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Kherson National Technical University**RESEARCH OF WORK OF MECHANICAL SELF-CLEANING DUST LEADER**

In industrial workshops, the dust content of the air often exceeds the maximum permissible concentrations. A mechanical self-cleaning filter has been developed and tested, which, in comparison with analogues, better captures fine (aerosol) dust of air by means of a rotating disk.

The paper presents the results of studies on the cleaning of ventilation air from dust using a mechanical self-cleaning filter.

Keywords: self-cleaning filter, air cleaning from dust.

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Херсонський національний технічний університет**ДОСЛІДЖЕННЯ РОБОТИ МЕХАНІЧНОГО ПИЛОВЛОВЛЮВАЧА З САМООЧИЩЕННЯМ**

У виробничих цехах запиленість повітря часто перевищує гранично допустимі концентрації. Розроблено та випробувано механічний самоочищається фільтр, який в порівнянні з аналогами, краще вловлює дрібну (аерозольну) пил повітря за допомогою обертального диска.

В роботі викладені результати досліджень по очищенню вентиляційного повітря від пилу за допомогою механічного фільтра що самоочищається.

Ключові слова: фільтр що самоочищається, очищення повітря від пилу.

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Херсонский национальный технический университет**ИССЛЕДОВАНИЕ РАБОТЫ МЕХАНИЧЕСКОГО САМООЧИЩАЮЩЕГОСЯ ПЫЛЕУЛОВИТЕЛЯ**

В производственных цехах запыленность воздуха часто превышает предельно допустимые концентрации. Разработан и испытан механический самоочищающийся фильтр, который по сравнению с аналогами, лучше улавливает мелкую (аэрозольную) пыль воздуха при помощи вращающегося диска.

В работе изложены результаты исследований по очистке вентиляционного воздуха от пыли с помощью механического самоочищающегося фильтра.

Ключевые слова: самоочищающийся фильтр, очистка воздуха от пыли.

Formulation of the problem

It is known that a long stay of a person in a dusty environment causes occupational lung diseases. The level of dustiness of industrial premises depends on the productivity of labor, the quality of products and, most importantly, the health of people. Therefore, cleaning the air from dust at enterprises is a paramount and important task [1].

Analysis of recent research and publications

At present, various dust collection systems from the air are used in production plants. One such system is the pneumatic extraction of dust, its transportation through pipelines with subsequent separation from the air [2]. Such systems do not always work effectively. Therefore, the concentration of dust in the working area of production facilities often exceeds the maximum permissible standards.

Formulation of research objectives

The purpose of the research was to develop and test a mechanical self-cleaning filter to capture fine dust from the air. The scope of the assignment included;

- manufacture of a prototype mechanical self-cleaning filter.
- testing a mechanical self-cleaning filter when cleaning the ventilation air in the production room.
- testing a mechanical self-cleaning filter when cleaning the air from the equipment.

Statement of the main material

Studies on the purification of ventilation air from dust were carried out in an installation, a general view of which is shown in Fig. 1. The installation consists of a fan 2 operating from an electric motor 1. A filter 3 made of organic glass is mounted on the suction socket of the fan. The filter has the shape of a circular disc and is perforated with holes of 5 mm. On the outside of the filter is a nylon mesh. A knife 4 fixedly attached to the shaft 6 is closely adjacent to the fixed filter. The blade is closely attached to the filter surface by a spring 5. The

shaft passes through the sleeve 7 and is rotated by the electric motor 9 through the reduction gear 8. The knife shaft and the fixed filter are located in the hopper 10, intended for dust collection.

