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The Processing and Analysis of Experimental Investigations into the Mechanisms for Removing Fine Impurities from Cotton

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Abstract:

To enhance the cleaning efficiency of machinery used in removing fine impurities from seeded cotton, a blind surface has been proposed as an alternative to the traditional mesh surface. The impact of modifications in the performance and structural integrity of the blind surface was assessed through computer-aided data recording. This involved a preliminary analysis of blind surface processes, evaluation of maximum and minimum force values, and examination of the fundamental characteristics of the ongoing processes.

Keywords: cotton, processing technology, impurities, theoretical framework, equations, louvered surface, power dynamics, purity, support structure.

Introduction

To collect data during the experimental studies referenced earlier, a 10-channel Topaz-3-02 strain gauge was employed, accompanied by an Agat power supply and an OBERTRON electronic device for inputting measurement data into a computer. This setup constituted a computerized measurement and information system【1】.

Key section

The precise evaluation of experimental study results relies heavily on the statistical analysis of the collected data. The numerical values representing forces and times are plotted along the coordinate axes. It has been observed that an increase in the thickness of the blind surface influences both the vibration range and frequency of that surface.

The theory of cotton raw material processing indicates that the primary cleaning action occurs in the central region of the working body. This phenomenon arises because cotton experiences considerable friction against the side walls of the cleaner at the edges of the pile drum, resulting in a degree of deceleration.

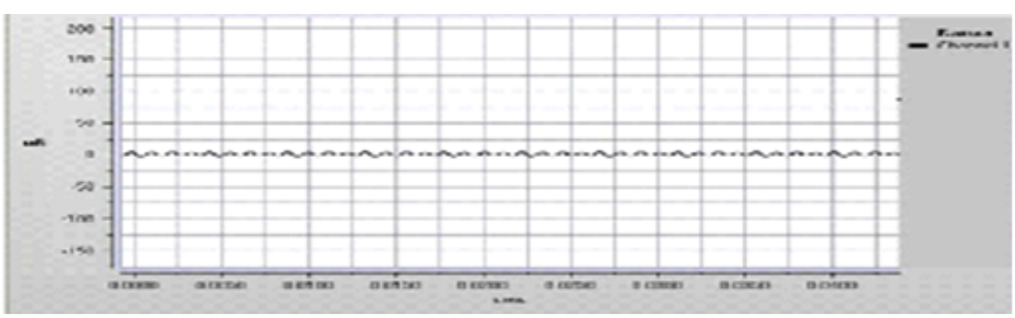
To investigate these load conditions, it is advisable to perform experimental studies on the surface of the blinds. The values derived from the vibration range and frequency of the louvered surface are presented in Table 1.

Experimental Data on Vibration Range and Frequency of the Louvre Surface

Table 1

Experiences	Max/ Min	IRP-1267 NTA branded rubber						IRP-1354 NTA branded rubber						IRP-1338 NTA branded rubber					
		5 t/s		6 t/s		7 t/s		5 t/s		6 t/s		7 t/s		5 t/s		6 t/s		7 t/s	
		Mv	mm	Mv	mm	Mv	mm	Mv	mm	Mv	mm	Mv	mm	Mv	mm	Mv	mm	Mv	mm
1- experience	max	18	0,50	34	0,95	56	1,56	24	0,67	48	1,34	67	1,87	29	0,81	65	1,82	80	2,24
	min	12	0,33	14	0,39	17	0,47	16	0,44	17	0,47	19	0,53	20	0,56	17	0,47	23	0,64
Scale	Δ	6	0,16	20	0,56	39	1,09	8	0,22	31	0,86	48	1,34	9	0,25	48	1,34	57	1,59
0,028	Yukl, H	0,21		0,695		1,365		0,201		1,66		1,205		0,175		0,65		1,05	
2- experience	Max	64	2,17	68	2,31	103	3,50	76	2,58	82	2,78	108	3,67	88	2,99	86	2,92	114	3,87
	Min	9	0,30	11	0,37	19	0,64	9	0,30	10	0,34	18	0,61	10	0,34	12	0,40	22	0,74
Scale	Δ	55	1,87	57	1,93	84	2,85	67	2,27	72	2,44	90	3,06	78	2,65	74	2,51	92	3,12
0,034	yukl, H	2,34		2,425		3,57		2,505		2,11		3,42		1,79		1,95		2,71	
3- experience	Max	63	2,01	69	2,20	105	3,36	72	2,30	88	2,81	114	3,64	82	2,62	95	3,04	118	3,77
	Min	9	0,28	12	0,38	14	0,44	10	0,32	14	0,44	16	0,51	12	0,38	14	0,44	18	0,57
Scale	Δ	54	1,72	57	1,82	91	2,91	62	1,98	74	2,36	98	3,13	70	2,24	81	2,59	100	3,2
0,032	yukl, H	2,16		2,48		3,64		1,98		2,31		3,205		1,57		1,90		2,64	
4- experience	Max	20	0,56	43	1,20	57	1,59	26	0,72	61	1,70	71	1,98	35	0,98	68	1,90	82	2,29
	Min	11	0,30	13	0,36	15	0,42	15	0,42	18	0,50	19	0,53	18	0,50	16	0,44	21	0,58
Scale	Δ	9	0,25	30	0,84	42	1,17	11	0,30	43	1,20	52	1,45	17	0,47	52	1,45	61	1,70
0,028	yukl, H	0,315		1,31		1,505		0,305		1,206		1,461		0,26		1,06		1,28	

