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Improvement of the Construction and Justification of Parameters of the PT-10 Cotton Cleaner From Large Trash

A.D. Djuraev[1], T.M. Kuliev[2], Sh. N. Choriev[3]

[1](Doctor of Technical Sciences, Professor, Department of general technical disciplines, Tashkent Institute of Textile and Light Industry, Tashkent, Uzbekistan)

[2](Candidate of Technical Sciences, Docent, General Director of "Paxtasanoatilmiymarkazi" JSC, Tashkent, Uzbekistan)

[3](Candidate of Technical Sciences, Head of Department of "Paxtasanoatilmiymarkazi" JSC, Tashkent, Uzbekistan)

Email: ozodbek4103@mail.ru)

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Abstract:

The constructional scheme and the principle operation of the fibrous material cleaner from large trash are presented in this article. The results of theoretical studies of dynamics of machine unit with gear mechanisms, rotary drums and screw area received by the laws of engine of working parts. Recommended values of parameters and modes of their movement are defined. Experiments are substantiated by comparative industrial experiments of the highest effect of cleaning the fibrous material in the recommended cleaner.

Keywords **—Cleaner, fibrous material, large trash, dynamics, moment, dissipation, effect.**

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I. INTRODUCTION

The technological line for cleaning fibrous material includes a zone of large and small cleaning [1]. The main drawback of fibrous material cleaner from large trash is the low cleaning effect and frequent jamming of the material in the cleaning zones [2,3].

The proposed constructional scheme of a fibrous material cleaner from large trash is shown in Fig.1. The operation of the cleaner in the working mode of cleaning raw cotton is carried out as follows. Raw cotton is fed by feeding rollers 1 to the first Ripper 2 located below them, which is driven by the first saw cylinder 7, which rotates in the direction of sharpening the teeth of its saws (in the figure – counterclockwise).

The first ripping drum 2 directs the raw cotton to the second ripping drum 3, which rotates in the opposite direction from the first ripping drum 2 (clockwise in the figure) and feeds the raw cotton through the tray 4 and the rotating guide 5 installed behind the face with it to the first upper gripping saw cylinder 7, which cleans the raw cotton on the grates 11, after which the removing stripping drum 15 on the reflective plate 6 directs the cleaned raw cotton to the spout opening 23.

Allocated through the gaps between the grate bars 11 of weeds and fallen with them, the briefing of raw cotton in the tray 17 are sent to a second exciting of the saw cylinder 8, which clears the briefing on the grate 12, and then removing the slatted drum 15 via the guide wire 21 at the rear side of the teeth of saws of the cylinder 8 and the reflective plate 6 directs cleaned flier bleach raw spout opening 23.

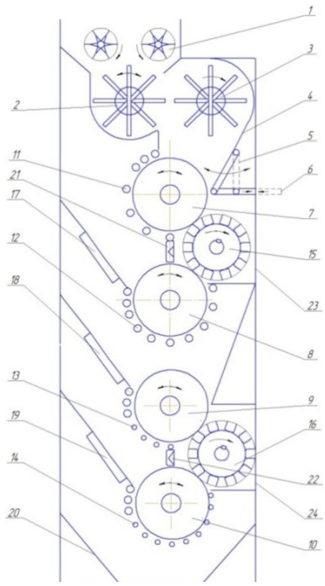

Fig.1. A scheme of the fibrous material cleaner from large litter

The processes of regeneration and cleaning of raw cotton flyers on saw cylinders 9 and 10 are similar to those described above, and the cleaned flyers are removed from these saw cylinders by a removing slat drum 16, which directs them to the second discharge spout opening 24 [4,5].

II. MATERIALS AND METHODS

It should be noted that the construction can only include three saw-grate zones for cleaning fibrous materials and the fourth saw cylinder 10 is replaced by a heat-removing screw, and the removing planed drum 16 engages only the saw cylinder 9. In order to proof the parameters of the machine theoretical dynamic studies are given.

