On Inertial Systems, Dust Cleaning and Dust Removal Equipment, and Work Areas in the Production of Aerated Concrete from the Hopper Suction Apparatus CSF

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Abstract

Production of concrete products, namely, applied technological equipment, the initial state of the raw materials used in the currently inefficient dust cleaning system, - everything contributes to the emission into the atmosphere of gas-air mixtures with a high content of dust. The research process, identifying bottlenecks, which are characterized by dusting, analysis of existing dedusting systems, their efficiency, performance, operation features in various media - is an important step of the time-processing activities to improve the effectiveness of work aspiration systems, to reduce dust emissions in the atmosphere. An analysis of the characteristics of the released dust, its properties and, especially, the particulate composition is optional and a prerequisite when choosing a construction of dust collector.

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Keywords: Production of aerated concrete; dust-cleaning system; the particulate composition of the dust; inertial machines; dust collectors; CSF devices.

Growth in housing and industrial engineering requires more building materials. One of the most popular, cost-effective construction material is aerated concrete blocks.

Along with the development of new technologies and formulations aimed at increasing strength and lowering of density in aerated concrete production plants for industrial manufactory for the production of aerated concrete

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products, as well as the majority of the production processes of the construction industry, there are common problems. One of them - unsatisfactory technical equipment of dusting system and localizing ventilation [1, 2, 3].

The use of raw materials in the free flowing (sand, lime, cement), and especially the technological process of aerated products, in combination with poor performance dedusting ventilation systems, leading to dusting of the air in the working area at various positions manufacturing line, emissions into the air, exceeding established standards of MPE. As a result, the problem of atmospheric pollution continues to be one of the main modern environmental problems [3, 4, 5, 6, 7, 8].

Features of the process, in particular placement of equipment and the nature of its work, especially of raw materials used in enterprises dedusting and cleaning methods, of air emitted into the atmosphere, all of this determine disperse composition of industrial dust.

Study disperse composition of industrial dust, i.e dust which released during the technological process, first of all it is important to analyze the adverse effects of human exposure. Choosing effective devices for cleaning the air of dust emitted into the atmosphere and devices designed for cleaning the air in the air-supply systems, aimed at providing comfortable working conditions and reduce the negative impact of the enterprise on the air - all this is directly related with the particulate composition of the resulting dust. Dispersed composition of dust - a quality indicator which reflects the distribution of dust particle size, is characterized by mass, volume, surface area and number of solids in different ranges of size, as well as their sedimentation velocities.

An important aim of studying disperse dust composition is to determine the concentration of contaminants in the ambient air at the inlet of the dedusting system of technological equipment, then through the outlet to air for less than 10 micron particles (PM10) and less particles it 2.5 microns (PM2.5) [9-13]

In the workshops for the production of aerated concrete for the removal of dust from dry dust collectors have been used with the two-step purification, which is primarily due to the high concentration and polydispersity dust free. Various types of cyclones are mainly used in the first purification stage. This type of dust collecting apparatus characterizes simple design, low energy consumption and operating costs. The downside is the inability to capture dust from the small size of the particles and low durability. The degree of purification in the bosom of the cyclones strongly depends on the disperse composition of dust particles in the incoming gas cleaning (the larger the particle size, the more effective the treatment) [14, 15]

In the second stage cleaning dust-gas streams bag filters are used, the use of which is limited to a relatively small air or gas volume, having a low temperature and moisture. However, the actual conditions of the manufacturing production line for the output of aerated concrete products differ sufficiently specific, precise air load, polydispersity of the released dust. The totality of the above circumstances, leads to insufficient degree of purification of dust-gas streams emitted into the atmosphere.

Most construction companies and other industries using pneumatic conveying systems, dust removal, containment ventilation inertial dust collectors have been used to counter swirling flow (CSF). These devices are characterized with increased compared with other dust-catchers performance - relatively low sensitivity to load variations in the air and the concentration of dust in the purified stream, a lesser degree of abrasion that knowledge, significantly increases the service life of these devices [16-19]. The main advantage of CSF to cyclones - more effects-trapping of 90-95%. This is achieved primarily a clearer organization of twist. Secondary twisted-flux helps support the flow-twist in the lower part of her body dust collecting device. The main cylindrical part of the swirl-gas flows are separated with different concentrations. Rotation of the dilute flow occurs in the central portion, and flows from the high concentrations - in the peripheral zone. After the separation chamber in the flow of low concentration to high concentration pushes the periphery of the device, leads to improving the efficiency of capture

CSF systems with dust collectors can also be single-stage, two-stage and multi-stage response. Designed layout scheme multistage engineering and environmental systems with eddy device (Fig. 1) [4, 17, 20, 21], the essential distinguishing singularities, of which is the implementation of the suction of air from the bunker area of the dust collector of the second stage with a return of the trapped product in process equipment (Fig. 1a), in engineering and ecological system (Fig. 1b), or engineering and environmental equipment (Fig. 1c).
Fig. 1. Scheme of the proposed layout systems with vortex machines with suction from the bunker of the second unit area when returning collected products: (A) in the process equipment; (B) engineering and environmental system; (C) engineering and environmental equipment; (D) the combined option; 1 - first apparatus, 2 - second apparatus, 3 - , 4 - fan, 5 - process equipment, 6 - lower input socket, 7 - upper input socket, 8 - flues, 9 - flap.
Fig. 2. Scheme of the proposed layout systems with vortex machines with suction from the bunker of the second unit area when returning collected products: 1 - first apparatus, 2 – second apparatus, 3 – third apparatus, 4 – fan, 5 - process equipment, 6 - lower input socket, 7 - upper input socket, 8 - flues, 9 - flap, 10 - discharger, 11 – main ventilator, 12 - return flow fan.