As productivity rises, the amplitude of vibrations correspondingly increases, while an increase in the strength of the louvre surface leads to a reduction in vibration amplitude. More than 80% of the cotton being cleaned from minor impurities in cotton cleaners primarily settles in the central zone of the drum, with the remainder of the cotton flow traversing the edges of the drum. The friction between the cotton and the side walls of the cleaner in this area results in a lower significance of the cotton's speed compared to that in the central region of the sliding zone.



free state

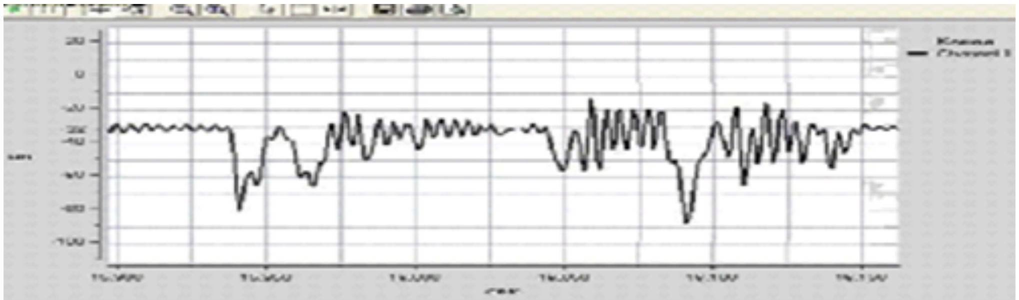
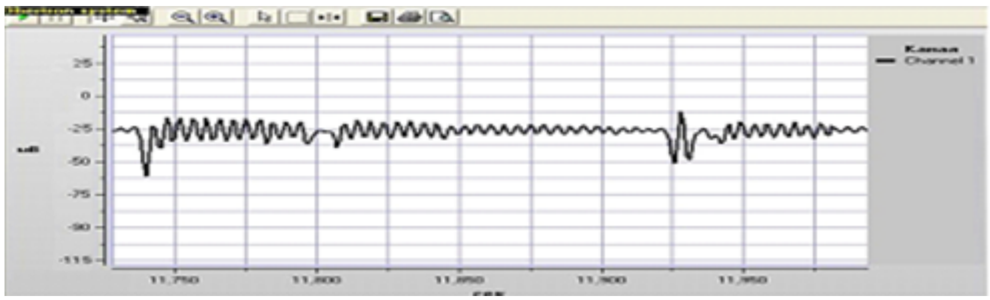


Figure 1 illustrates the vibrations of the oscillating meshes positioned on the opposing edges of the louvre surface.



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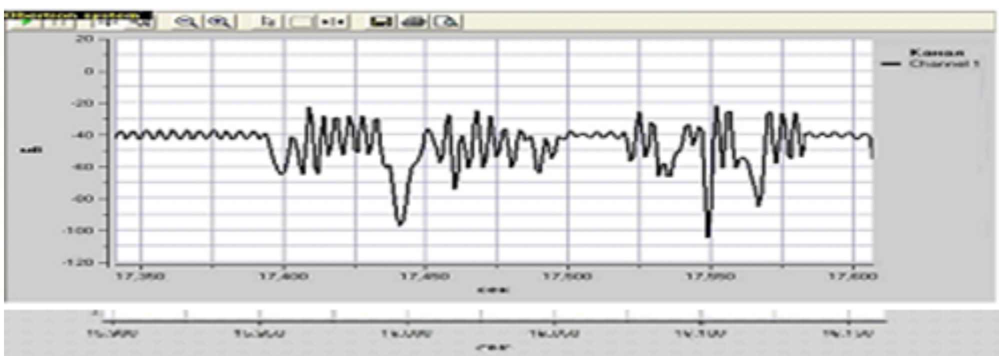

Figure 2 displays the vibrations of the flexible plates located in the central section of the louvered surface of the cleaner.

Analysis of the vibration records from the oscillating louver surfaces indicates that as loads increase, the vibration amplitude rises for both the central and edge louver surfaces of the cleaner. However, the frequency of forced vibrations of the louvre surface remains relatively constant, regardless of the working drum's rotation speed or the number of pile rows present.

Further examination of the data reveals that as the thickness (or stiffness) of the louvre surface increases, the range of vibrations decreases. For instance, at a thickness of 0.6 mm and a load of 0.5 t/h, the vibration range of the louvre surface reaches 0.45 mm at the edges and 2.45 mm in the center. When the load is increased to 7.0 t/h, the vibration range on the central louvre surfaces reaches 1.70 mm, while the edge surfaces experience a range of 2.9 mm.

