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IMPACT OF TECHNICAL ELEMENTS ON AIR DUST MOVEMENT IN THE INDUSTRIAL ASPIRATION SYSTEM OF POSITIONING AIRTUBES

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Annotation

Aspiration system function is dust extraction in the production area and transportation to the dust traps through the airtubes. Dust particles that are transported through the airtube remain in certain parts of the tube, partially or completely blocking the tube is one of the most common issues in the industrial aspiration systems. As a result of such processes, the airtube resistance increases, as well as the friction pressure also expands and all of the above leads to the disruption of normal operating schedule.

Analyzing the results of a large number of studies in this area, it was found out that dust extraction inside the airway, in the horizontal and hinged areas of the airways and turned, disassembled, combined, as well as in parts far away from the ventilator often occur. Therefore, as an aim of preventing the dust particles settlement to the airtube, taking into account the peculiarities of air-dust motion and by analyzing the principles of functioning of the methods and tools used up to now, it is necessary to consider the ways to achieve effective functioning of the aspiration system by research conducting.

Keywords: dust particles, ventilation, aspiration, airflow, airtubes, gas, safety, dispersion.

Introduction.

One of the topical issues up to date is combating with settled dust on the aspiration system airtube. This is because to clean the settled dust on the airtube is spent too much time for the working functions like completely stopping the aspiration system and partially cleaning the area of settled dust particles and due to the mixed location of the tube with the production facilities, such work becomes dangerous. Also, until these works are complete, and taking into account that all technological processes need to be stopped is known to have a negative impact on industrial productivity. At the same time, it is difficult for the dust extraction devices to operate efficiently during the dust extraction process, as it may cause system failure.

The process of extracting mineral resources and obtaining raw materials out of it. In the process of extracting mineral resources and obtaining raw materials out of it, during technological and other works at the mining and processing factories and sorting shops, it is observed that dust extraction in the production premises is 10-100 times higher than the minimum permissible concentration (MPC). Nowadays, the aspiration system is considered to be the most effective and widespread in precautionary measures of these issues. The function of the aspiration system is dust extraction in the production area and transportation to the dust traps through the airtubes. Dust particles that are transported through the airtube remain in certain parts of the tube, partially or completely blocking the tube is one of the most common issues in the industrial aspiration systems. As a result of such processes, the airtube resistance increases, as well as the friction pressure also expands and all of the above leads to the disruption of normal operating schedule. Depending on the danger of combustible or explosive dust particles, due to the decreasing of the transverse section area of the tube in the airtube parts with the dust slab, sharp increase in air flow rate and because of the collision of dust particles transported by the settled dust slab, there is a risk of fire or explosion. In addition, the excessive amount of dust in the production premises may be a consequence of causing injure to laborers, and early discontinuance of industrial materials and technical equipment [1].

To ensure long lasting and efficient operation of aspiration systems, during the processes of their planning and installation works, it is necessary to observe accomplishment of the following technical specifications. For dust absorption from the dusty area in the aspiration system airtubes, it is desirable for the tube to be positioned at the minimum distance between the ventilation and starting point of the airtube and to have the air intake of the airtubes relative to the horizontal plane at 45-60^0 angles. The number of pumping out nozzles in the airtubes should not exceed six. In addition, aspiration systems are integrated into one or multi-purpose devices with dust holding capacity. For instance, if the amount of absorbed dust exceeds 3-5 g / m3, it uses a two-stage dust holding system. [2].

During the process of designing aspiration systems it is determined the velocity of the air flow depending on the maximum size of the transported dust particles and the type of dust. Gaining of dust and air flow rate increases hydraulic resistance in aspiration lines and leads to premature wear of the tube. Large parts of the transported dust remain on the lower surface of the tube and forming an additional roughness of the tube surface, with small dust particles hanging up in this roughness, and finally changing the aspiration system parameters due to the inner air tube [3].