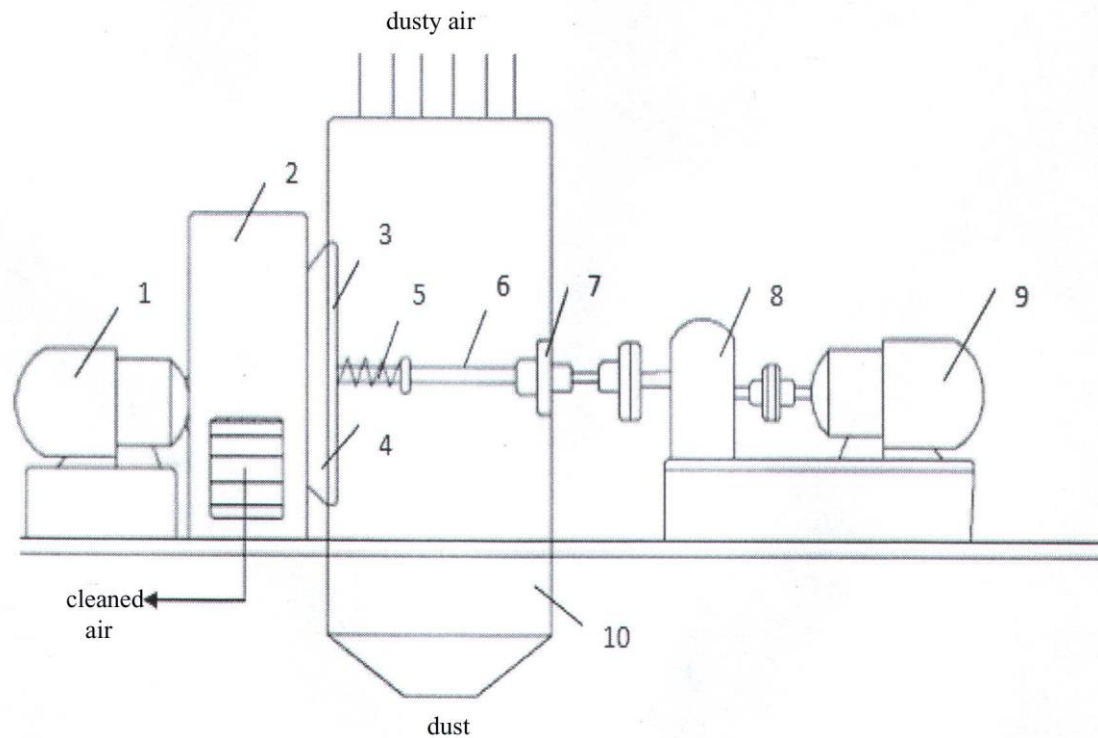


Fig. 1. General view of the experimental setup: 1 - electric motor; 2 - the fan; 3 - the filter; 4 - the knife; 5 - a spring; 6 - shaft; 7 - the bushing; 8 - reducer; 9 - the electric motor; 10 - hopper for dust collection

When the unit is operating, dusty air enters through the open top of the hopper 10, passes through the filter 3, and then is vented to the atmosphere by means of a fan. Dust particles are retained on the surface of the filter, forming a filter layer. As the dusty air passes through the filter, the thickness of the filter layer increases, its aerodynamic resistance increases, and productivity decreases. There comes such a moment when the resistance of the filter increases so much that the movement of air practically ceases. The layer of textile dust formed on the filter surface plays a dual role. On the one hand, it is a filtering element, which increases the degree of gas purification, on the other - increases the resistance of the filter and reduces the performance of the fan. Therefore, the optimal option would be a constant presence on the disk of a layer of fibrous dust of a certain thickness.

The procedure for carrying out the experiments consisted in the fact that dusty air was passed through the filter for a certain time [3]. The trapped layer of dust was removed from the filter element and weighed on an analytical balance. Knowing the amount of dust and the concentration of dust in it, as well as the amount of dust removed from the filter element, determined the efficiency of the apparatus (weight method).

The filter regeneration time in the experiments varied from 0 to 8 hours. Initially, the filter underwent continuous regeneration with a constantly rotating knife. After that the knife for dust removal was switched on after an hour, two, etc. In each case, the dust collected from the filter was weighed and the total amount was determined. Then the amount of dust collected in 1 hour was calculated. The operating time of the installation in all cases was 8 hours. The results of these studies are given in Tab. 1 and in the graph of Fig.2.

