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DEVELOPMENT AND OPERATION OF THE INSTALLATION FOR CLEANING AIR FILTERS OF QUARRY DUMP TRUCKS

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Abstract: The widespread use of heavy-duty dump trucks for intra-quarry freight transportation is a current direction for meeting existing modern energy and environmental requirements in this industry.

In the process of carrying out research and practical work on the operation of heavy-duty mining dump trucks, it was established that it is necessary to improve the technology of maintenance (MOT) of the internal combustion engine air purification system, where one of the important components is the use device for mechanized air cleaning

filters, allowing to improve the quality of work and increase their service life.

This article presents the results of scientific developments carried out to determine the main parameters of a device for mechanized cleaning of cylindrical air filters of mining dump trucks.

Key words: mining dump trucks, engine air cleaning system, air filter cleaning device.

1. INTRODUCTION

Currently, modern vehicles, including mining dump trucks, widely use various filtration means, including. air purifiers of internal combustion engines (ICE), which are an important element of its air preparation system.

During the operation of mining dump trucks, polluted air passing through the air filter is cleared mainly of dust and, as a result, the air filter becomes clogged, which leads to a decrease in the filling ratio of the engine cylinders and its power and fuel-economic indicators deteriorate.

In order to exclude these possible cases,

air filters undergo a cleaning process. The frequency and frequency of cleaning air filters are determined depending on the specific operating conditions. However, the chosen method of cleaning air filters is important in ensuring the quality of the technological work performed and their rational service life.

It is known that determining a rational method for cleaning internal combustion engine air filters will provide the necessary scientific and practical information about the possibility of its use under operating conditions.

2. GOAL AND PROBLEM STATEMENT

It is well known that for new air filters, the cleaning coefficient begins to increase at the beginning of operation; due to the clogging of large pores with dust particles, or at the beginning of operation, the air filters become saturated with a layer of fine dust and their filtration efficiency increases , and then, after reaching the maximum value of the cleaning coefficient, it begins decrease due to clogging.

In this regard, air filter manufacturers use the average value of their cleaning coefficient.

Thus, conditionally, the entire period of air filter contamination consists of two parts, the first - the cleaning coefficient begins to increase to the maximum value, the second - the cleaning coefficient begins to decrease to the permissible value of the filter's hydraulic resistance to the flow of purified air, after which it requires cleaning.

Naturally, as the frequency of cleaning increases, the onset period shortens when, based on the hydraulic resistance of the filter to the flow of the air being purified, there is no need to clean it, i.e. the filter becomes oversaturated with retained dust particles, which largely depends on the method (manual or mechanized) of its cleaning.

Since the mass of residual dust after each mechanized cleaning of the air filter is much less than during manual cleaning, the time for the filter to become oversaturated with retained dust particles occurs much later.

In this regard, the research goal has been set - the development of an installation for mechanized cleaning of air filters with scientifically based parameters will provide the necessary scientific and practical information about the possibility of its use and operating features.

3. ANALYSIS OF PUBLICATIONS

Currently, there are many known methods for purifying air from solid particles, such as powder porous filter materials, electric vortex filters, electrocentrifugal particulate filters, resin-impregnated paper filters, synthetic fiber filters, etc. [1,2,3].

It is known that the type of filter elements determines their specific hydraulic resistance, specific air load and dust holding capacity with the same efficiency of air purification, and accordingly, the corresponding requirements for maintenance technologies are established [5,6,7].

Moreover, in recent years there has been a dynamic development of the technology for producing air filters from non-natural raw materials, but so far the bulk of filter elements for air purification are made of paper [4,8,9].

All modern technologies for cleaning air filters, including internal combustion engine air cleaners, are considered an active method, where retained dust is removed to varying degrees from their porous surface, thereby reducing the pressure drop (hydrodynamic resistance) across the filters and increasing the service life of the filters [10,11,12].

The concentration of dust in the quarry atmospheric air around a vehicle moving or performing loading and unloading operations is not constant and depends mainly on environmental parameters (humidity, temperature, pressure, wind direction), the type and condition of the road surface, the condition and composition (mineralogical and dispersed) transported cargo, precipitation, vehicle traffic conditions (speed, single or column) and other factors.

Therefore, the concentration of dust in the air around a moving car or other mining equipment has variable values. In this regard, the frequency and frequency of cleaning air filters also depends on the location of operation of quarry equipment in the quarry and, therefore, these circumstances can also affect the choice of method for cleaning contaminated air filters [13,14,15,19].

Thus, it should be stated that the choice of a scientifically based method for cleaning contaminated air filters of internal combustion engines of quarry equipment and the development of an installation for the implementation of this method is an important approach for improving the technology of maintenance (TO) of the engine air treatment system.

4. RESEARCH METHODS

Currently, almost all manufacturers of internal combustion engine air purifiers, when testing their products, are guided by the requirements of existing regulatory documents [16,17,18].

Since cleaning ICE air cleaners from dust must take into account the complex processes of their contamination, the selected parameters of the installation being developed for this purpose should ensure the quality of the work performed and a possible increase in their service life.