For formation of the dust slab in tubelines in turbulent airflow mode, due to the uneven speed of dust and air flow in the airtubes near the area of the airtube wall which causes settlement of dust particles instead of its transfer [4].

The results of studies of dust-air turbulent flow indicate that the concentration of dust particles in the lower part of the tube increases. Such a transition rate leads to the gravitational sealing of dust particles at the bottom of the tube [1].

The results of the researches of disperse composition of dust transported by the airtube inwards of the aspiration system. As the results of the researches of disperse composition of dust transported by the airtube inwards of the aspiration system show that the large particles of dust (25mym) at the starting point of the aspiration system were 70%, and the fine particles of dust (5mym) were 6-25%. In the central part of the system large particles of dust increased by 50%, while large particles declined by 10-20%. The amount of the small dust particles was 90%, and the large dust particles were 6% near the ventilator. From this situation we see that depending on the distance between the dusty zone and the ventilation slopes due to the lack of air flow velocity required for the transport of large dust particles inside the airtube, from the affect of gravity force the large dust particles settling in the inside of the tube was found out [3]. At present, many industrial enterprises use a large number of ripe filters and cyclones for the dust extraction process, because the operation principles of these devices is simple and high efficiency.

When comparing the technical data of the devices with dust holding capacity it has been established that the effectiveness of the joining devices can reach 80-85%, and the cyclone can reach 95-98%. However, the effectiveness of the devices with dust holding capacity depends primarily on the size of the dust particles. For example, the effectiveness of the cyclone at 7-10 microns dust particles is 65%, with the efficiency of 98% at holding the large dust particles of 15-20 microns in size. And the effectiveness of holding 25mym dust particles in centrally-rotary devices was 85%, in inertial dust holders this figure was 50-60%. It is known that aspiration systems in the production will eventually reduce the efficiency of dust extraction from 70-80% to 40-50% [3]. The results of the conducted expert studies show that the reasons for such low efficiency of the dus holders are the following: the appearance of many holes along the airtubes of the aspiration system, the depletion of dust particles inside the airtube, the increased aerodynamic barrier inside the airtubes and for other reasons.

The geometric dimensions of the settled dust slab were obtained by separating the airtubes from the 16 aspiration systems operating in the production. As a result, the degree of the airtube cleanliness degree was measured by the relationships of the ratio "S" for the area that is not covered by the dust particles and the "S_0" ratio in the area of the clean airway (table 1.). On the basis of these data, the extent to which the dust particles, cyclones and the dust particles affected by the aspiration system were assessed to have an effect on the dust content [4].

Table 1 – Results of inspection of aspiration systems

Number of the aspiration system	Cyclone productivity Q_c, m^3/s	The degree of dust cleanliness of the airtube S / S_0	Effectiveness of dust holders E, %
1	0,80	0,83	52,98
2	1,95	0,87	58,96
3	1,95	0,90	66,01
4	0,80	0,92	72,34
5	2,69	0,91	72,77
6	1,79	0,63	25,09
7	1,85	0,58	21,50
8	1,96	0,75	38,58
9	1,88	0,23	11,19
10	1,96	0,36	18,45
11	1,96	0,24	04,45
12	2,99	0,40	10,22
13	1,88	0,97	88,94
14	1,96	0,93	80,70
15	2,05	0,04	03,22
16	1,84	0,92	74,17

The extent of these parameters depends on the distribution of dust concentrations in the transverse section of the airway, curvature of the airway angle, fraction and chemical composition of the dust and other factors. In the vertical areas of the airtube the dust settles in the tube only in a case when the adhesive force of the dust is very high. Settlement of dust particles is most common in the horizontal or hinge areas of the airtube. It is recommended as an aim of not settling the dust in these areas, the required airflow rate must not be less than 18-20 m/s so that the dust passes through the air in these zones [3]. The rate of settlement of dust particles is the rate of diffusion coefficient and the settlement velocity of dust particles, which are expressed by the local Reynolds number. Therefore, the main factors affecting the thickness and shape of the dust slab are airflow velocity and dust particles concentration. As can be seen from the experimental results in Table 1, as the thickness of the dust slan in the inward of the airtube increases, the effectiveness of the dust holding devices is shown to be low [4].

