{d\Delta\varphi_{n_2}}{dt} - U_{nnp}\frac{d\varphi_{np}}{dt}\right)$;

where: $J_p, J_{n_1}, J_{n_2}, J_ш, J_{np}$ – the reduced moments of inertia of the engine rotor, saw drums, impurity screw and bar drum, $\varphi_p, \varphi_{n_1}, \varphi_{n_2}, \varphi_ш, \varphi_{np}$ – the movement of rotating masses of the machine unit, $M_{n_1}, M_{n_2}, M_ш, M_{np}$ – the moments of technological resistance.

For the numeral solution of systems of differential equations (1) and (2) it is carried out under the appropriate initial conditions and at the following calculated values of parameters. For a machine unit with a rubber-bar drum drive gear: $\dot{\varphi}_p = 100{,}5\ s^{-1}$; $\dot{\varphi}_б = 100{,}5\ s^{-1}$; $U_{gб} = 1{,}0$; $C = (120 \div 125)\ N/rad$; $b = (4{,}5 \div 5{,}5)\ Nm\cdot s/rad$; $J_p = 0{,}172\ kg\cdot m^2$; $J_б = 1{,}37\ kg\cdot m^2$; $M_{бn} = (18{,}5 \div 24{,}1)\ Nm$; $\delta(M_{бn}) = (0{,}1 \div 0{,}14)M_{бn}$; $f_c = 50\ Hz$; $cos\varphi = 0{,}84$; $\omega_0 = 157{,}1\ s^{-1}$; $\eta = 0{,}82$; $\omega_K = 98{,}91\ s^{-1}$, $P = 2$; $S_K = 0{,}191$.

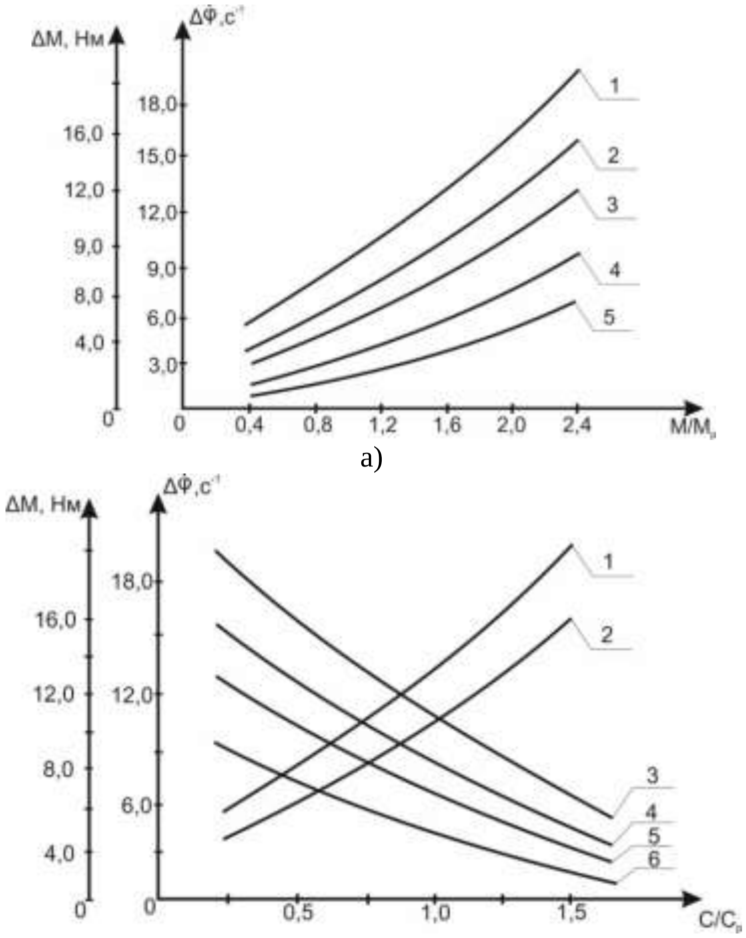
For a machine unit with driving gears for saws, bar drums, and impurity augers $\dot{\varphi}_p = 100{,}5\ s^{-1}$; $\dot{\varphi}_{n_1} = \dot{\varphi}_{n_2} = 50{,}25\ s^{-1}$; $\dot{\varphi}_ш = 20{,}68\ s^{-1}$; $\dot{\varphi}_{пр} = 50{,}25\ s^{-1}$; $U_{gn_1} = 2{,}0$; $U_{nш} = 4{,}86$; $U_{n_1n_2} = 1{,}0$; $U_{nnp} = 1{,}0$; $M_K = 28{,}7\ Nm$; $M_{n_1} = (22{,}5 \div 25{,}4)\ Nm$; $M_{n_2} = (25{,}2 \div 26{,}5)\ Nm$; $M_ш = (6{,}5 \div 7{,}0)\ Nm$; $M_{np} = (16{,}9 \div 18{,}2)\ Nm$. In this case, the random components of the moments of technological resistances taking into account [10,11,12], do not exceed (10÷12) % of their average values.

