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The Influence of the Preset of the Sampling Drum on the Number of Fibers Captured by its Teeth

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ABSTRACT: The article studies the regularities of motion of a discrete drum of a rotor spinning machine in various speed modes, the degree of loading of discrete drums with one, two and three slopes. A schematic diagram of a device for measuring the rotation speed of a sampling drum with an optical sensor is presented. The results obtained with this device were tabulated and analyzed, and the optimal parameters were determined.

KEYWORDS:fiber, discretization, discretionary drum, frictional force, angle, speed, radius, discretionary zone.

I. INTRODUCTION

A number of experimental studies are known to study sampling modes in spinning machines [5]. But, studies on the study and justification of the speed modes of sampling a complex of fibers on two three-way sampling drums are absent. It should be noted that in previous experimental studies, the sampling drum rotation frequency was considered a constant value, and there was also no comparison of the sampling drum loading in idle and operating modes and in the process of feeding the sampling zone.

Therefore, our experimental studies were aimed at determining:

- patterns of motion of the sampling drum in different modes of motion;

-comparison of speed modes of motion of sampling drums at different helical lines in which there are drum teeth;

- study of the loading of the drums with one, two and three-way execution of the sampling drum.

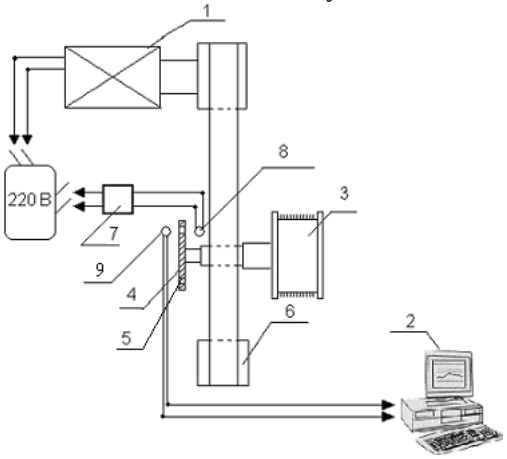

Figure: 1. Schematic diagram of measuring the speed of a sampling drum by an optical sensor

1- Electric motor, 2- Computer, 3- Sampling drum, 4- Disc, 5- Holes, 6- Idler roller, 7- Power supply, 8- LED, 9- Photocell

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II. THE MAIN FINDINGS AND RESULTS

According to the kinematic diagram in Figure 1 of the installation, the required power on the drive of the sampling drum of the spinning machine, and in particular on the motor shaft, is determined from the expression

$$P_{дв} = \frac{T_{дв} \cdot n_{дв}}{9550}, \quad (1)$$

where, $T_{дв}$, $n_{дв}$ – is the torque and the number of revolutions per minute on the electric motor shaft.

Gear ratio between motor shaft and sampling drum

$$U = \frac{n_{дис}}{n_{дв}} = \frac{3879}{1200} = 3{,}23$$

The overall efficiency of the drive from the motor to the sampling drum is

$$\eta_{общ} = \eta_p \cdot \eta_n^3 = 0.95 \cdot 0.99^3 = 0{,}92$$

where, η_p - kpdof the belt drive; η_n - kpdrolling bearings.

Considering that the motor power is 0.12 kW, then the power on the sampling drum shaft will be

$$P_{дис} = 0{,}92 \cdot 1{,}2 = 0{,}1 \text{ кВт}$$

Then the moment and the circumferential force on the shaft of the sampling drum are calculated according to:

$$T_{дис} = 9550 \cdot \frac{P_{дис}}{n_{дис}} = 0{,}24 \text{ Нм}$$

$$F_{дис} = \frac{T_{дис}}{r_{шк}} = 6{,}4 \text{ Н}$$

where $r_{шк}$- is the radius of the sampling drum, 0.0375m.

If, with a single-pass sampling drum, the decrease in the rotation frequency in the operating mode reaches 40 min-1, then

$$T_{дис} = 9550 \cdot \frac{0{,}1}{3840} = 0{,}248 \text{ Нм}$$

$$F_{дис} = \frac{0{,}248}{0{,}0375} = 6{,}613 \text{ Н}$$

Then the difference in forces between idle and operating modes is

$$\Delta F = 6.613 - 6.4 = 0.213 \text{ Н}$$

Hence, we can argue that the resistance of the fibers in the process of sampling with a single-pass variant of the sampling drum is 0.213 N.

By similar calculations, we determine the values of ΔFдис for two-lead and three-lead versions of the sampling drum. The results obtained are presented in Tables 1÷3.

