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# EXPLOSION AND FIRE RISK ASSESSMENT SYSTEM FOR INDUSTRIAL DUST IN FOREIGN COUNTRIES

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## Abstract

Industrial dust assessment systems for industrial dust, which are available in a number of foreign countries, differ from those adopted. Currently, there is no reliable way to calculate the risk of explosion of dust based on their composition, heat of combustion and other physicochemical properties. If subsequent studies do not theoretically predict the level of dust hazard, experimental measurements will be required.

Industrial dust for explosion hazard has been tested in laboratory methods and officially approved in foreign countries. These methods differ from each other because they are largely independently developed and their international standardization has not yet been carried out [10; 8 p].

## Introduction

There are differences in the methods adopted in different countries, as well as common features. In particular, they provide an assessment of hazardous properties in small dust samples in devices with a volume of several liters. Although the experiments are widely known, mass tests are performed in the laboratory. This approach minimizes the time required for research and ensures the safety of experiments as much as possible, even when the dust has toxic or other abnormal properties.

Because the experiments were performed on a laboratory scale, the results obtained were not sufficiently developed for large-scale extrapolation, but practice shows its high reliability.

Due to differences in the methods of testing industrial dust in foreign countries, the evaluation systems adopted are considered separately. Many countries' hazardous dust assessment systems are based on methods used in the United States, the United Kingdom, Germany, and Russia. Therefore, the review considers the systems for assessing the explosive and flammable properties of dust adopted in these countries [13; 366 p].

Explosion risk assessment methods adopted in the United States have been developed by the Federal Bureau of Mining [16; 264 p.]. These methods include testing the dust in a suspended state using a variety of devices to create a state of weightlessness in the air.

In the first stage, the dust sample is spread over 200 mesh (74 mkm in diameter) and the fraction passed through a sieve is tested. When the dust has a moisture content of more than 5%, it is pre-dried. Prior to testing, the dust is examined under a microscope and, if necessary, its physical and chemical properties are determined. Based on the results of the detection of explosive hazards, it calculates a non-dimensional pair of meters that characterizes the explosive hazard of suspended dust and the lightness of the explosive hazard index, which is equal to the first two products [14; 214 p.].

$$I_{AB} = \frac{T'_{CB} \cdot E'_{\min} \cdot C'_{HK\Pi B}}{T_{CB} \cdot E_{\min} \cdot C_{HK\Pi B}} \qquad I_B = \frac{P_{\max} \cdot (dP / d\tau)_{\max}}{P'_{\max} \cdot (dP / d\tau)'_{\max}} \qquad (1.5)$$

where, $T_{CB}$ – the spontaneous combustion temperature of suspended dust;

$E_{\min}$ – the minimum ignition energy of the dust in the suspended state;

$C_{HK\Pi B}$ – lower limit of flammability;

$(dP / d\tau)_{\max}$ – maximum velocity of pressure during explosion;

$T'_{CB}, E'_{\min}, C'_{HK\Pi B}, P'_{\max}, (dP / d\tau)_{\max}$, as well as the Pittsburgh coal.

The ease of connection and the risk of explosion are determined by comparing the combustion properties of the studied substance with the combustion of standard dust selected as Pittsburgh coal dust. The explosion is related to the explosion rate, as shown in Table 1.5. If the explosiveness index is higher than 1.0, the test substance is higher than the risk of Pittsburgh coal dust at the boundary between high and medium hazardous dust separation.

In addition, a noisy shower in the weightless state of the air detects the minimum explosive oxygen content and the ignition temperature and the minimum ignition energy to detect dust in the aerogel state.

The system adopted in the UK [18; 199 p.] Provides measurement of the explosive properties of dust in the suspended state in production.