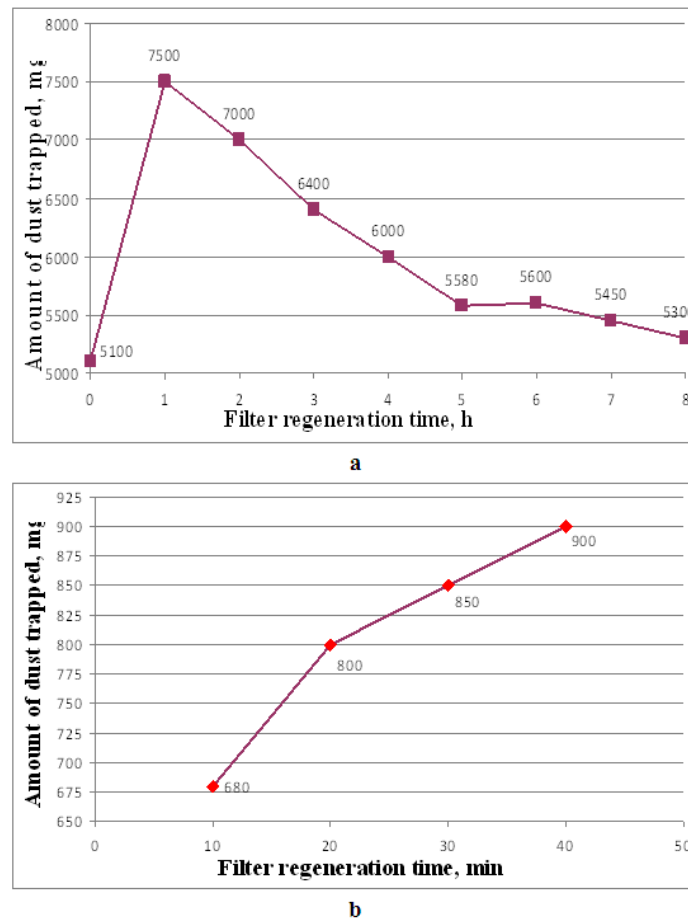


Fig. 2. Dependence of the amount of dust trapped on the filter regeneration time

Table 1

Absolute and specific amount of dust captured on the unit

№	Indicators	Filter regeneration time, h									
		0	1	2	3	4	5	6	7	8	
1	The amount of dust trapped by the installation during the test, mg	5100	7500	7000	6400	6000	5580	5600	5450	5300	
2	Average amount of captured dust, per 1h, mg	630	937	875	800	750	725	700	681	662	

It can be seen from the graph that in the first series of experiments with continuous filter regeneration, air purification was insufficient (637 mg/h). This is explained by the fact that in the absence of a layer of dust on the grid, its "slip" through the filter cells [4] is observed. As the thickness of the dust layer increased, the amount of dust trapped increased and reached a maximum (0.37 mg/h) with a regeneration time of 1h. By this time a layer of 1mm thick was formed on the filter. This was enough to achieve almost complete dust collection. With a further increase in the regeneration time, the degree of gas purification increased, but at the same time the resistance increased and the productivity of the installation decreased by air, so that the total amount of dust trapped was reduced. With a regeneration time of 2 hours, the amount of dust trapped was reduced to 875 mg, after 3 hours - 800 mg/h and so on.

As the filter works, a filter layer of dust forms on its surface. Moreover, the longer the operating time, the greater the thickness of the filter material layer. However, the relationship here is not straightforward. Tab. 2 and the graph in Fig. 3 show the change in the thickness of the filter material layer on the filter disk, depending on the filter operation time.

Table 2

The influence of the operating time of the installation on the thickness of the filter bed

Operating time, h.	1	2	3	4	5	6	7	8
Thickness of the filtering layer, mm.	1	1,75	2,4	2,9	3,3	3,6	3,8	4,0

