Analysis of the chemical composition of dust particles in the warehouse of building materials

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Abstract. According to the World Health Organization (who), in addition to the already known (nitrogen oxide, sulfur dioxide, carbon monoxide), solid suspended dust particles were added to the most dangerous for human air pollutants. The inclusion of these particles in the list of especially dangerous pollutants has opened the way for a large number of studies, including their accounting in different conditions and for different types of economic activities in order to reduce their concentration in the air. To assess the harmful effects of dust on humans as air pollutants, it is necessary to know the chemical composition of these particles. The article considers the dust entering the atmosphere of warehouses for two variants (cases) of storage in soft tissues, in a cloth or plastic packaging. Dust of the most common building materials and dust of organogenic rocks, on the example of flask. The chemical composition and structure of materials on the basis of quantitative and qualitative microprobe analysis (EDS). Visually presented in the form of tables with the content of each element at different points of the same material and in the areas of two different materials.

Introduction

Modern warehouse is a complex organization of the enterprise, consisting of areas for storage of goods, office space and the surrounding area. Sometimes warehouses are combined into huge complexes, spread over tens of thousands of square meters.

It is necessary at first, when assessing the harmful effects of dust storage facilities, to take into account the specifics of the internal space, where all floors are made of poured concrete with a hardener. Over time, from the movement on the surface of the stacker concrete begins to emit dust, which should be disposed of in a timely manner, so that it does not get into the air of the working area and the air of the environment [1].

Secondly, all loads are placed on wooden pallets, which, in turn, can be placed on racks in several tiers. Of course, when loading and unloading from a great height will crumble dust, and if the package is damaged on the floor can fall loose substances, household chemicals and other contents.

Thirdly, a large amount of dust can be released from the technological operations carried out in warehouses, especially with the inefficient operation of dust removal systems [2].
Fourth, the warehouse, which operates around the clock, respectively, and has the movement of freight transport constantly. Therefore, dust from warehouses spreads in the air near the warehouse.

As building materials and minerals can be used not only such common as cement, dry mixes, but also organogenic rocks. These are sedimentary rocks consisting of the remains of animals and plant organisms and products of their activity. As an example, consider the flask, which has a very wide range of uses, both as a sorbent and as an additive to building materials.

Flask is a cemented siliceous substance is diatomaceous earth or diatomite. They consist of opal silica, the amount of which varies due to the unstable content in their composition of impurity clay. Flask-strong and very light, strongly porous rocks of pale yellow, light yellow, from gray all shades to black. Some of their varieties are externally similar to Tripoli and diatomites (soft flask), but mostly are rock-like, hard and dense rocks. The average density ranges from 1200 to 1500 kg / m³ and is in accordance with their high porosity (up to 30-40%). They have a low compressive strength-up to 1-3 MPa, and, as a rule, are not frost-resistant.

The rock is strong, sonorous on impact, has a semi-ductile fracture, has a large porosity and hygroscopicity. It has good heat and sound insulation properties. It is customary to distinguish three groups of flasks:

- Flasks having a gray and dark gray color, earthy and semi-porous fracture of medium density, contain 35-65% amorphous silica and 40-80% clay particles.
- Fertilized flasks: have a grey and dark grey colour with conchoidal fracture. Contain 60-75% amorphous silica and 20-30% clay.
- Flask of clay (or teplovdenie): coloration is light, sometimes yellowish. On density there are both soft, and dense flasks. They contain 30-50% amorphous silica and 50-70% clay particles \[3\].

**Purpose of the study**
The purpose of the experimental study is to analyze the chemical composition of dust particles in the warehouse of building materials.

**Methods of monitoring and evaluation**
Several dust samples were considered as common building materials, such as cement, dry mixes, but also poorly studied organogenic rocks. All experiments were carried out by microscopy, followed by chemical and micro-X-ray spectral analysis.

Dust was collected in the air environment of warehouses of building materials, as well as organogenic rock – flask deposits of Astrakhan and Volgograd regions. These types of dust were chosen because of their little-known and are the material for further research.