Solving the problem and analyzing the results.

The solution and analysis of research results are mainly aimed at the nature of changes in the torque and angular speeds of machine units of the cotton regenerator 2RX-M. In this case, during the operation of the regenerator, the frequency and amplitude of fluctuations in the angular speeds of the rod and saw drums, which ensure the loosening and release of cotton fiberglass and waste and their regeneration into the cleaning unit, mainly affect. Therefore, on bases of the numerical solution of problems of the dynamics of the working parts of the machine 2PX-M the resulting patterns were processed and constructed graphical dependence of changes ΔMg and ΔM_g и $\Delta\dot{\varphi}_p, \Delta\dot{\varphi}_{n_1}, \Delta\dot{\varphi}_{n_2}, \Delta\dot{\varphi}_{np}, \Delta\dot{\varphi}_ш, \Delta\dot{\varphi}_б$from changes in technological loads from cotton, ratios of moments of inertia, and elastic-dissipative parameters elastic gear to drive the machine. The constructed graphical dependencies are shown on fig.3.

The analysis of the obtained graphical dependencies is shown on fig.3. shows that an increase in resistance from regenable cotton fiberglass to a rubber-slatted drum leads to an age $\Delta\dot{\varphi}_б$ to (12.5÷15) s^{-1} at $J/J_p = 1{,}0$. With increases in the value of the moment of inertia of the rubber-slatted drum to $J/J_p = 1{,}8$, the oscillation span $\Delta\dot{\varphi}_б$ reaches (10,2÷11,6) s^{-1}. In this case, the range of vibrations of the angular velocity of the motor rotor $\Delta\dot{\varphi}_p$ does not exceed (7,0÷7,3) s^{-1}. It should be noted that the difference between $\Delta\dot{\varphi}_б$ and $\Delta\dot{\varphi}_p$ is due to the fact that some of the vibrations are attenuated by the belt drive shaft. The torque span on the shaft of an asynchronous motor does not exceed (14,5÷15) Nm. The process of removing regenerated cotton fiberglass from the saw teeth of working drums is intensified due to the occurrence of not only $\Delta\dot{\varphi}_б$, but also от ΔM_g. Therefore, it is important to study the influence of belt transmission parameters on the range of angular velocity and torque fluctuations. Thus, when increasing the C/C_p from 0,2 to 1,45, the oscillation range $\Delta\dot{\varphi}_б$ decreases from 13,9 s^{-1} to 4,2 s^{-1} with a load of $M/M_p = 1{,}6$, and when reducing the load to $M/M_p =$

1,0, $\Delta\dot{\varphi}_6$ decreases to (2,8÷3,1) s^{-1}. Therefore, to ensure the necessary values of $\Delta\dot{\varphi}_6$ within (12,0÷13,0) s^{-1}, the recommended values of the system parameters are: $C/C_p = (0{,}6 \div 0{,}8)$; $J/J_p = (0{,}8 \div 1{,}0)$; $M/M_p \leq (1{,}0 \div 1{,}2)$.



a)

$1 - \Delta M_g = f(M/M_p)$; $2{,}3 - at\ J/J_p = 1{,}0$; $4{,}5 - at\ J/J_p = 1{,}8$;
$2{,}4 - \Delta\dot{\varphi}_6 = f(M/M_p)$;
$3{,}5 - \Delta\dot{\varphi}_6 = f(M/M_p)$.

b)

$1 - \Delta M_g\ at\ M/M_p = 1{,}6$; $2 - \Delta M_g$ at $M/M_p = 1{,}0$; $3{,}4 - \Delta\dot{\varphi}_6 = f(C/C_p)$; $5{,}6 - \Delta\dot{\varphi}_6 = f(C/C_p)$; $3{,}5 - at\ M/M_p = 1{,}6$; $4{,}6 - at\ M/M_p = 1{,}0$.

Fig. 3. Graphic dependences of the variation of the angular velocity range of vibrations on the rotor shaft of the electric motor and the rubber-slat drum and the torque range on the motor shaft on the process load (a) and on the relative value of the torsional stiffness of the flexible transmission (b).

