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Assessment of the Fire Hazard Category of Closed Spaces in the Oil Products Industry

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Abstract: *This article discusses the issues of assessing the fire and explosion safety of storage and processing facilities for petroleum products. The category of fire and explosion hazard and fire hazard of premises and buildings is determined for the most unfavorable period in relation to fire or explosion, based on the type of combustible substances and materials in the apparatus of the premises, their number of fire hazardous properties of the features of technological processes.*

Keywords: *fire, explosion, dust, deflagration explosion, air suspension.*

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Introduction. Assessment of the category of explosion risk sulfur in the example of oil in the gas industry in the Republic of Uzbekistan. The main document defining the category of buildings and premises is the normative document all-union norms of technological design (ANTD)-24-86. The requirement of this document is taken as the basis for the calculations [1].

According to this document, the category of fire and explosion hazard of premises and buildings is determined for the most unfavorable for the fire or explosion period, the outcome of the kind of combustible substances and materials in the apparatus, the number of fire hazard properties of technological processes.

In our case, the combustible material is sulfur dust. According to ANTD-24-86, the amount of dust that can form an explosive mixture is determined from the following prerequisites:

- The settlement accident was preceded by a dust accumulation in a production room passing under normal conditions;
- at the time of the settlement accident, planned (repair work) or sudden depressurization of one of the technological devices occurred after which a consequent emergency release of all the dust in the apparatus was placed in the room.

The first premise fully corresponds to the operating conditions and as shown by field studies, the amount of dust on the structures of the warehouse and on the surface of the material embankments is sufficient to create an excess pressure of more than 5 kPa in case this dust will participate in the explosion [2].

Methods and materials. The second premise to the rooms in question is not suitable. According to the operating conditions of sulfuric beverages warehouses, the greatest release of dust into the room occurs when the cars are unloaded. To determine the mass of dust emitted into the air during this process, we use the formula

$$B=0,5\,K\frac{F}{\rho}V_K^3\cdot G\rho_0 QdM \qquad (1)$$

And we introduce it into the calculation formula for determining the excess pressure. As a result, we obtain the following expression

$$\Delta P=\frac{0,5\cdot F\cdot V_K^3\cdot G\cdot\rho_H\cdot Q\cdot d_M\cdot K\cdot a\cdot H_T\cdot\rho_0\cdot Z\cdot l\cdot n}{P^2\cdot V_{eb}\cdot\rho\cdot C_p\cdot T_o\cdot K_H} \qquad (2)$$

Based on the calculated data, the dust mass necessary to create an overpressure of 5 kPa in a warehouse having a size of 16·24·72 m is 261.9 kg. According to the calculated data and the results of full-scale studies, the mass of dust released into the air when unloading the car is an order of magnitude lower than the mass of dust necessary to create an excess pressure of 5 kPa [2; 6].

Determination of the mass of dust capable of exploding and participating in explosive combustion is made according to the criteria. The criteria can be expressed as follows:

$$1\le\frac{P_f}{P_{Kp}^b};\frac{U_f}{U_{Kp}^b};\frac{Y_f}{Y_{Kp}^b}\langle 1 \qquad (3)$$

Where:

P_f - - the actual pressure at the flame front during a deflagration explosion, Pa;

$P_{\kappa p}^b$ - the critical pressure of the gas flow, at which a sufficient amount of dust is swirled to participate in explosive combustion. For sulfur dust deposits = 93,8 Pa;

U_f - the actual speed of gas flow. At a deflagration explosion is determined by the apparent speed of flame propagation, m/s;

$U_{\kappa p}^A$ - the critical gas velocity at which a sufficient amount of dust is swirled to participate in explosive combustion. For deposition of dust, sulfur = 12.3 m/s;

$U_{\kappa p}^b$ - Critical drift of dust, which creates an aerosvess with sufficient concentration for continuation of explosive combustion. For deposition of dust, sulfur = 430,5 g / cm2.

Knowing the critical parameters P and determining the maximum value of one of the three parameters in a deflatration explosion in real conditions, we estimate the possibility of participation of deferred dust in the explosion. As a result of the analysis, the calculated-experimental value of $P_f=18,2$ Pa, $U_f=0,5$ m/s, was obtained.

In the interaction of these parameters, the dusting of dust does not occur, the criteria for active data is less than one and consequently the deposited dust does not participate in the explosion and is not taken into account in the calculations. To determine the excess pressure that occurs when a dust cloud is blown up, which results in the unloading of the car, we enter the value of the mass m=25,83 kt to determine the excess pressure. As a result of the calculations, the excess pressure is ΔP = 0,02 kPa.

The obtained value is much lower than 5 kPa. In accordance with the requirement of ANTD-24-86, the long-term storage of sulfur should be attributed to the category "B" premises - a fire hazard [2; 3].

The lower concentration limit of flame (LCLF) propagation is one of the main indicators of fire and explosion hazard of aeroweaving disperse substances. The lower concentration limit of propagation is understood as the minimum concentration of dust at which the spread of a flame along an aerosweet is possible. From a review of the literature related to the assessment of fire and explosion hazard of sulfur dust, it can be seen that its lower concentration limit of propagation has different values. To clarify the values of the lower concentration limit of propagation, there was a need for research. To carry out experimental work on the definition of this indicator, a standard method was adopted [4; 5].

For optimum spraying, the pressure and spray time are determined by the selection method. The indicator of the uniformity of spraying is the coefficient of relative density of the sediment Ki. To determine the values of Ki, a disk sampler is used with a coaxial thin-walled glass placed in the lower part of the reaction vessel.