A system of differential equations describing the dynamics of a machine unit with mechanisms for driving saw drums and a second bar drum cleaner:

$$\frac{\omega_0-\dot{\varphi}_n}{\omega_0}=\frac{S_K}{2M_K}M_\partial+\frac{1}{2\omega_c M_K}=\dot{M}_\partial;$$

$$J_p\cdot\ddot{\varphi}_p=M_\partial-c_1\cdot(\varphi_p-u_{\partial 1}\cdot\varphi_1)-в_1\cdot(\dot{\varphi}_p-u_{\partial 1}\cdot\dot{\varphi}_1)\quad(1)$$

$$J_1\cdot\ddot{\varphi}_1=U_{\partial 1}\cdot C_1(\varphi_p-u_{\partial 1}\cdot\varphi_1)+U_{\partial 1}\cdot в_1\cdot(\dot{\varphi}_p-u_{\partial 1}\cdot\dot{\varphi}_1)-$$
$$-C_2(\varphi_1-u_{12}\cdot\varphi_2)-C_3(\varphi_1-u_{13}\cdot\varphi_3)-$$
$$-в_2\cdot(\dot{\varphi}_1-u_{12}\cdot\dot{\varphi}_2)-в_3\cdot(\dot{\varphi}_1-u_{13}\cdot\dot{\varphi}_3)-M_1;$$

$$J_2\cdot\ddot{\varphi}_2=U_{12}\cdot C_2(\varphi_1-u_{12}\cdot\varphi_2)+$$
$$+U_{12}\cdot в_2\cdot(\dot{\varphi}_1-u_{12}\cdot\dot{\varphi}_2)-M_2;$$

$$J_3\cdot\ddot{\varphi}_3=U_{13}\cdot C_3(\varphi_2-u_{13}\cdot\varphi_3)+U_{13}\cdot в_3\cdot(\dot{\varphi}_1-u_{13}\cdot\dot{\varphi}_3)-$$
$$-C_4(\varphi_3-u_{34}\cdot\varphi_4)-в_4\cdot(\dot{\varphi}_3-u_{34}\cdot\dot{\varphi}_4)-M_3;$$

$$J_4\cdot\ddot{\varphi}_{\$4}=U_{34}\cdot C_4(\varphi_3-u_{34}\cdot\varphi_4)+U_{34}\cdot в_4\cdot(\dot{\varphi}_3-u_{34}\cdot\dot{\varphi}_4)-$$
$$-C_5(\varphi_4-u_{45}\cdot\varphi_5)-в_5\cdot(\dot{\varphi}_4-u_{45}\cdot\dot{\varphi}_5)-M_4;$$

$$J_5\cdot\ddot{\varphi}_5=U_{45}\cdot C_5(\varphi_4-u_{45}\cdot\varphi_5)+$$
$$+U_{45}\cdot в_5\cdot(\dot{\varphi}_4-u_{45}\cdot\dot{\varphi}_5)-M_5;$$

where, $M_5=M_{5M}\pm\delta(M_{5M})$.

$\varphi_p,\varphi_1,\varphi_3,\varphi_4,\varphi_5,\varphi_2$ - respectively angular movements of the rotor of the electric motor, saw drums, the second bar drum and the weed auger; - torsional stiffness coefficients of belt drives; - coefficients of dissipation of belts of the cleaner; - technological resistances from cotton on working parts of the cleaner; $U_{\partial 1},U_{12},U_{13},U_{34},U_{45}$ - transfer ratios of belt transfers between masses.

