REFERENCES

1. Водопроводные сети и сооружения : учеб.-метод. комплекс для студентов специальности 1-70 04 03 «Водоснабжение, водоотведение и охрана водных ресурсов» / сост., общ. ред. О.С. Софинской. – Новополоцк : ПГУ, 2004. – 180 с.
2. Правила технической эксплуатации систем водоснабжения и водоотведения населенных мест : Приказ Мин-ва жил.-коммунал. хоз-ва Респ. Беларусь № 20. – Минск, 2008 – 119 с.
3. Надежность в технике. Основные понятия. Термины и определения : ГОСТ 27.002-89. – Введ. 01.07.90. – М. : Ин-т машиноведения АН СССР, Межотрасл. науч.-техн. комплекс «Надежность машин» и Госком СССР по управлению качеством продукции и стандартам, 1990. – 12 с.
4. Примин, О.Г. Обеспечение надежности и долговечности водопроводных трубопроводов // НДТ – Наилучшие доступные технологии водоснабжения и водоотведения. – 2013. – № 2. – С. 232–241.
5. Абрамов, Н.Н. Водоснабжение : учеб. для вузов / Н.Н. Абрамов. – Изд. 2-е, перераб. и доп. – М. : Стройиздат, 1974. – С. 480.
6. Эксплуатация систем водоснабжения, канализации и газоснабжения : справ. пособие / В.Д. Дмитриев [и др.] ; под ред. В.Д. Дмитриева, Б.Г. Мишукова. – 2-е изд., перераб. и доп. – Л. : Стройиздат, 1988. – С. 383.

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OPTIMAL PLACEMENT OF ISSUES SUPPLY THE DIFFUSERS AND EXHAUST AIR DUCTS GENERAL VENTILATION

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At an article consider issues of improving industrial ventilation by optimal location of supply and exhaust devices General systems. Article include scheme of air movement by using different diffusers and exhaust devices and formulas to determine their optimal placement.

Ventilation should provide the required climatic and sanitary conditions, especially in the working area. In practice, however, most often take the supply of clean air to the upper zone where it is superheated and saturated with gas and dust hazards, and from there transports them then in the working area. The upper distribution of supply air generally excludes the possibility of reliable maintaining the necessary purity of the atmosphere in the working area.

The inflow to the upper zone is justified only by convenience of laying of air ducts. To opt out of this scheme of distribution of air, the need for new approaches in the design of the physical facilities, allowing not to blow, flooding the work area with supply air.

Widespread distribution obtained of jet supply air does not provide uniform ventilation of the working area. In this case, are formed as active and overly ventilated, and stagnant zones that are not consistent with the increase of air environment quality and completeness of using the beneficial properties of fresh air [1].

The location and design of supply air ducts and diffusers in are in accordance with the production technological and the layout of its equipment. But with any change of technology is necessary to reconstruct system of transportation and distribution of air. The actual ski are not yet available ventilation solutions for the efficient ventilation of the working area in terms of enterprises with frequently changing technology. But flexible technology will be basis of domestic industrial enterprises.

The supply air must come directly into the working area and evenly to ventilate to the entire volume, regardless of production technology. Only in this case possible any re-arrangement of production equipment without reconstructing ventilation systems.

These tasks conforms to the design premises with two floors: the lower primary and upper perforated [2]. Inlet diffuser should be placed evenly between the sexes and to release clean air directly into the underfloor-space. From there he will go straight into the working area through the perforations of the upper floor and continuously displacing harmful emissions up, will provide the necessary purity of the atmosphere.

To reduce the amount of air issuing from the holes should be at slow speed, which may be of the order of 0.1-0.15 m/s, i.e. less than the permissible speed in the working area. In addition, to approach the people to the equipment in the necessary places on the floor are superimposed perforated metal sheets in tracks. Generally, such overhead sheets, you can adjust the flow of air on the floor, directing more volume to work areas and process equipment. The division of the underground section with independent air supply ducts allows you to create the appropriate microclimate and purity of air in the required places under any arrangement of process equipment [3].

Schematic of flow through perforated floors are particularly suitable for hot shops and light industry, as well as wherever you need to maintain the purity of the atmosphere in the whole volume or local areas of the working area.

Section space under perforated floors, and can be equipped with exhaust ventilation, if necessary extraction from the lower zone (for shops with the release of dust, heavy gases, vapours).

In the case of the use of perforated about column air terminal unit, due to the specificity of its design, its installation is performed in each column, and the about column air terminal unit are located at the longitudinal walls of the building in a staggered manner relative to the columns. At a certain distance from the outer surface of the perforated air terminal unit supply streams are merged into one big free jet (Fig. 1). When you merge in the moment of impact of the streams on the stream there is some loss of energy, which leads to a decrease in the rate of total movement in the formed jet.