The coefficient of relative density of the precipitate is found by the formula:

$$\mathrm{K}i = \frac{m_c S_{pc}}{S_c\left(m_g + m_c\right)} \qquad (4)$$

Where:

m_c and m_g are the mass of the precipitate in the beaker and on the surface of the sampler disk, mg;

S_c and S_{pc} are the cross-sectional area of the glass and the reaction vessel, cm^2.

The lower concentration limit of flame propagation is determined by the formula:

$$\mathrm{LCLF} = \frac{M_x}{V} \cdot Kn \qquad (5)$$

Where:

M – mathematical expectation of the sample, corresponding to the LCLF, g;

V - capacity of the reaction vessel, m^3

K_n - is the correction factor.

The value of M_x is calculated by the Spearman-Kerber method:

$$M_x = в\text{-d}\ (S_1 - 0{,}5) \qquad (6)$$

Where:

в – the minimum value of the sample with the ignition frequency equal to I, g;

d – the amount of change in the sample, g;

S_1 – the sum of the ignition frequencies in the entire region of unstable ignition

The correction factor *Kn* is calculated by the formula:

$$Kn = К - \Delta \qquad (7)$$

Where:

К – the average value of the relative density of the precipitate, equal

$$\mathrm{K} = \frac{1}{n}\sum_{i=1}^{n} K_i \qquad (8)$$

Where:

K_i - the value of the relative density of the sediment in i-th feeding;

n - number of studies;

Δ - trust the interval equal to.

$$\Delta = \frac{S}{n} t_2 \quad (9)$$

Where:

S – dispersion;

t_2 - Quantile of the Student's distribution for a one-way confidence interval and a confidence probability of 0,95.

Results and discussions. The dispersion is calculated by the formula

$$S = \sqrt{1\frac{1}{n-1}\left[\sum_{i=1}^{n} K_i^2 - \frac{(\sum_{i=1}^{n} K)_i}{n}\right]} \quad (10)$$

Table 1. The value of the quartile t_1, depending on the number of tests given in Table 1

n	**t_l**	**n**	**t_l**
10	1,833	16	1,763
11	1,812	17	1,746
12	1,796	18	1,740
13	1,782	19	1,734
14	1,771	20	1,729
15	1,761	---	---

The determination of LCLF was carried out for sulfur dust of different fractional composition. The first series of experiments was carried out with dust dried in a thermostat until constant in a thermostat until constant weight. The second series was conducted with the dust of sulfur, which has a natural moisture content. The graph of the dependence of the gentle concentration limit of flame propagation as a function of the particle size is shown in Fig.1.

The data on the LCLF are presented in Table 1.

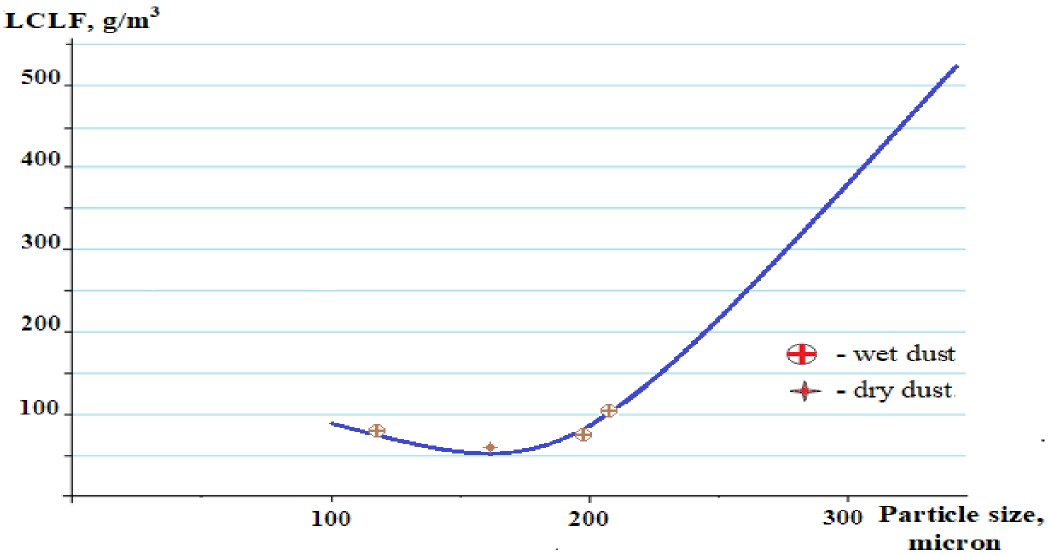

Fig.1. Dependence of LCLF sulfur dust on particle size

To determine the influence of the time factor on the LCLF, sulfur samples were exposed to a non-heated room, in which they had free access to the air.

Table 2. Lower concentration limit of flame spread of sulfur

Particle size, micron	Humidity, %	LCLF, g/m^3
0-71	0	35
71-80	0	35
80-90	0	33
90-100	0	31
100-125	0	30
125-160	0	40
160-350	0	500
0-71	1,2	38
71-80	1,2	35
80-90	1,1	32
90-100	1,0	30
100-125	0,95	34
125-160	0,85	40
160-350	0,70	500

Study of the transition of sulfur dust to aerosweet state under the influence of air currents.

Discussion Conclusions

1. As a result of the analysis it was established that the amount of dust deposited on the constructions of warehouses and on the surface is poured by a sulfur coma is sufficient to create an excess pressure of 5 kPa, if this dust is involved in explosive combustion.
2. The category of fire risks of oil in the gas industry and the fire and explosion hazard class of the premises are determined.
3. A mass of dust capable of vortexing in explosive burning is determined.
4. In accordance with the requirements of fire safety warehouses of sulfuric sulfur should be attributed to a room of category "B" - a fire hazard.

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