Analysis of the data in tables 4 a, b, c shows that with an increase in the overlapping of the sampling drum, the values of the force of the action of the tooth of the sampling drum on the fibers correspondingly increases. So, with a two-way execution of a sampling drum, the given force of change is within 0.092 - 0.148 N at nдис = 3600 min-1, and for a three-pass variant of a sampling drum, the impact force varies within 0.137 - 0.494 N. It can be argued that an increase in the frequency of rotation of the working area will also lead to an increase in the force of the action of the teeth of the sampling drum on the fibers. At the same time, changes in this force in a single-pass version of the sampling drum are insignificant. Thus, at nдис = 3840 min-1, the force varies within 0,005÷0,05 N, and at a speed of nдис = 4080 min-1, the impact force reaches 0.04÷0.06 N. For a two-pass sampling drum at a speed of 3840 min-1 force varies within 0.13 - 0.29 N, and at a speed of 4080 min-1, force varies within 0.14 - 0.32 N.

This means that, taking into account the adhesion force between the fibers, the tensile coefficient decreases by 10÷15% in view of the fact that the adhesion force between the fibers reaches 0.8 g, and this percentage is from the pulling force. In this case, the sampling drum will carry with it 9.3÷12.5 fibers and in total in the sampling zone there will be 28 .....38 fibers according to (2.21), then a pulling force acts on one fiber from the teeth of the sampling drum.

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With a single pass, the arrangement of the teeth:

$$F_{вал} = \frac{0{,}213H}{28.....38} = 0{,}0056.....0{,}0076$$

H

It should be noted that when a two-start and three-start sampling drum is executed, the gripping ability of the drum teeth increases, and thus the amount of fibers captured from the tape increases. In this case, the number of fibers captured and carried away by a two-pass sampling ram can be determined from the expression:

$$n''_{д} = \frac{\Delta F_2}{F_{вал}} = \frac{0{,}297}{0{,}0016.....0{,}0076} = 39{,}1....53{,}03$$

Similarly, you can determine the number of fibers located in the sampling zone with a three-way arrangement of the teeth on the drum surface:

$$n'''_{д} = \frac{\Delta F_3}{F_{вал}} = \frac{0{,}376}{0{,}0056.....0{,}0076} = 49{,}3....67{,}14$$

Calculated values of the force of the action of the tooth of the sampling drum on the fibers during their sampling

With a single-pass variant of the sampling drum, at 3600 min^{-1}

Table 1 a

Idlemode	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
Workmode	3576	3573	3568	3576	3573	3573	3578	3576	3572	3566
$n_д$	24	27	32	24	27	27	22	24	28	34
T_x	0,263	0,263	0,262	0,263	0,263	0,263	0,2637	0,263	0,2632	0,2627
$T_н$	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265
F_x	7,01	7,01	6,9	7,01	7,01	7,01	7,03	7,01	7,02	7,005
$F_Н$	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06
ΔF	0,05	0,05	0,16	0,05	0,05	0,05	0,03	0,05	0,04	0,055
$\Delta n_{ср}$	27 мин$^{-1}$									

With a two-start variant of the sampling drum, at 3600 min^{-1}

Table 1 b

Idlemode	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
Workmode	3528	3535	3547	3539	3521	3532	3546	3535	3538	3560
$n_д$	72	65	53	61	79	68	54	65	62	40
T_x	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265
$T_н$	0,27	0,2701	0,2692	0,2692	0,2712	0,2703	0,2693	0,2701	0,2699	0,2682
F_x	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06
$F_Н$	7,2	7,202	7,173	7,194	7,232	7,208	7,181	7,202	7,197	7,152
ΔF	0,14	0,142	0,113	0,134	0,172	0,148	0,121	0,142	0,137	0,092
$\Delta n_{ср}$	62 min^{-1}									

With a three-start variant of the sampling drum, at 3600 min^{-1}

Table 1 c

Idle mode	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
Work mode	3486	3550	3370	3465	3506	3490	3538	3502	3468	3448
$n_д$	114	50	230	135	94	110	62	98	132	152
T_x	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265
$T_н$	0,2739	0,269	0,2833	0,2756	0,2723	0,2736	0,2699	0,2727	0,2753	0,2769
F_x	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06	7,06
$F_Н$	7,304	7,173	7,554	7,349	7,261	7,26	7,197	7,272	7,341	7,384
ΔF	0,244	0,133	0,494	0,289	0,201	0,236	0,137	0,212	0,281	0,324
$\Delta n_{ср}$	117 min^{-1}									

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With a single-pass sampling drum, at 3840 min^{-1}