The air flow rate value inside the airtube of the aspiration system, not only during the start or stopping of the aspiration system, as well as in the case of the settlement of the transported dust particles into tubelines are subjects to change. Settled dust slab in the airtubes may block the tube completely or partially [5].

Also, according to the total length of the airtube, the gas velocity is marked by lack of fluctuation and the diameter of the tube is equal in all sections and the radius of the rotation of the pipe is consistently similar, the aerodynamic resistance of the pipe decreases. During the operation of such an aspiration system dust particles conveniently settle into the inward of the pipe.

When blasting with airflow, the blowing force affects all the particles in the air slab. Strength of the dust slab is the bonding between dust particles and the surface of the pipe depends not only on adhesion, but also on the interaction of dust particles with autogheria. There are adhesion-denudation, autoadhesion-erosive and adhesion-autoadhesion three types of the dust particles extraction if the settled dust slab in the pipe is affected by the air flow [1].

Table 2 - Autoadhesion strength of the dust slab due to different types of adhesion

Adhesion group	Type of dust	Autoadhesion strength of the dust slab, mg/sm^2
I	non-sticky	0-200
II	slightly sticky	200-2000
III	medium sticky	2000-7000
IV	strongly sticky	> 7000

During the denudation extraction the upper surface of the dust slab is extracted, and when the erosion it is observed by the splitting of the dust slab surface. In dust holding experiments, interaction of the weight of particles in the dust slab is of great interest. The autoadhesion of the dispersed mass depends not only on the autoadhesive properties of the material of the dust particle, but also on other important factors. For example, the viscosity of the dust particles can be assessed on the basis of the strength of the dust slab.

The physical and chemical properties of the dust particles affect the degree of adhesion of the dust holding devices and the airtube walls. Due to the degree of viscosity, dusts are divided into 4 groups (table 2): non-sticky, slightly sticky, medium sticky and strongly sticky.

This classification was obtained in the production of about 30 types of dust without taking any objective effects. And on an objective index, it is possible to refer the autoadhesion strength of the dust slab. As a result of the measurements carried out in relation to different types of adhesion, it is possible to determine the autoadhesion strength of the dust particles. Table 3 summarizes the test results of dust detection by cyclones and electrostatic precipitators.

Table 3 - Autoadhesion strength of the dust slab

Type of dust	Place where the dust is tested	Autoadhesion strength of the dust slab mg/sm^2	Adhesion group of dust
Magnesite	Electrolysis:		
	I square	3400	III
	II square	4960	III
Lime	Cyclone of electrolysis:	408	II
	I square	436	II
	II square	520	II
	Electrolysis:		

Dolomite	I square II square III square	207 266 320	II II II
Chamotte	Electrolysis: III square	 339	 II

Conclusion.

If any of these dust slabs appear in normal conditions, its strenght can be as a viscosity value of dust particles. The relative index of the stickyness of the dust particles, gives an idea of the properties of the dust slab and the behavior of the dust particles. However, it is difficult to determine the actual strength of the dust slab that occurs on the walls of the dust holding devices.

The strength of the settled dust slab of dust particles that emerge from devices with dust holding capacity and other technical equipments can be clearly identified only from the operating devices or from the model specimens obtained from the test.

The most effective way to determine the strength of the dust slab is to determine by air erosion [2]. It means that by gradually amplifying the air flow index transmitted through the slim-oriented thin tube, because of particles extraction by the surface of the dust slab, due to the formation of the erosion groove, to determine the limit speed V_1 of the air flow [3,5]. It is not difficult to determine the sthrengh of the dust slab with any specific limit velocity of known airflow.