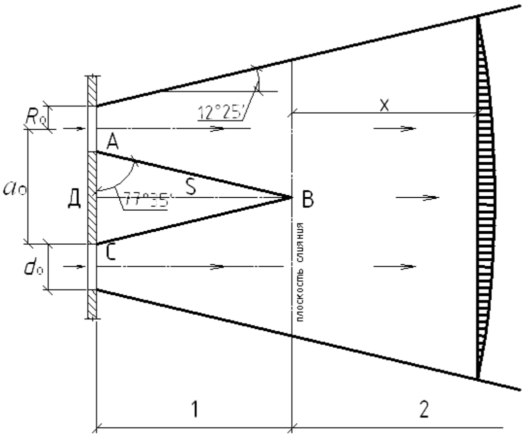

Fig. 1. The structure of the air flow generated by a perforated air terminal unit:
1 – plot of individual streams; 2 – continuous air jet

The merging of the air streams occurs at a distance from the holes, which can be calculated by the formula:

$$S = \frac{1}{2} \cdot (a_0 - 2) \cdot R_0 \cdot tg\left(90^0 - \alpha\right), \quad (1)$$

where a_0 – the distance between the centers of the holes air terminal unit, m;

R_0 – the radius of the perforations, m;

$\alpha = 12^0 25'$ – the expansion angle of a free air jet.

Average speed of air movement, m / s, on the approach to the plane of confluence of the streams will be:

$$\upsilon'_{cp} = 3{,}2 \cdot \upsilon_0 \cdot R_0 \cdot \frac{\varepsilon}{S}, \quad (2)$$

where υ_0 – the initial velocity of the exit air from the perforations, m/s;

$\varepsilon = 0{,}6$ – the compression ratio of a jet;

S – the distance from the exit air streams from the perforations to the plane of their merger, m.

The average total speed of jet plane after the merge is determined by the formula:

$$\upsilon''_{cp} = 3{,}2 \cdot (1 - k) \cdot \upsilon_0 \cdot \frac{R_0}{(S + x)}, \quad (3)$$

where $k = 0{,}1 \div 0{,}2$ – the coefficient of interinhibitive air streams at the time of their merger;

x – the distance from the plane of the merge up to that point the total jet, m.

Full range generatrix of the jet ends when it reaches speed

$$\upsilon''_{cp} = 0{,}2\, м / c.$$

From the expression (3) we find:

$$S + x = \left(\frac{1}{\upsilon''_{cp}}\right) \cdot 3{,}2 \cdot (1 - k) \cdot \upsilon_0 \cdot R_0.$$

Then when $\upsilon''_{cp} = 0{,}2\ м / c$ have the length of the jet:

$$l_{cmp} = S + x = 16 \cdot (1 - k) \cdot \upsilon_0 \cdot R_0. \quad (4)$$

When the width of the workshop premises from 12 to 24 meters effective working area is ventilated enclosures through perforated ducts or air terminal unit placed along the long walls (Fig. 2). In this case, the exhaust air is carried out through several evenly suction air duct, located in the upper zone.

In this equipment arrangement the width of the space, m, will consist of the following:

$$B = 2 \cdot (\theta + \delta + l_{стр}) + c, \tag{5}$$

where θ – the gap between the outer wall and air terminal unit or air duct, m;

δ – the width of the air terminal unit or diameter of the air duct, m;

$l_{стр}$ – the range of the air stream formed by air terminal unit or perforated air duct, m;

c – the distance of air movement by inertia and due to the suction action of the channel.

The range of the jet is calculated by the formula (4).

General suction air ducts it is advisable to run from the floor to a height, m:

$$H = h_{р.з.} + 2 \div 4\, м.$$

The distance between the axes of the suction air ducts should be equal to:

$$l_{вс} = 0{,}25 \cdot B, \tag{6}$$

where B – the width of the space, m.

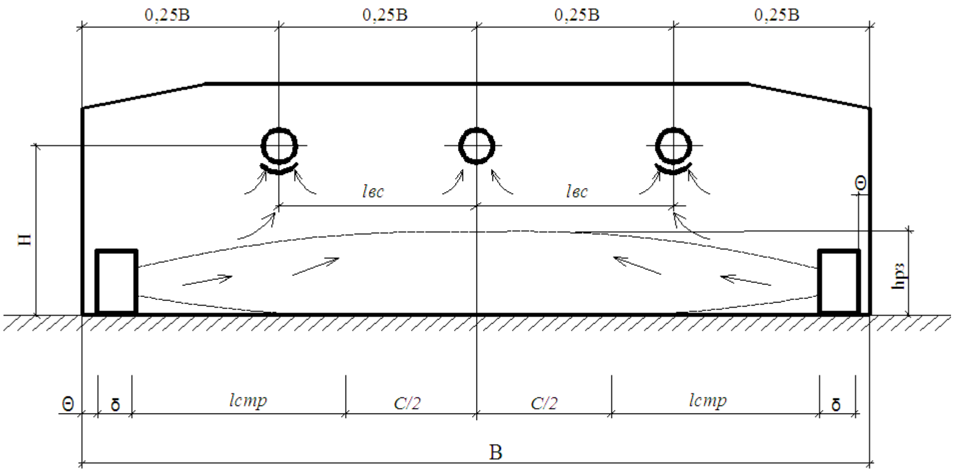

Fig. 2. The scheme of ventilation through the perforated air terminal unit and exhaust air ducts

When designing systems, General ventilation is often the placement of the air ducts take, without any computational studies, which negatively affects the efficiency of air exchange in the premises.