An assessment of the degree of dust removal from internal combustion engine air cleaners during manual and mechanized cleaning installations is made by comparing the mass of residual dust after the appropriate cleaning method.

The developed installation also makes it possible to determine the hydraulic resistance to air flow and at the same time the tightness of the cleaned filter by vacuuming (creating a pressure difference between the embedded and outer surfaces of the filter) using an exhaust (suction) air fan.

5. RESULTS AND DISCUSSION

5.1. Fundamental design features

The installation for mechanized cleaning of air filters was developed taking into account the nature of their contamination (dust retention by inertia, by the blocking effect and by the diffusion effect). Since air filters work on the principle of depth filtration and, therefore, retained dust particles (up to approximately 20 microns in size) must be removed from the thickness of the filter material. Trapped dust particles and trapped in the depths of the structure of the filter material should be cleaned with a reverse flow of compressed air while simultaneously creating the necessary pressure difference between the internal and external surfaces, centrifugal forces using a pulsed (up-down) rotational movement, as well as blowing out larger particles with the outer surface of the air cleaner with a tangential flow of compressed air (Fig. 1). This approach eliminates the pressing of dust into the pores of the filter element structure, filter deformation, ruptures of the filter element and other possible defects during manual cleaning.

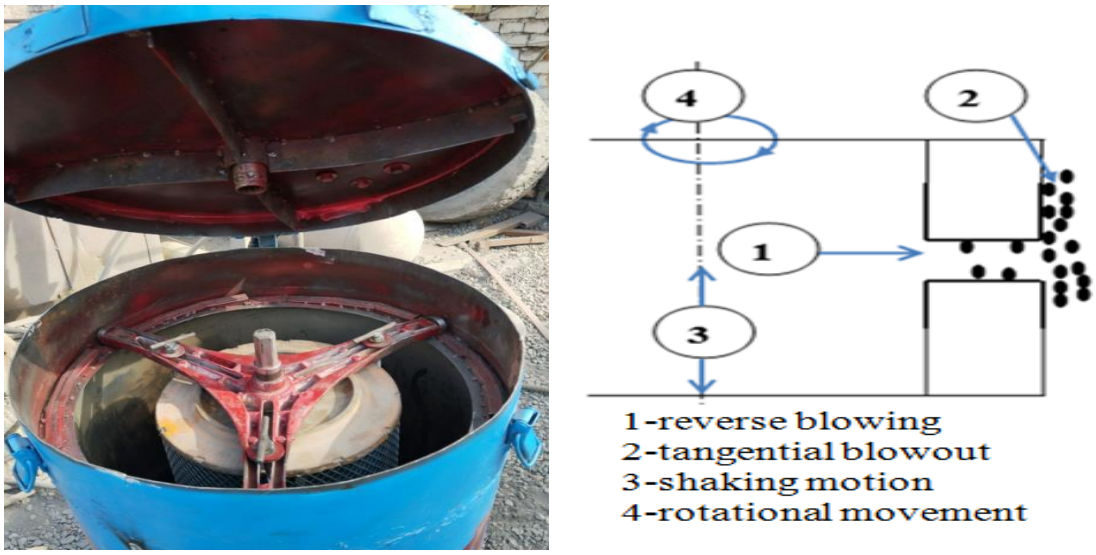

Fig.1. Diagram of the operating principle and appearance of the mechanized installation cleaning air filters from dust

The installation works as follows. The air cleaner to be cleaned is installed inside the housing on a mandrel, compressed air is supplied to the internal cavity of the filter (reverse blowing) and at the same time mechanical shaking (axial vibration) and rotational movements are transmitted to the air filter, and also at the beginning and at the end of cleaning, tangential blowing of the filter with compressed air is carried out . The end of the air filter cleaning process is determined by the reading of a mono-vacuum gauge or differential pressure gauge by the value of the reduction in the hydraulic resistance of air passing through the filter.

5.2. Operational testing of a mechanical air filter cleaning installation

In order to determine individual comparative evaluation indicators of the developed installation for mechanized cleaning of air filters, operational tests were carried out in the conditions of the quarry of Shargunkumir JSC. The comparative effectiveness of methods for cleaning contaminated filters was assessed based on the average mass of residual dust after cleaning (See table)

Table.

Performance tests installations for mechanized cleaning air filters

Air filter cleaning method	Air mass filter, g		Average mass of residual dust after cleaning, g
	new	polluted	
Manual	3315±1.0	3850±55	16.5±2.5
Mechanized			11±2.0

5.3. Discussion of experimental results

Performed operational studies to determine the effectiveness of mechanized cleaning of air purifiers showed that the use of this cleaning method makes it possible to reduce the mass of residual dust after cleaning and thereby improve the quality of work performed during the maintenance of the air treatment system of mining dump truck engines.

6. CONCLUSION

Comparative operational studies of an installation for mechanized cleaning of air filters have shown that the use of this installation simultaneously ensures the quality of the work performed and an increase in the frequency of reused air purifiers after cleaning, which in turn will reduce operating costs and significantly improve the working conditions of workers.

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