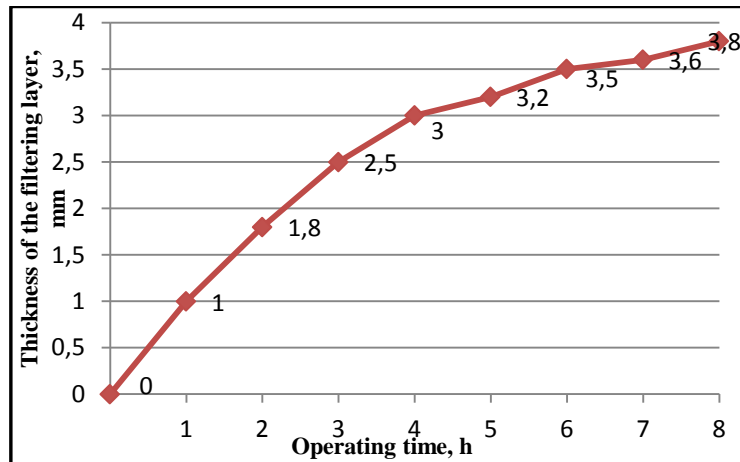


Fig. 3. Influence of the operating time of the installation on the thickness of the filter layer

From the data given, it can be seen that the increase in the thickness of the filtering layer is not the same in time. So for the first hour it was 1 mm; for the second 0,75; for the third - 0,65; the fourth is 0,5, and so on. Reduction in the increase in the thickness of the dust is associated with a decrease in the capacity of the filter due to the growth of its resistance.

The influence of the thickness of the filter layer on the filter resistance is shown in Tab. 3 and in the graph of Fig.4.

Table 3

Effect of the thickness of the filter layer on the resistance of the filter

Thickness of the filtering layer, mm	0	1	1,75	2,4	2,9	3,3	3,6	3,8	4,0
Time of formation of the filtering layer, h	0	1	2	3	4	5	6	7	8
Filter resistance, mm of water column	80	120	125	130	135	140	145	150	160

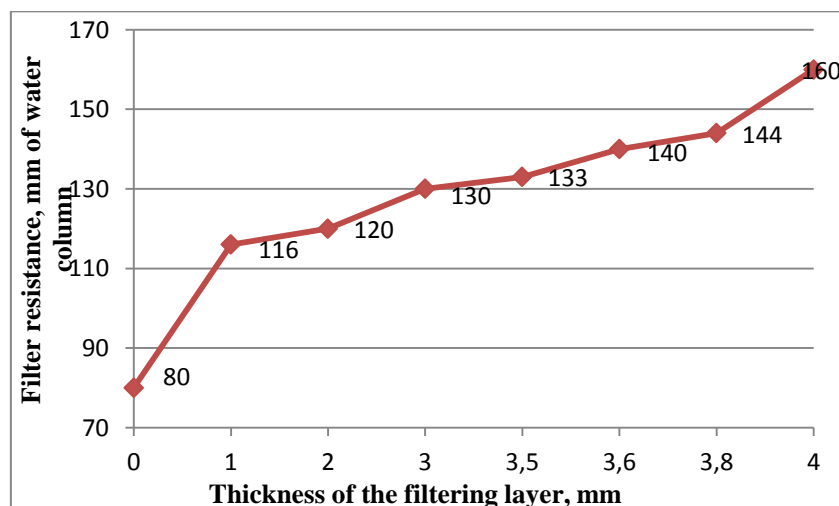


Fig.4. Effect of the thickness of the filter layer on the resistance of the filter

The data show that the resistance of the filter increases with time. So, if the filter without a layer of fibrous dust had a resistance of 80 mm of water column, then after one hour of its operation the resistance increased by one and a half times and amounted to 120 mm of water column, and after 8 hours of filter operation

it increased to 160 mm of water column, became 2 times more than the original. This leads to a decrease in the throughput of the filter.

The technique of these experiments was that the velocity of the air emerging from the filter was measured. Knowing the air velocity and the diameter of the channel, the filter capacity was determined. The measurements were made for different thicknesses of the filtering layer (Table 4 and graph, Fig. 5).