In large shops sometimes have perforated the supply air terminal unit to run parallel to each other (Fig. 3).

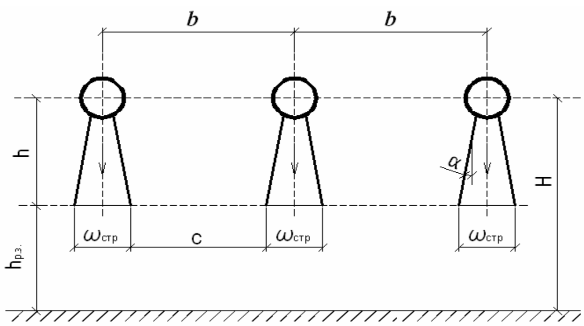

Fig. 3. Scheme to the determination of the distance between the air ducts

In this case the distance between their axes, m, can be defined by the formula:

$$b = 2 \cdot h \cdot ctg(90 - \alpha) + c, \tag{7}$$

where h – the distance between the border of the working area and the outlet air duct, m;

$\alpha = 12^0 25'$ – the expansion angle of a free turbulent air jet;

$c = 3 \div 5\,м$ – the distance needed to distribute supply air between the rows of air ducts.

The width of the inlet slit is taken to be constant, it only changes its length along the air duct.

Required the height of the laying of air ducts:

$$H = h + h_{р.з.}, \tag{8}$$

where $h_{р.з.} = 2\,м$ – the height of the working area.

The average speed of the jet of air, $м/с$, at the upper boundary of the working area will be:

$$\upsilon_{ср} = \frac{1{,}71 \cdot \upsilon_0}{\sqrt{\frac{h - d/2}{B_0}}} = \frac{1.71 \cdot \upsilon_0}{\sqrt{\frac{2 \cdot h - d}{2 \cdot B_0}}}, \tag{9}$$

where υ_0 – the air velocity at the exit of the air duct, m/s;

d – the diameter of the air duct, m

Since the jet velocity at the upper boundary of the working area is equal $0{,}2\,m/s$, when the altitude from the expression (9) find the necessary initial velocity of the jet at the exit:

$$\upsilon_0 = 0{,}16 \cdot \sqrt{\frac{2 \cdot h - d}{2 \cdot B_0}}, \tag{10}$$

In this case, the length of the flat jet (height) is taken within 1 m.

The height of the suspension inlet air duct, m, with uniform distribution of air downwards from the through-holes (Fig. 4) will be determined by the formula:

$$H = \frac{dв}{2} + h + h_{р.з.}, \tag{11}$$

where $dв$ – the diameter of the supply air duct, m;

$h_{р.з.} = 2\,m$ – the height of the working area.

$$h = \left(\left(\frac{a_{ср} - l_{ср}}{2} \right) \cdot tg\left(90^0 - \alpha\right) \right), \tag{12}$$

where $a_{ср}$ – the average distance between the centers of the inlet holes of the air duct, m;

$l_{ср}$ – average hole length, m;

$\alpha = 12^0 25'$ – the expansion angle of a free turbulent air jet.

$$H = \frac{dв}{2} + \left(\left(\frac{a_{ср} - l_{ср}}{2} \right) \cdot tg\left(90^0 - \alpha\right) \right) + h_{р.з.}. \tag{13}$$

The application of these recommendations and the use of the above formulas will allow the design of General ventilation systems taking into account the position of supply and exhaust devices to meet specific climatic and sanitary conditions in the working area with the least expenditure of energy and materials.

REFERENCES

1. Батурин, В.В. Основы промышленной вентиляции / В.В. Батурин. – М. : Стройиздат, 1990. – 448 с.
2. Луговский, С.И. Совершенствование систем промышленной вентиляции / С.И. Луговский, Г.К. Дымчук. – М. : Стройиздат, 1991. – 136 с. : ил.
3. Повышение санитарно-гигиенической, экологической и энергетической эффективности систем вентиляции : учеб. пособие по курсу «Вентиляция» / С.И. Луговский [и др.]. – Новополоцк : Изд-во ПГУ, 1994. – 120 с.
4. Сазонов, Э.В. Теоретические основы расчета вентиляции : учеб. пособие / Э.В. Сазонов. – Воронеж : Изд-во ВГУ, 1990. – 208 с.
5. Отопление и вентиляция : учеб. для вузов. В 2 ч. Ч. 2. Вентиляция / В.Н. Богословский [и др.] ; под ред. В.Н. Богословского. – М. : Стройиздат, 1976. – 432 с.