РАЗДЕЛ XIV. ТЕХНОСФЕРНАЯ БЕЗОПАСНОСТЬ

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Reducing the impact of hazardous substances released in the air of the delayed coking unit operator working area

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Abstract

The article discusses the issue of the problems of oil refineries in Russia, the impact of harmful chemicals on the human body. A supply and exhaust ventilation unit is proposed to reduce the concentration of harmful substances in the air of the operator's working area of the delayed coking unit.

Keywords: oil refining industry, hazardous substances, maximum permissible concentration, occupational diseases, air of the working area.

Аннотация

В статье рассматривается вопрос о проблемах нефтеперерабатывающих предприятий России, влиянии вредных химических веществ на организм человека. Предложена приточно-вытяжная вентиляционная установка с целью снижения концентрации вредных веществ в воздухе рабочей зоны оператора установки замедленного коксования.

Ключевые слова: нефтеперерабатывающая отрасль промышленности, вредные вещества, предельно допустимая концентрация, профессиональные заболевания, воздух рабочей зоны.

Despite the widespread implementation of integrated engineering, technological and sanitary and hygienic measures, production factors that adversely affect the health of workers are still encountered at modern oil refineries.

The petrochemical industry is one of the leading sectors of the Russian economy making a significant contribution to the formation of the country's budget [1]. The petrochemical and oil refining industries occupy one of the leading places in terms of the number of workers in unfavorable conditions (53%).

The composition of oil and oil products includes a significant number of substances that differ sharply in their toxicometric parameters and belong to different hazard classes. Refinery workers are exposed to the adverse effects of a complex of chemical factors in the working environment [2]. The influence of these factors in the conditions of petrochemical industries can be the cause of both the formation of occupational diseases and the progression of chronic general somatic diseases. To avoid this, it is necessary to measure the concentration of harmful substances (HS) in the air of the working area for further application of measures to eliminate these factors.

In accordance with the analysis of working conditions using the example of LLC «RN-Komsomolsk NPZ», measurements of concentration of HS were carried out at the workplace of operator of delayed coking unit (DCU). The measurement results are shown in Table 1.

Table 1

Results of measurements of concentrations of HS

Name of substance	Amount of HS, g/h	MPC, mg/m ³ [3]	Fact. value, mg/m ³	MPC in the air of populated areas, mg/m ³ [4]	Hazard Class
Sulfur dioxide	9,87	10	7,5	0,5	3
Hydrogen sulfide mixed with C1-C5 hydrocarbons	1,6	3	2,6	0,008	2

<i>Benzene</i>	6,8	15	10	0,3	2
<i>Hydrogen sulphide</i>	2,6	10	8,5	0,008	2
<i>Nitrogen oxides (in terms of NO₂)</i>	4,3	5	4,3	0,2	3
<i>Gasoline (solvent, fuel)</i>	7,3	100	260	5	4
<i>Kerosene (in terms of C)</i>	7,8	300	360	5	4
<i>Nefras C150 / 200 (in terms of C)</i>	5,1	100	130	5	4
<i>Naphtha (in terms of C)</i>	6,5	300	450	5	4
<i>Dust carbon: coal, pitch, oil, shale cokes</i>	4	6	9,38	0,15	4

Class of working conditions by factor – 3.2. According to the data in Table 1, the actual values of the concentrations of some harmful substances significantly exceed the maximum permissible concentrations (MPC), which negatively affects the health of the operator and the performance of his labor functions. To avoid this, it is necessary to choose a more powerful supply and exhaust ventilation system, since there is no possibility to change the technological process in order to reduce the amount of harmful substances released into the air of the working area.

The control room has a Shuft UniMAX-P 2000SW-A supply and exhaust ventilation system with the following parameters: air flow - 2000 m³/h, air heating power – 12,82 kW. Since the concentration of some of the substances exceeds the MPC, therefore, this installation does not provide the required air exchange in the room. We will calculate the supply and exhaust ventilation system for the selection of equipment that will reduce the concentration of HS at the workplace of operator of DCU.

Based on the amount of HS released into the air of the room, and the MPC in the air of the working area and populated areas, the required air exchange is at least 3600 m³. Thus, it is necessary to select an air handling unit that provides a minimum air inflow and outflow of 3600 m³/h each.

Let's calculate the air exchange rate [5]:

$$n = \frac{L}{V}, \text{h}^{-1} \quad (1)$$

where: V is the volume of the room, m³ (384 m³).

$$n = \frac{3600}{384} = 9,4 \text{ h}^{-1}$$

The estimated area of the duct is determined by the formula:

$$f_{calc} = \frac{L_{calc}}{3600 \cdot \vartheta}, \text{m}^2 \quad (2)$$

where: L_{calc} – calculated air exchange, m³/h;

ϑ – recommended speed, m/s (4-7 m/s).

Specific frictional pressure loss is determined by the formula:

$$P_l = R_{sp} \cdot l, \text{Pa} \quad (3)$$

where: R_{sp} – specific friction losses, N / m³;

l – section length, m.