Table 2 a

Idle mode	3840	3840	3840	3840	3840	3840	3840	3840	3840	3840
Work mode	3801	3816	3808	3812	3816	3808	3804	3818	3826	3808
$n_д$	39	24	32	28	24	32	36	22	14	32
T_x	0,246	0,247	0,2466	0,2468	0,247	0,2466	0,2463	0,2472	0,2477	0,2466
$T_н$	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248
F_x	6,56	6,58	6,576	6,581	6,58	6,576	6,568	6,592	6,605	6,576
$F_Н$	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61
ΔF	0,05	0,03	0,034	0,029	0,03	0,034	0,42	0,018	0,005	0,034
$Δn_{ср}$	28 min^{-1}									

With a two-start sampling drum, at 3840 min^{-1}

Table 2 b

Idle Mode	3840	3840	3840	3840	3840	3840	3840	3840	3840	3840
Work mode	3768	3710	3684	3744	3748	3764	3754	3734	3764	3740
	72	130	156	96	92	76	86	106	76	100
$n_д$										
T_x	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248
$T_н$	0,253	0,257	0,259	0,255	0,254	0,253	0,254	0,255	0,253	0,255
F_x	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61
$F_Н$	6,74	6,85	6,9	6,8	6,78	6,76	6,77	6,8	6,76	6,8
ΔF	0,13	0,24	0,29	0,19	0,17	0,15	0,16	0,19	0,15	0,19
$Δn_{ср}$	99 min^{-1}									

With a three-start sampling drum, at 3840 min^{-1}

Table 2 c

Idle mode	3840	3840	3840	3840	3840	3840	3840	3840	3840	3840
Work mode	3654	3660	3648	3722	3642	3696	3714	3642	3680	3690
$n_д$	186	180	192	118	198	144	136	198	160	150
T_x	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248	0,248
$T_н$	0,261	0,260	0,262	0,256	0,262	0,258	0,257	0,262	0,259	0,258
F_x	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61	6,61
$F_Н$	6,96	6,93	6,98	6,82	6,98	6,88	6,85	6,98	6,9	6,88
ΔF	0,35	0,32	0,37	0,21	0,37	0,27	0,24	0,37	0,29	0,27
$Δn_{ср}$	166 min^{-1}									

With a single-pass variant of the sampling drum, at 4080 min^{-1}

Table 3 a

Idle mode	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080
Work mode	4056	4054	4050	4048	4052	4050	4046	4052	4056	4048
$n_д$	24	26	30	32	28	30	34	28	24	32
T_x	0,232	0,2325	0,2323	0,2322	0,2324	0,2323	0,2321	0,2324	0,232	0,2322

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$T_н$	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234
F_x	6,18	6,2	6,19	6,19	6,19	6,19	6,18	6,19	6,18	6,19
F_H	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24
ΔF	0,06	0,04	0,05	0,05	0,05	0,05	0,06	0,05	0,06	0,05
$\Delta n_{ср}$	29 min^{-1}									

With a two-pass variant of the sampling drum, at 4080 min^{-1}

Table 3 b

Idle mode	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080
Work mode	3996	3884	4008	3972	3940	3936	3970	3937	4015	3989
$n_д$	84	196	72	108	140	144	110	143	65	191
T_x	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234
$T_н$	0,238	0,245	0,238	0,24	0,242	0,242	0,24	0,242	0,237	0,239
F_x	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24
F_H	6,34	6,53	6,34	6,4	6,45	6,45	6,4	6,45	6,32	6,37
ΔF	0,1	0,29	0,1	0,16	0,21	0,21	0,16	0,21	0,08	0,13
$\Delta n_{ср}$	125 min^{-1}									

With a three-start variant of the sampling drum, at 4080 min^{-1}

Table 3 c

Idle mode	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080
Work mode	3912	3928	3938	3826	3912	3912	3884	3876	3912	3911
$n_д$	168	152	142	254	168	168	196	204	168	169
T_x	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234	0,234
$T_н$	0,244	0,243	0,242	0,249	0,244	0,244	0,245	0,246	0,244	0,244
F_x	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24	6,24
F_H	6,5	6,48	6,45	6,64	6,5	6,5	6,53	6,56	6,5	6,5
ΔF	0,26	0,24	0,21	0,4	0,26	0,26	0,29	0,32	0,26	0,26
$\Delta n_{ср}$	179 min^{-1}									

III.CONCLUSIONS

1. The regularities of changes in the frequency of rotation of the sampling drum for idle and operating modes of operation with one, two and three-way execution of the sampling drum were obtained experimentally.

2. The dependences of the change in the average values of the drop in the frequency of revolutions of the sampling drum in the operating mode on the increase in the frequency of rotation for one, two and three-way versions of the sampling drum are obtained. It was revealed that with an increase in the preset of the sampling drum, the sampling performance increases.

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