The advantages of such systems are: exception-set of the second discharger circuit apparatus; reduces the likelihood of clogging of the hopper of the second apparatus; suction apparatus from the hopper reduces leakage by 15-20%.

The arrangement according to the scheme shown in Fig. 1, and is usually used when process equipment is at a negative static pressure. In addition, the reset can be done at local pumps but it requires serious calculations prevention dust suction in the working area [22].

The arrangement according to the scheme of the system shown in Fig. 1, b, is suitable in the reconstruction of existing facilities with the amount of sucked dust cleaning intake air volume at 10-15% of the total flow entering the treatment, taking into account the performance and the pressure mounted.

The arrangement according to the scheme shown in Fig. 1 in, suitable in the reconstruction and with a large stock of the performance and the pressure set ventilator. In case the return gas from the second hopper of the apparatus on the lower input of the first lower unit can reach 15-27% of the gas flow entering the dust collection. This is due to the fact that the highest efficiency of the machines CSF different designs is achieved when the share of gas supplied to the lower input 27-33%.

The arrangement according to the scheme shown in Fig. 1 g, is used as a rule in the absence of stock performance and the pressure of ventilator. Expenditu re of gas sucked out of the hopper of the second unit is 5-10% and the optimum ratio of gas flow to the upper and lower input of the first apparatus is achieved by adjusting the first strapping machine.

Furthermore, it may be reduced aerodynamic resistance CSF apparatus by installing straighteners at the outlet of the first device which enable energy transfer residual air swirling at the outlet of the dust collector to the energy of the axial flow. One problem with dedusting systems with the return of dust and gas flow from the second device is a risk of dust deposition in the return flue. To prevent this, use swirler and twister [22, 23]. In addition, to create a swirling flow in the return duct can be use the energy of swirling flows in the second apparatus CSF.

The effectiveness of the system facilitates the installation of a fabric filter, which provides thin air purification, as well as the use of separator-concentrator - the results of previous studies by the authors have shown that the efficacy of the device is increased when applying different dusty flows on the top and bottom of the dust collector CSF inputs. This fabric filter through the installation of inertial devices is protected against overload by dust, which ensures stable operation of the system.

Research inertial dust cleaning systems and dedusting equipment, and work areas in the production of aerated concrete from the hopper suction apparatus CSF, technological equipment scheme was proposed "Fig. 2 ". To solve a system of equations is composed:
\[
\begin{align*}
L_{nc} + L_{nat1} &= L_{nat1} \\
L_{nat1} &= L_{at3} + L_{at2} \\
L_{omco2} &= A(L_{at2} + L_{at2}^n) \\
L_{at3} &= L_{at2}^n + L_{omco2} \\
L_{omco2} &= BL_{at3} \\
L_{at4} &= L_{omco2} + L_{omco3}
\end{align*}
\] (1)

\[
\begin{align*}
G_{nc} + G_{nat4} &= G_{nat1} + G_{y31} \\
G_{nat1} &= e_1(G_{nc} + G_{nat4}) \\
G_{nat1} &= G_{at2}^n + G_{at3} \\
G_{at3} &= G_{at2}^n + G_{atmco3} \\
G_{at2}^n &= e_2 G_{at3} \\
G_{at2}^n + G_{at2} &= G_{atm} + G_{atmco2} \\
G_{atm} &= e_2(G_{at2}^n + G_{atm2}) \\
G_{at4} &= G_{atm4} + G_{y34} \\
G_{at4} &= e_3 G_{at4} \\
G_{at4} &= G_{atmco2} + G_{atmco3}
\end{align*}
\] (2)

Slip function \( e_i \) is defined on the basis of experimental studies:

\[
\begin{align*}
e_1 &= e_1 \left( \frac{L_{nc} + L_{nat4}}{L_{at2}} \right) \\
e_2 &= e_2 \left( \frac{L_{nc} + L_{nat4}}{L_{at2} + L_{atm}^n + L_{atmco2}} \right) \\
e_3 &= e_3 \left( \frac{L_{nc} + L_{nat4}}{L_{at2}} \right) \\
e_4 &= e_4 \left( \frac{L_{nc} + L_{nat4}}{L_{at2}} \right)
\end{align*}
\] (3)

where in

- \( L_i \) - the inlet gas flow rate in the apparatus \( i \)- (i = 2 ... 3), m³ / s;
- \( G_i \) - Dust flow inlet device \( i \)- (i = 2 ... 3), kg / s,
- \( e_i \) - a leakage coefficient \( i \) apparatus, A, B - coefficients defined-based adjustment system,
- \( G_{at2}^n, G_{atm2}^n \) - on the lower dust discharge and the upper inlet \( i \) apparatus,
- \( L_{at2}^n, L_{atm2}^n \) - the gas flow rate respectively on the upper and lower inlet \( i \) apparatus,
- \( L_{atmco2} \) - a suction of gas consumption The apparatus of \( i \) apparatus,
- \( G_{atmco2} \) - dust flow in the suction unit of \( i \) apparatus.

The solution of the method of successive approximations, allows to determine the modes in terms of the efficiency of the dust collector.

Thus, in the production of aerated concrete in the dedusting systems, dust collectors can be effectively utilized CSF returning collected products from the second unit.
References