Conversely, with a louvre surface thickness of 0.4 mm, the vibration range is observed to be 0.25 mm at the edge louvre surfaces and 1.87 mm at the central mesh surfaces under a load of 5 t/h. As productivity increases to 7.0 t/h, the vibration range for 1.9 mm thick louvre surfaces reaches 2.9 mm in the center and 1.17 mm at the extremes.

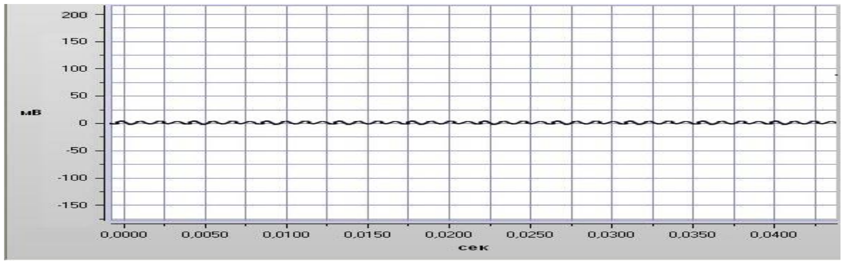

Figure 3 presents a graphical representation of the installation of the louvered surface, illustrating the positioning between the edges and the center of the louvered surface.

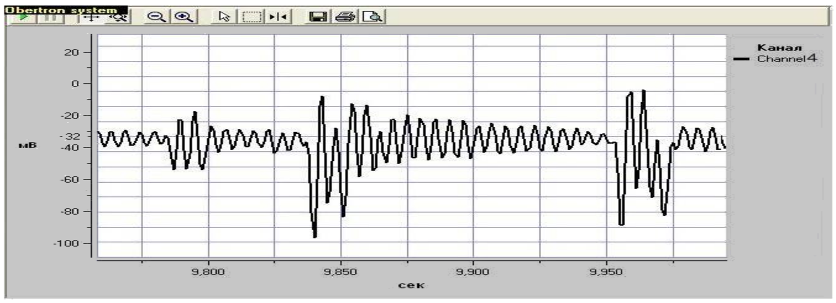

Figure 4 displays a performance graph depicting the variations in vibration values of the oscillating louver surfaces of the cotton cleaner.

It is important to note that as the load increases from 5.0 t/h to 7.0 t/h, the difference in the vibration range averages between 0.8 mm and 1.15 mm. This variation can be attributed to the fact that cotton flows more uniformly through the center of the spinning drum compared to the edges.

Figure 4 illustrates the graphical relationship between the load applied to the louvre surface and the effectiveness of cleaning cotton from small impurities. When plates with a thickness of 0.5 mm are installed in the central zone of the louvre surface, the load ranges from 1.57 N to 2.64 N as productivity increases from 5.0 t/h to 7.0 t/h. In contrast, with a flexible blind surface thickness of 0.9 mm, the load indicator rises from 2.16 N to 3.64 N.

For the louvre surface, the load varies from 0.21-0.31 N to 1.36-1.50 N, with a mud thickness of 0.9 mm. As productivity increases from 5.0 t/h to 7.0 t/h, the groove with a thickness of 0.5 mm shows a load range from 0.17-0.26 N to 1.05-1.28 N. This data suggests that greater thickness in the louvre surface support requires an increased load for deformation.

Figure 5 presents a view of the rubber bushing of the cotton cleaner, which is installed on the louver surface.

It is crucial to investigate the coefficient of uniformity (thickness) of the support of the louvre surface, particularly when the wiper alters the positioning of the depressions on the surface. Generally, the grooves on the louvre surface significantly impact the cleaning effectiveness; however, an increase in the height of the pods may lead to greater fiber damage. Therefore, it is essential to determine the optimal height for these depressions.

Figure 3.7 illustrates the graphs depicting the relationship between the vertical vibration coverage of the louvre surface and the uniformity of the support. An analysis of the graphs reveals that as the uniformity coefficient values increase from 1.3×10^{-3} N/m to 2.5×10^{-3} N/m, while the height of the grooves on the louvre surface remains at 1.0×10^{-3} m, the vertical vibration coverage of the louvre surface decreases linearly from 2.41×10^{-3} m to 0.73×10^{-3} m.

Conclusion

In comparing the connection graphs obtained from theoretical research (Figure 3.7, graph 3), it is observed that the mutual difference diminishes as the values of "S" increase, remaining within the recommended coefficient of uniformity range of 6.0 to 7.5. Correspondingly, the values of vertical vibrations of the louvre surface decrease linearly from 1.8×10^{-3} m to 0.24×10^{-3} m when the height of the grooves on the louvre surface is 0.5×10^{-3} m (Figure 3.7, graph 2).

To ensure that the recommended values of vibration and coverage for the louvre surface are met, it is advisable to utilize rubber 1338, which has a base uniformity coefficient ranging from $(1.2 \times 10^{3}$ to $1.5 \times 10^{3})$ N/m.