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Assessment of the efficiency of gas and dust cleaning systems in asphalt-concrete plants

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Abstract
This article provides calculations of pollutant`s emission into the atmosphere, calculations of inorganic dust and the efficiency of the gas cleaning plant. And also, hydrodynamic modes of bubble absorbers are given for the Samarkand asphalt concrete plant.

Keywords: Flow, inorganic dust, efficiency, hydrodynamic mode, bubbling absorber, speed, layer, density, gas-containing

Introduction

Over the past decade serious practical steps, that would significantly change the attitude of the human community to nature, to the problem of its preservation, to ensure the sustainable development of future generations. The bank of unsolved environmental problems continued to increase. There are many reasons for this, and among them, not least is the weak professionalism of the decision makers in the field of environmental protection, in particular, in its protection from industrial waste. The above fully applies to the problem of protecting atmospheric air from dust and gas emissions. A large number of sources can significantly pollute the air. Low sources are those, in which the emission is lower than 50 m, and high sources are meant as an emission higher than 50 m. Conventionally they call sources that have an air-gas mixture temperature above 50 °C; at lower temperatures, emissions are considered cold [1, 6].

Emissions of enterprises of different industries and transport contain a large number of various harmful impurities. Samarkand ELUP is located in the village Farhad, Samarkand city. The main activity of the enterprise is the production of asphalt-concrete mix and concrete products. The production capacity of the enterprise is 200 thousand tons per year of asphalt concrete mix, and production of 10 thousand m^3/year of reinforced concrete structures. Asphalt-mixer brand AMMAN with a capacity of 160 tons at one o'clock. The production activity of the enterprise is carried out on the same industrial site, in the following workshops and areas: administrative and household buildings, crushing and screening workshop, asphalt concrete workshop, bitumen storage, cement storage, boiler room, reinforcement workshop, machine shop, garage, workshop for manufacturing concrete products (road borders), fuels and lubricants.

Methodology

On the territory of Samarkand ELUP, 38 emission sources were identified, pollutants occur as a result of the operation of the following equipment and technological operations: Asphalt-mixing device "AMMAN" - 1 pieces. The plant capacity is 200,000 tons of asphalt concrete per year with a capacity of 160 t/h. Opening hours 1300 hours/year. The aspiration system cyclone degree of purification -85% is installed in the equipment. Annual gas consumption is 660 thousand m^3/year. Calculation of inorganic dust emission, specific dust emission from an asphalt mixing plant according to the method, the concentration of dust entering the cleaning is 30g/m^3. The volume of the gas-air mixture is 4,4m^3/s (3,452nm^3/s).

Inorganic dust M = 30 * 3.452 = 103.56g/s.
Inorganic dust M = 103.56 * 1300 * 3600/106 = 484.6608g/s.

After cleaning, the inorganic dust enters the atmosphere:

M = 103.56 * (1-85 / 100) * (1-99.9 / 100) = 0.0155341 g/s.
Inorganic dust M = 0.0155341 * 1300 * 3600/106 = 0.072699 t/g.

The effectiveness of the dust-cleaning gas installation is determined by the formula:

ђ = ($M_н$-$M_к$)/$M_н$ * 100% = 61, 7- 9.3/61.7 * 100 = 84.9
$M_н$-is the initial concentration of mg/m3;
$M_к$-final concentration mg/m3.

The reliability and efficiency of gas cleaning systems depends on the physicochemical properties of the particles to be captured, and on the basic parameters of dust and gas flows. To improve the cleaning efficiency, baffle plates and perforated sheets are installed in the washing chamber, on the path of gas movement. A sprinkler is installed at the end of the wash chamber.

Main part

The effectiveness of almost all dust collectors depends on the particle size distribution. However, the work of electrostatic precipitators is also influenced by the electrical resistivity of ash and dust layers, temperature and humidity of gases. The operational reliability of many devices depends on the stickiness of the particles and their abrasiveness, the initial dustiness of gases and their aggressiveness. [2, 34]

The hydrodynamic mode of the bubble absorbers depends on the reduced gas flow rate on the bubble plates of the absorber, which is defined as the ratio of the gas flow to the working area S_{work} of the tray.

S_{work} = S-E S_{work} where, S is the total area of the dish, E S_{work} is the sum of the areas occupied by the overflow. If the equated velocity is small, the gases are bubbled as separate bubbles. As the above velocity increases, individual bubbles merge into a continuous jet, which at some distance from the orifice of the plate breaks up into separate bubbles, forming a gas-liquid layer of cellular-film structure. The transformation of the gas jet into separate bubbles due to the hydraulic resistance of the layer of the absorption solution on the plate. [3. 21]

Exiting to the surface of the layer, the shells of gas bubbles burst almost immediately, forming splashes that rise above the layer to a certain height, depending on their size and the speed of the released gas flow. Increasing the gas flow rate decreases the bubbling area and increases the zone of fixed foam. The ultimate is the bubbling process, called foam mode, when the bubbling zone is replaced by the foam zone.

Most of the absorption solution may be in the bubbling zone, however, the maximum contact surface is developed in the foam zone. The boundaries of hydrodynamic regimes for each design of the plates are different and determined in specific cases by empirical formulas.

Gas-containing φ is a ratio of the volume occupied by the gases in the layer to the total volume of the layer. The density of the layer $p_п$ depends on both on the density of p_d gases and on the density of the absorption solution $\rho_ж$

$$\rho_п=\varphi\rho_г+(1-\varphi)\,\rho_ж \cong (1-\varphi)\,\rho_ж$$

The relative density of the layer is determined by the equation

$$k=\frac{\rho п}{\rho ж}=1-\varphi$$

The amount of absorption liquor on the plate is determined by the height of the clear liquid h_0 equivalent to the height of the $h_п$ layer and expresses the amount of liquor held (in m^3) per 1 m^2 of the plate`s area. There is a relationship between these values.

$$\frac{h0}{hп}=1-\varphi=k$$

The contact surface of the phases is determined by the surface of the bubbles in the gas-liquid layer. The specific surface of the contact phase α_s per unit area of the plate is determined as follows:

$$\alpha_{s=}\ \alpha h_п=\frac{6\ \varphi hп}{dп}=\frac{6\ \varphi ho}{dп(1-\varphi)}$$

Where $\alpha = \alpha_s / h_п$ is the specific contact surface per unit volume of the gas-liquid layer; $d_п$ is the bubble`s diameter.

Plate full flow resistance:

$$\Delta P = \Delta P_1 + = \Delta P_2 + = \Delta P_3.$$

The hydraulic resistance of a dry plate is determined by a formula that takes into account local resistance:

$$\Delta P1 = \varepsilon\ pr\omega 2 / 2$$

The resistance, caused by the surface tension forces,m that arise when gases exit from the holes of the dish into the layer of the absorption solution is determined by the formula

$$\Delta P3 = \varepsilon\ \sigma\Pi / S = 4S / d_{equivalent}$$ where,

P and S - the perimeter and cross-sectional area of the hole (slot);

$d_{equivalent}$ - equivalent diameter of the hole (slot).

The resistance of the gas-liquid layer approximate is taken to be equal to the static pressure of the layer:

$$\Delta P2 = g\rho ж h0 = g\rho_п h_п$$ where,

$\rho_ж$ and $\rho_п$ are the densities of the light liquid and foam, respectively. For vehicles with a movable nozzle also characterized by the presence of several hydrodynamic modes of operation. [2,567]

Conclusion

The proposed bubble absorber with the establishment of an asphalt concrete plant, the effectiveness of the dust of the gas treatment plant asphalt concrete plant increases from 95% to 99%.

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