Table 4

Effect of filter resistance on its performance

Filter operating time, h	0	1	2	3	4
Thickness of the filtering layer, mm	0	1	1,75	2,5	2,9
The resistance of the filter, mm of water column	80	120	125	130	135
Average air velocity from anemometer measurements, m/h	4,8	2,2	2,1	1,9	1,85
Plant capacity, m ³ /h	1000	450	400	380	350

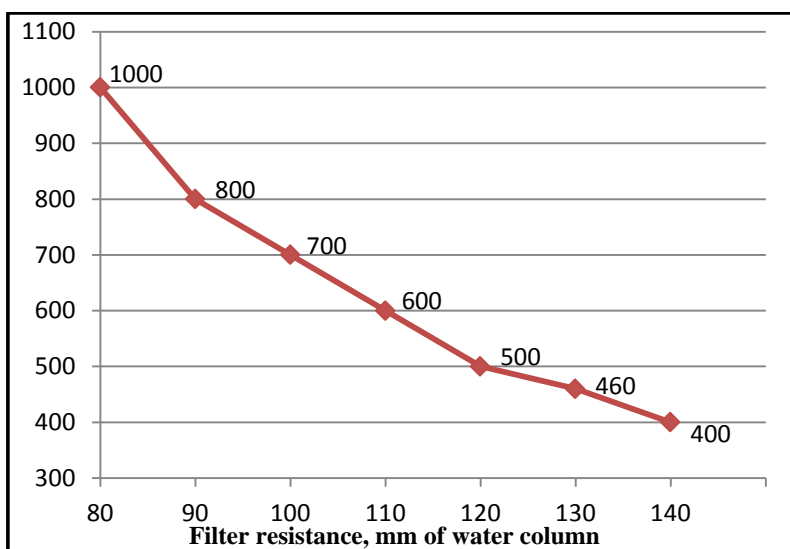


Fig. 5. Effect of filter resistance on performance

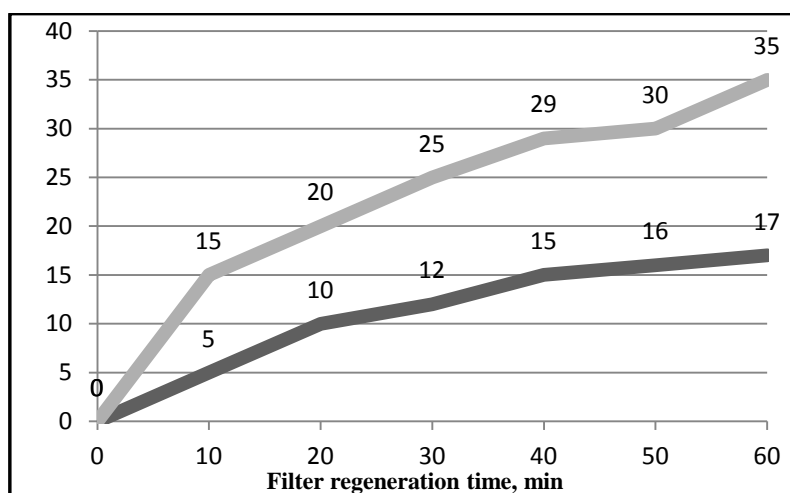


Fig. 6. Effect of filter regeneration time on performance

The given data testify that with increase in resistance the filter performance sharply decreases, especially after the first hour of operation. Without a layer of dust on the filter, its resistance was 80 mm of water column, which corresponded to an average air velocity of 4,8 m/s and a capacity of 1000 m³/h. After an hour, when a 1 mm layer of dust formed on the filter, and its resistance increased to 120 mm of water column, the air velocity decreased from 4.8 to 2,2 m/s, and the productivity to 450 m³/h, respectively.

After 4 hours of operation, the thickness of the dust layer on the filter was 2.9 mm, which increased the filter resistance to 135 mm of the water column, the average air velocity decreased to 1.85 m/s, and the productivity to 350 m³/h, almost three times. From this it should be concluded that the filter should not allow the formation of a layer of dust more than 1 mm. To do this, it is necessary to regenerate the filter once per hour.

Conclusions

1. The proposed design of a self-cleaning filter contributes to the creation of a stable aerodynamic operation of the dust collection system.
2. The device allows reducing dust content in 9 - 10 times.
3. With a stable aerodynamic mode, the degree of air cleaning from dust is 90%.
4. The dust collector can be used to clean air from fine dust.

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