III. RESULTS AND DISCUSSION

The solution of the system of differential equations (1) describing the dynamics of the movement of the saw and bar drums, the heat-removing screw was carried out on a PC using special programs with the following initial knowledge of the parameters:P=7,5 kVt, n=960 rpm, $f=50Hz$, $\cos\varphi=0{,}87$; $\omega_0=157{,}1$ s^{-1}; $\delta=0{,}84$; $\omega_H=98{,}91$ s^{-1}; $S_H=0{,}054$; $S_K=0{,}191$; P=2; $U_{\partial 1}=0{,}5$; $U_{12}=3{,}28$; $U_{13}=1{,}0$; $U_{34}=1{,}0$; $U_{45}=0{,}83$; $J_p=0{,}121kgm^2$; $J_1=3{,}52kgm^2$; $J_2=1{,}41kgm^2$; $J_3=3{,}18kgm^2$; $J_4=3{,}12kgm^2$; $J_5=2{,}5kgm^2$; $C_1=250\,Nm/rad$; $C_2=135\,Nm/rad$; $C_3=250\,Nm/rad$; $C_4=250\,Nm/rad$; $C_5=200\,Nm/rad$; $в_1=6{,}5Nm\cdot s/rad$; $в_2=3{,}9Nm\cdot s/rad$; $в_3=6{,}5Nm\cdot s/rad$; $в_4=6{,}5Nm\cdot s/rad$; $в_5=4{,}2Nm\cdot s/rad$; n_p=2,2 t/h.