Microscopic analysis of the selected dust samples was performed using the scanning electron microscope Versa 3D Dual Beam. The elemental composition of the samples was studied by scanning transmission electron microscopy (STEM). High vacuum mode (Hi Vac) with the use of various detectors: secondary, backscattered and passing electrons (ETD, CBS, STEM), allows to obtain high-resolution images of metal, composite and powder materials. The dispersed analysis of the selected dust samples was performed using microphotographs obtained as a result of microscopic examination using specialized software Image J \[4,5\].

The dispersion composition of dust fractions is determined from the obtained photos with an increase of up to 500 nanometers. Further processing is accompanied by a micro-x-ray spectral analysis of dust depending on the material content at each point of the studied sample.

**Research results**
Figure 1 shows a 3D image of a scanned sample of dust in the warehouses of building materials (cement, dry mixes, etc.). In figures 2,3 presents the chemical composition in the structures of the material, on the basis of quantitative and qualitative microprobe analysis (EDS) [6-11].

Figure 1. Micrograph of particles of dust in the warehouse of building materials.

Figure 2. X-ray microscopic analysis of dust in the warehouse of building materials (a - point 1) and (b - point 2).

Figure 3. X-ray microscopic analysis of dust in the warehouse of building materials (point 3).

Table 1 shows the elemental composition of dust in warehouse premises of building materials at various points, as well as their percentage ratio of molecular weight and weight of dust.

Table 1. The elemental composition of dust in the warehouse of building materials at various points.

| № sample points | Element | Weight (%) | Atomic (%) |
|-----------------|---------|------------|------------|
| Point 1         | C       | 4.02       | 6.78       |
|                 | O       | 49.31      | 62.41      |
Figure 4 (a, b) shows 3D images of scanned samples of dust from the flasks of two deposits (Astrakhan and Volgograd regions).

![Image of dust particles](image)

**Figure 5** shows the chemical composition and structure of the material, based on quantitative and qualitative X-ray microscopic analysis (EDS) [12,13]. Table 2 shows the elemental composition of the dust of the flask, as well as their percentage ratio of the molecular weight and weight of two samples of the flask material.
Figure 5. X-ray microscopic analysis of the dust of the flasks of the deposits of the Astrakhan (a) and Volgograd region (b).

Table 2. The elemental composition of the dust of the flask of various deposits of the Astrakhan and Volgograd regions.

| Field            | Element | Weight (%) | Atomic (%) |
|------------------|---------|------------|------------|
| Astrakhan region | O       | 47.26      | 61.97      |
|                  | Na      | 6.24       | 5.69       |
|                  | Mg      | 1.02       | 0.88       |
|                  | Al      | 4.64       | 3.61       |
|                  | Si      | 28.7       | 21.43      |
|                  | S       | 0.94       | 0.61       |
|                  | Cl      | 5.38       | 3.18       |
|                  | K       | 1.52       | 0.82       |
|                  | Ca      | 1.16       | 0.61       |
|                  | Ti      | 0.19       | 0.08       |
|                  | Fe      | 2.95       | 1.11       |
| Volgograd region | O       | 55.15      | 69.05      |
|                  | Na      | 0.28       | 0.25       |
|                  | Mg      | 0.41       | 0.34       |
|                  | Al      | 3.23       | 2.4        |
|                  | Si      | 36.71      | 26.18      |
|                  | K       | 1.44       | 0.74       |
|                  | Ca      | 0.34       | 0.17       |
|                  | Fe      | 2.45       | 0.88       |

Summary
Comparative analysis showed that the fundamental elements are Si, Na, Al, Ca, Fe. At the same time Si varies from 4.68 to 32.21% in common building materials, and in dust flask from 28.7 to 36.71%. The most significant difference is the share of CA in the dust flask materials in all fields. Its share is usually significantly less than in common building materials. Ca reaches up to 9.21%, while in the flask does not exceed 1.5%. For example, Al from of 0.58 to 2.06%, and in the dust of the flasks 3.23 to 4.64%.

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