Table (1.5). Explosion hazard indicators

| **Relative level of explosion risk** | **Mild ignition** $I_{AB}$ | **Risk of explosion** $I_B$ | **Explosion hazard index** $I_{MB} = I_{AB} \cdot I_B$ |
|---|---|---|---|
| Weak | <0,2 | <0,5 | <0,1 |
| Average | 0,2-1,0 | 0,5-1,0 | 0,1-1,0 |
| High | 1,0-5,0 | 1.0-2.0 | 1,0-10,0 |
| Very high | >5,0 | >2,0 | >10,0 |

It assesses the fire hazard of the installed dust, not the test.

For non-existent dusts, the first step is to test the classification experiments and evaluate the explosive ability to disperse the dust cloud. According to the test results, they are divided into explosives (group A) and non-hazardous (group B). Dust, if it belongs to group A, burns and spreads, at least one-third of which is ignited by a low-level source.

The sample must not be contaminated or crushed before the test can begin. For coarse materials larger than the British “dust” standard, the sample is removed through a standard 12 sieve (1.4 mkm in micron cell size). If the flame of the standard sample is not spread on the experimental apparatus and the fractions are tested separately [19; p. 27], the distribution to finer fractions is carried out. The tests are performed after drying the sample at 105 °C for one hour. The test results are applied to a specific dust sample, not to the material. The availability of several types of devices allows the use of different methods of creating a dust cloud, and provides a change in the amount of dust in the device and the air pressure for spraying.

For group A explosive dusts, the spontaneous combustion temperature of the suspended air, the minimum amount of explosive oxygen, *LLCE* (*lower limit concentration of explosion* – the minimum ignition energy, the maximum burst pressure and its growth rate are determined.

The system of explosion and fire risk assessment of industrial dust adopted in Germany defines many indicators characterizing the risk of suspended dust, its sediments, as well as products of thermal decomposition [17; 9-p]. During the test, it is recommended to select fresh and dry samples consisting of fine fractions, as such materials are the most explosive. Analysis should be performed prior to testing. If the sample contains particles larger than 200 microns, it is delivered to ensure that there are no particles larger than the maximum size. The sample is then dried at 75 °C for 24 h.

The tests begin with an initial assessment of the explosion in the sample. To do this, a sample of 10 $cm^3$ is sprayed into the air above the gas stove, visual information or video footage provides information about the size and process of the flame, and accurately assesses the risk of dust explosion. Then the spontaneous combustion temperature, the maximum burst pressure and its growth rate are determined.

For aerogel powders, flammability tests are performed and the spontaneous combustion temperature is determined. The German system does not include weightlessness indicators such as minimum explosive oxygen content and minimum contact energy.

Fundamentals of an internal system that determines the number and nature of fire hazard indicators of materials for industrial dust explosion and fire risk assessment were studied by M. Goggiello [3; 25-p.]. It was later improved [15; 5] and generalized in his monograph [11; pp. 44-45]. The practical experience of using this system, accumulated in many organizations, allows to obtain the necessary initial information to create a safe environment for the technological processes of flammable dusts. Therefore, the list of fire and explosion hazard indicators provided with the definition commands [16; p. 264] is included in the State Standard regulating the scope of fire and explosion hazard indicators for petroleum products and organic chemicals [3; 25-p.]. The tests include a number of parameters for airborne and accumulated dust.

In assessing the risk of explosion of dust suspended in the air, LLCE determines the maximum explosion pressure and its growth rate, the minimum flammability and the minimum explosive oxygen content. Unlike the United States and the United Kingdom [18;

p. 199], in other countries there is no such indicator as the self-ignition temperature of the suspended state.

The hazard of installed dust is characterized by eight indicators: flash point and spontaneous ignition, ignition temperature limits, combustion temperature, minimum fire-fighting concentration of flammable substances, as well as self-heating and closing temperature.

This means that the approach to assessing the level of risk of suspended dust in the countries under consideration is almost the same. The difference is that there is no definition of LLCE experience in Germany, and in the United States as described above [21]; In addition to the parameters, the relative flammability and the relative flammability of the dust in the suspended state are determined.

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