When considering the nature of the movements of the saw and rod drums of the regenerator 2RX-M, it is important to determine the average values of the angular velocities of the working parts. In this case, the special provision is $\Delta\dot{\varphi}_6 \leq \Delta\dot{\varphi}_n$ and $\Delta\dot{\varphi}_6 \leq \Delta\dot{\varphi}_{n_2}$. This is due to the fact that during the operation of the regenerator 2RX-M, the linear speed of the rubber bars must be greater than the linear speed of the teeth of the saw drums, $V_6 > V_3$. According to the kinematic scheme of the regenerator 2RX-M, it is seen that the angular speed of the saw drums and the linear speed of the teeth are two rows less, that the angular speed and linear speed of the rubber slats of the regenerator. But, taking into account the influence of different values of resistance moments, moments of inertia, as well as elastic-dissipative parameters of elastic gears, the gear ratio is reduced to (1,7÷1,8), which will negatively affect the removal of cotton fiberglass from the teeth of the saw with a rubber-slat drum. For fig.4 graphical dependences of changes in the average values of angular speeds of saw and bar drums of the machine unit of the regenerator 2RKH-M are presented.

Analysis in fig. 4 shows that when the load increases to $M/M_p = (2{,}0 \div 2{,}4)$, it reduces the average values of $\dot{\varphi}_6$ to (80÷84) s^{-1}, and $\dot{\varphi}_{n_1}$ and $\dot{\varphi}_{n_2}$ to (43,3÷45,3) s^{-1}. Therefore, the recommended values of the system parameters are: $M/M_p \leq (1{,}0 \div 1{,}2)$; $J_1 = (2{,}2 \div 2{,}3)$ kgm^2; $J = (2{,}1 \div 2{,}2)$ kgm^2; $C_1 = (225 \div 250)$ Nm/rad; $C = (150 \div 200)$ Nm/rad.

ISSN: 2005-4238 IJAST

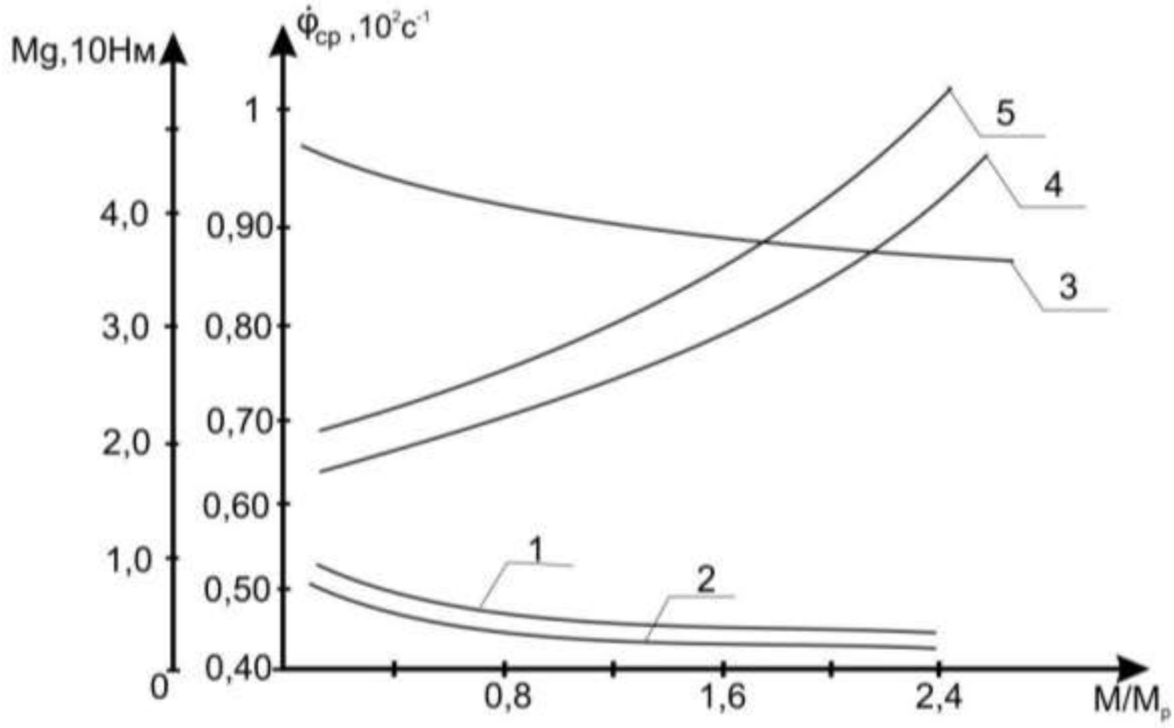


Fig .4. Depending on the change in the average values of the saw and bar drums, as well as the load on the engine shaft from the change in the technological load of the regenerator.

Test results of the recommended fibrous material regenerator's construction.

For testing, the outlet of the prototype regenerator was connected to a KV-03 condenser with a diffuser working with a VS-8 fan, and a pipe was connected to the inlet of the regenerator to supply waste from the floor, which will simulate the supply of waste from an outdoor vehicle. Fig.5 presents a general view of the prototype regenerator made on the basis of the parameters of the working parts and the drive given by the results of theoretical research.