Pressure losses in local resistances are calculated by the formula:

$$Z = \sum \xi \cdot P_d, \text{Pa} \quad (4)$$

where: $\sum \xi$ is the sum of the coefficients of local resistances;

P_d – dynamic pressure, Pa.

The total pressure loss is found by the formula:

$$\sum P_{total} = P_l + Z, \text{Pa} \quad (5)$$

The results of the aerodynamic calculation of the supply and exhaust ventilation systems are shown in Tables 2 and 3.

Table 2

Results of aerodynamic calculation of supply and exhaust ventilation systems

Plot No.	Flow rate, m ³ /h	Length, m	Accepted section, mm	Duct area, m ²	Speed, m/s	Pressure loss per meter, Pa/m
<i>Supply system</i>						
1-2	1750	4,75	355	0,1	4,9	0,75
2-3	2250	5,35	400	0,13	5	0,66
3-4	2860	1,98	450	0,16	5	0,58
4-5	3600	1,12	500	0,17	5,1	0,52
<i>Exhaust system</i>						
6-7	1750	4,75	355	0,1	4,9	0,75
7-8	2250	5,35	400	0,13	5	0,66
8-9	2860	1,98	450	0,16	5	0,58
9-10	3600	1,12	500	0,17	5,1	0,52

Table 3

Results of aerodynamic calculation of supply and exhaust ventilation systems

Friction pressure loss, Pa	Local resistance, Pa	Dynamic pressure, Pa	Pressure loss in local resistances, Pa	Total pressure loss, Pa
<i>Supply system</i>				
3,6	5	14,5	72,5	76,1
3,5	9,5	14,9	141,6	145,1
1,1	5,7	15,1	86,1	87,2
0,6	7	15,6	109,2	109,8
<i>Exhaust system</i>				
3,6	5	14,5	72,5	76,1
3,5	9,5	14,9	141,6	145,1
1,1	5,7	15,1	86,1	87,2
0,6	7	15,6	109,2	109,8

Calculation of heat consumption for heating the supply air:

$$Q = 0,28 * G_{air} * C * (t_f - t_i), \text{ W} \quad (6)$$

where: G_{air} – the amount of heated air, kg/h (4410,74 kg/h);

C – weight heat capacity of air, kJ / kg (1,005 kJ/kg);

t_f – final temperature of the heated air, °C (18 °C);

t_i – initial temperature of the heated air, °C (28 °C);

$$Q = 0,28 * 4410,74 * 1,005 * (18 + 28) = 57094,4 \text{ W};$$

$$Q = 57,1 \text{ kW.}$$

Selection of the supply and exhaust ventilation system:

Based on the values obtained in the calculation, we will select an installation that must meet the following parameters: the required air exchange is at least 3600 m³/h, the power for heating the air is at least 57,1 kW.

The best option is the supply and exhaust ventilation unit – Ostberg HERU 1600 T RWR [6]. The appearance and technical characteristics of this equipment are shown in Figure 1 and listed in Table 4.

Figure 1. Ostberg HERU 1600 T RWR

Table 4

Technical characteristics of the Ostberg HERU 1600 T RWR supply and exhaust ventilation system

Parameter	Value
Air exchange, m ³ /h	4000
Dimensions, mm	2221x1768x1600
Weight, kg	530
Heating power, kW	98,1
Power, kW	98,1
Heater	Water
Power supply, V	380
Filter	F7

The layout of the air ducts and supply and exhaust ventilation system is shown in Figure 2.

Figure 2. Scheme of arrangement of air ducts and a supply and exhaust ventilation system

Thus, this measure will reduce the concentration of harmful substances in the air of the working area of operator of DCU at LLC «RN-Komsomolsk NPZ» to the limit values, thereby achieving a high level of performance and a minimum risk of worker poisoning with hazardous substances.

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Improving air quality in the workplace of a cement packer

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Abstract

The article deals with the problem of air pollution in the working area of the cement packer, as well as the effect of cement dust on the human body. It is proposed to carousel sealing method carousel machine in order to reduce the concentration of cement dust in the air of the working area.

Keywords: cement packing process, cement dust, worker health, carousel machine.

Аннотация

В статье рассматривается вопрос о проблемах загрязнения воздуха рабочей зоны упаковщика цемента, а также влиянии цементной пыли на организм человека. Предложен способ герметизации карусельной машины с целью снижения концентрации цементной пыли в воздухе рабочей зоны.

Ключевые слова: процесс упаковки цемента, цементная пыль, здоровье работающих, карусельная машина.

The cement industry is the leading branch of the building materials industry, which determines the economic potential of Russia along with such industries as metallurgy, electric power, chemistry and mechanical engineering, allowing to expand production volumes and the range of produced goods. The importance of cement cannot be overestimated, since it is used as a binder for the majority of dry building mixtures and serves as one of the main components.

«Spasskcement» JSC, located in the city of Spassk-Dalny is the largest cement producer in the Far East. The enterprise uses a full production cycle as its production technology, from the extraction and processing of raw materials to the production of more than 20 types of cement [1].