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Түйін

Аспирациялық жүйенің атқаратын қызметі, өндіріс бөлмесінде пайда болған шаңды со-рып, ауақұбырлары арқылы шаң тазалағыш құрылғыларға тасымалдап жеткізу. Өндірісте, аспирациялық жүйелерді қолдану барысында жиі кездесетін проблемалардың бірі, ауақұбыры арқылы тасымалданатын шаңбөлшектерінің, құбырдың белгілі бір бөліктерінде отырып қалып, құбырды жартылай немесе толықтай бітеп тастауы. Мұның нәтижесінде құбыр бойының кедергісі жоғарылап, үйкеліске жұмсалатын қысым көбейіп қалыпты жұмыс режимі бұзылады.

Осы бағытта жүргізілген көптеген зерттеулер нәтижелерін сараптай келе, шаңбөлшектерінің ауақұбыры ішінде отырып қалуы, ауақұбырларының көлденең және еңкіш орналасқан бөліктерінде және құбырлардың бұрылған, айрылысқан, қосылған, сондай-ақ желдеткіштен алыс орналасқан бөліктерінде жиі орын алатындығы анықталды. Сондықтан, шаңбөлшектерінің ауақұбыры ішінде отырып қалуын болдырмай алдын алу үшін, ауа-шаң қозғалысы механизмінің ерекшеліктерін ескеріп, және осы уақытқа дейін қолданылып келген әдістер мен құралдардың жұмыс істеу принциптерін сараптап, зерттеулер жүргізу арқылы, аспирациялық жүйенің нәтижелі жұмыс істеуіне қол жеткізу жолдарын қарастыру қажет.

Резюме

Как известно, работа аспирационной системы заключается во всасывании пыли из производственного помещения, в котором проводилась работа, через поздухопровод путем траспортировки к устройствам пылеотсосов.

В процессе производства, во время работы аспирационной системы одной из наиболее распространенных проблем являются частицы пыли, которые в процессе транпортировки оседают в определенных частях труб и частично, либо полностью останавливают ее работу. В результате преграда вдоль трубы и давление передающееся к трению увеличиваются и нарушается постоянный режим работы.

На сегодняшний день оргомное количество производственных процессов проходят с выделением в воздух вредных веществ, пыли, различных взвесей, которые пагубо влияют на оборудование и здоровье персонала. Раньше, работникам находившимся в зоне загрязненного воздуха, выдавались средства индивидуальной защиты, которые представляли собой респираторы с обычными фильтрами, но такая защита оказалось малоэффективной.

Фильтрующие элементы очень быстро забивались, и работник постоянно отвлекался на их замену. НО в последние время для очистки воздуха на многих предприятиях стали использовать более совершенную систему очистки воздушных масс - систему аспирации.

Система аспирации воздуха - это одна из разновидностией вентиляции, предназначенная для удаления из воздуха с последующей утилизацией различных твердых частиц, взвесей, из рабочих зон производственных помещений.

Summary

The work of aspiration system is sucking of the dust, transferring it to the vacuum cleaner devices. One of the biggest problems in the using of aspiration system is that the parts of dust transferring via the air-channel remain in the certain parts of the pipe and it stops the work fully or partly. As the result, the pressure increases and the permanent work regime is disturbed.

To date, the number of production processes has been increasing, with the release of harmful substances, dust, various suspensions into the air, which adversely affect the equipment and health of personnel. Previously, employees who were in the contaminated air zone were given personal protective equipment, which were respirators with conventional filters, but such protection proved to be ineffective.

The filter elements were quickly clogged, and the worker was constantly distracted to replace them. BUT in recent years for cleaning air in many enterprises began to use a more advanced system for cleaning air masses - the aspiration system.

The air aspiration system is one type of ventilation designed to remove from the air, followed by the disposal of various solid particles, suspensions, from the working areas of the production premises.