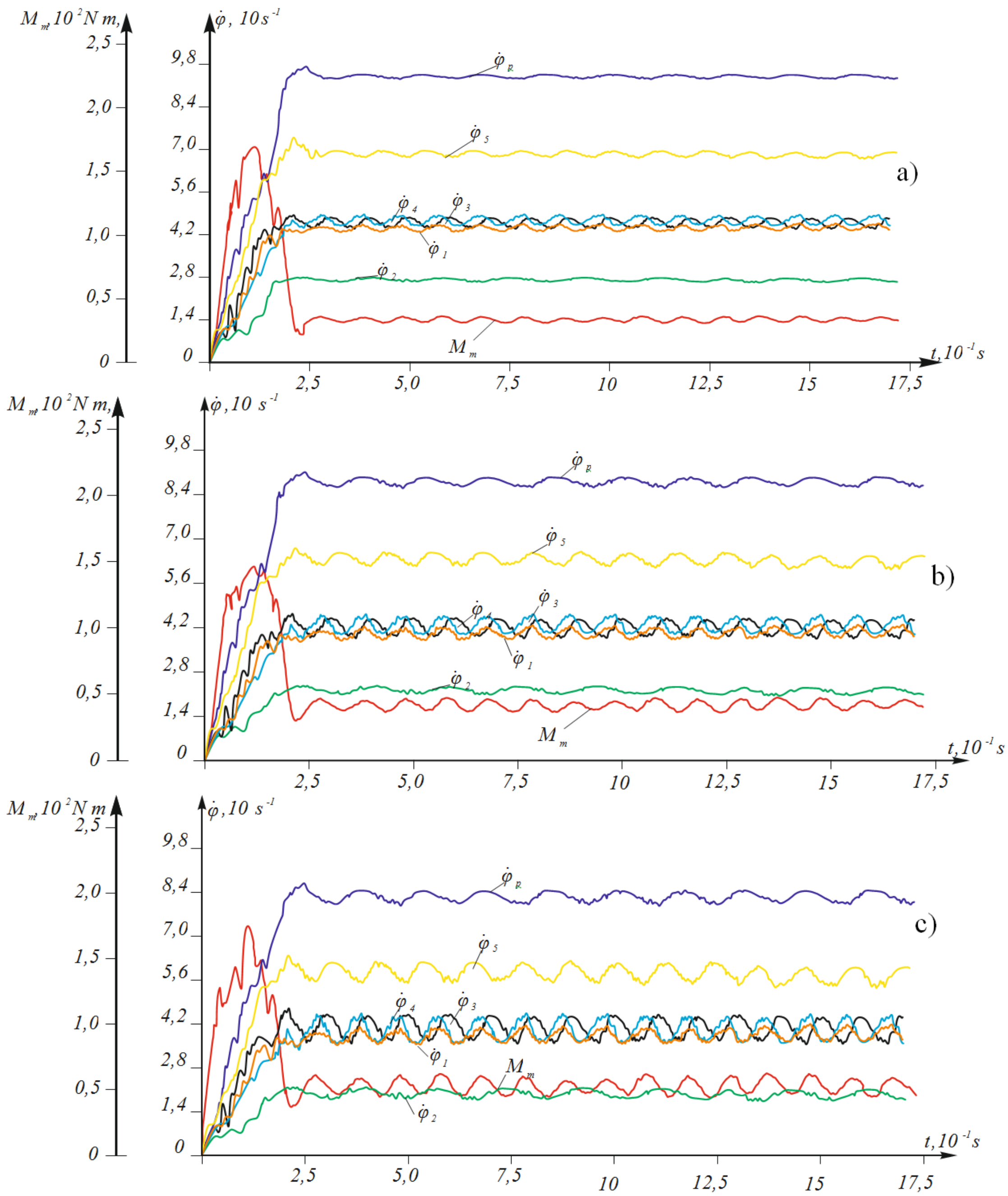

Fig. 2.Regularities of changes in the angular speeds of the rotor of the electric motor, saw and rod drums, as well as the heat-withdrawing screw, the driving moment on the motor shaft. a – at n_p=1.7 t/h; b – at n_p=2.2 t/h; c – at n_p=3.0 t/h

According to the results of solving problem (1), the regularities of changes in the angular velocities of the motor rotor, saw and bar drums, as well as the heat-removing screw, the driving moment on the motor shaft are obtained, which are shown in fig.2. According to the obtained regularities in fig.2 it can be seen that the system enters the steady state for (0.22÷0.25) seconds, which also depends on the performance of the cotton cleaner. With an increase in productivity up to 3.0 t/h, the average values of angular velocities are reduced (table 1) for working bodies. But, at the same time, the angular velocity fluctuations increase, as well as the torque of the M_m increases [6, 7].

TABLE I
AVERAGE VALUES OF ANGULAR VELOCITIES, s^{-1}

№	**Name of the working part**	**Angular velocity**		
		n_p=1,7 t/h	**n_p=2,2 t/h**	**n_p=3,0 t/h**
1	On the motor shaft	93,5	90,2	88,5
2	1st saw drum	46,6	42,1	40,2
3	2nd saw drum	45,9	41,8	39,7
4	3rd saw drum	45,4	41,3	39,2
5	Rotary andreel	60,1	57,9	56,1
6	Heat-removing auger	18,7	15,2	14,7

Recommended values are: J_p=(0,1÷0,11) kgm^2; J_1=(2,2÷2,5) kgm^2; J_2=(1,12÷1,3) kgm^2; J_3=(2,3÷2,5) kgm^2; J_4=(3,1÷3,3) kgm^2; J_5=(2,5÷2,8) kgm^2.

Production tests of the PT-10 cotton cleaner from large trash were carried out in comparison with the serial cotton purifier CHX-5M. The results are shown in table 2.

TABLE 2
EXPERIMENTAL RESULTS

№	Trash release after CHM-5M, %				Release of trash after the ПТ-10, %				Thetotald ifference
	Basic	After cleaning	Difference	Efficiency	Basic	Aftercleaning	Difference	Efficiency	
1	8,7	3,5	5,2	59,7	9,8	3,7	6,1	64,2	4,5

Analysis of the results obtained according to table 2 shows that the efficiency of cleaning cotton from trash in the recommended version of the cleaner is higher by 4.5 % than in the serial cleaner.

IV. CONCLUSIONS

To improve the constructional scheme of the fibrous material cleaner from large trash is recommended. The results of theoretical studies of the dynamics of the machine unit with the drive mechanisms of the saw and rotary drums and the self-withdrawing screw obtained the laws of movement of the working parts. Recommended values of parameters and modes of their movement are defined. Comparative production tests proved the high effect of cleaning the fibrous material in the recommended cleaner.

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