Fig.5. General view (drive) of the 2RKH-M regenerator.

Tests revealed that at an air flow of 2 m^3/s the performance of the new regenerator waste at the expense of their cultivation will be increased in 1,8-2,0 times - up to 2 t/h. Its regenerative effect will be roughly the same as the serial regenerator RKH, - 95 %, and cathartic effects, due to reductions in transit impurities and increase the frequency of cleaning regenerated fiberglass of raw cotton would be significantly higher: total amount to 85-90 % across large litter 90-95 %, small litter 80-85 %, according to uluk 50-70 %. Tests of the prototype regenerator in laboratory conditions have shown that when the regenerator is fed with waste of cotton gins UXK units containing up to 40 % of raw cotton volatiles, it reliably operates with a capacity of up to 2000 kg/hour and with a cleaning effect of up to 90 % and with a stable regeneration effect of not less than 95 %. At the same time, the contamination of regenerated fiberglass did not exceed 10%, and the content of raw cotton fiberglass was no more than 2,0 %, which meets the requirements of the industry. The introduction of a new regenerator by reducing the blockage and contamination of regenerated fiberglass will reduce the mass fraction of defects and weed impurities in the fiber, which will give a significant economic effect at a typical ginnery.

Conclusions: The design of the fiber material regenerator has been improved. Based on the numerical solution of the problem of the dynamics of regenerator machine units, taking into account the mechanical dynamic characteristics of the engine, inertia, elastic – dissipative properties of elastic gears, technological loads from the regenerated material, the laws of movement of working bodies are obtained, their main parameters are justified. On the basis of tests of the regenerator, high technological indicators of the machine were obtained.

References

1. Djuraev A., Mirakhmedov D., Otakulov O., Abdullaev A. “Theoretical bases and improvement of constructions of grate cleaners cotton from large litter. Monograph. Ed. "Ferghana" 119 p.
2. Djuraev A., Murodov O. Improvement of constructions and methods for calculating the parameters of plastic grates on rubber supports of cotton cleaners from large litter. Monograph. Ed. "Science and technology", Tashkent, 136 p.
3. Miroshnichenko G.I. “Fundamentals of designing machines for primary cotton processing”. Moscow: Mashinostroenie, 1972, 486 p.
4. Cotton regenerator. Auth. Arch. No. 5392495.
5. Inagamov A. Kh., Yunusov R. F., Borodin P. N., Raw cotton regenerator. Patent UZ FAP00708, Byull. No. 3, 2012.
6. Djuraev A., Mavlonov O., Daliev Sh. “Development of structures and methods for calculating the parameters of staking drums”. Monograph. Ed. LAP LAMBERT, Academic Publishing, 2016, 134 p.
7. Rajabov O. Experimental study of the interaction of multifaceted and cylindrical spinky cylinder in cotton cleaner from small waste. Scopus. International journal of advanced research science. Engineering and technology. Volume-6, Issue-3, march 2019, p. 8382-8387.
8. Djuraev A., Mamatova. D “Influence of belt transmission parameters on the stiffness of the elastic elements of the driven pulley and tensioning roller” Scopus. International journal of recent technology and engineering (IJRTE) ISSN: 22773878, Volume-8, Issue-4, November 2019, p.37-42
9. Djuraev A., Yunusov S.Z., Normatov E.A. “Analysis of the surface of the arralious double plastic consolidated collector”. Scopus. International journal of advanced research science. Engineering and technology. Volume-5, Issue-12, December 2018, p. 7578-7582.
10. Djuraev A., Daliyev Sh.I., “Development of the design and justification of the parameters of the composite flail drum of a cotton cleaner”. European sciences review scientific journal. №7-8 2017 p. 96-100.
11. Djuraev A., Tashpulatov D.S., Elmanov S.M., Plekhanov A.F., Zhilisbayeva R.O. Effective technology of natural fiber cleaner from impurities on elastic supports and justification of grate parameters. Scopus Article. Journal, Technology of the textile industry. № 6. 2018, 70-75 p.
12. Djuraev A., Tashpulatov D.S., Elmanov S.M., Plekhanov A.F., Zhilisbayeva R.O. Development of resource-saving technology of natural fiber cleaner from impurities and justification of the parameters of the grate on elastic supports. Scopus Article. Journal, technology of the textile industry. № 6. 2018, 76-79 p.
13. Syamsir, A., Mohamad, D., Beddu, S., Itam, Z., & Sadon, S. N. (2019). An examination on durability and degradation of glass fiber reinforced polymer structures. Test Engineering and Management, 81(11-12), 3379-3388. Retrieved from www.scopus.com