

Capabilities of use of dry separation of microsilica to obtain target products

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Abstract. This article is devoted to methods of processing of the dust entrained from the ore-thermal furnaces for silicon production. Chemical and granulometric analysis of dust entrainment of silicon production was carried out. Possibility of using gravitational-centrifugal separation to obtain target products, such as spherical silica and nano-structured carbon was considered.

1. Introduction

As of today, many factories in the metallurgical industry do not subject their waste to further processing capable of turning wastes into useful material, but prefer to recover wastes by transporting them to mud storage areas. This method of waste disposal leads to environmental problems, as one ton of finished products of the plant comes with a ton of dust products. For example, the amount of trapped dust in a silicon plant may amount to 42,000 tons per year, which inevitably leads to an increase in the size of mud storage areas and ecosystem damage.

2. Granulometric composition of dust captured by a preliminary purification system

The gas cleaning system of silicon plants provides for two stages of purification. The first stage is a pre-cleaning system and serves to capture large, heavy dust that can disrupt the operation of the fine cleaning system. Most often this system is a cyclone battery [1-3]. A typical granulometric composition of the dust collected at the 1 stage of purification is shown in figure 1 and table 1.

Table 1. Disperse composition of pre-cleaning dust.

Number of particles in the sample (%)	5	10	25	50	75	90	95	99	100
Size (μm)	1.8	3.6	11.2	25.2	48.1	71.9	85.9	111.2	115.3



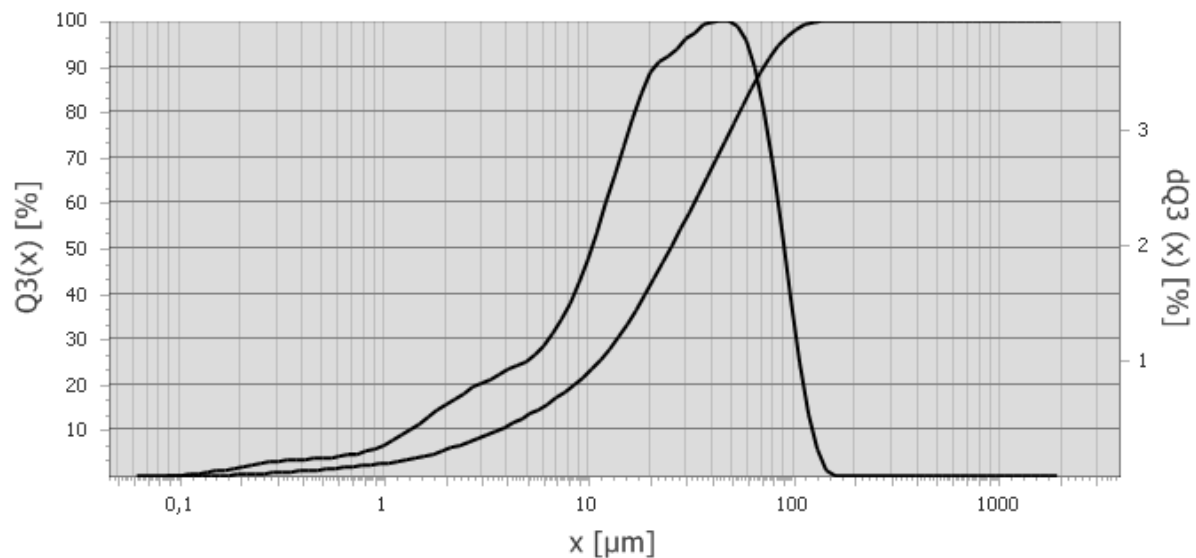


Figure 1. Granulometric composition of dust captured by a preliminary purification system, measured on “Analysette 22 NanoTec” particle size analyzer.

3. Granulometric composition of fine dust

Dust trapped by the fine cleaning system is of great interest. Studies carried out by different groups of scientists show that the main component of dust (at least 92%) trapped by the fine cleaning system is finely dispersed spherical silicon dioxide. Figure 2, obtained with the help of JEOL JIB-Z4500 scanning electron microscope, shows the spherical shape of the silica particles. The second largest component of the mixture is highly dispersed, nanostructured carbon. Granulometric analysis of dust of fine cleaning is shown in figure 3 and table 2.

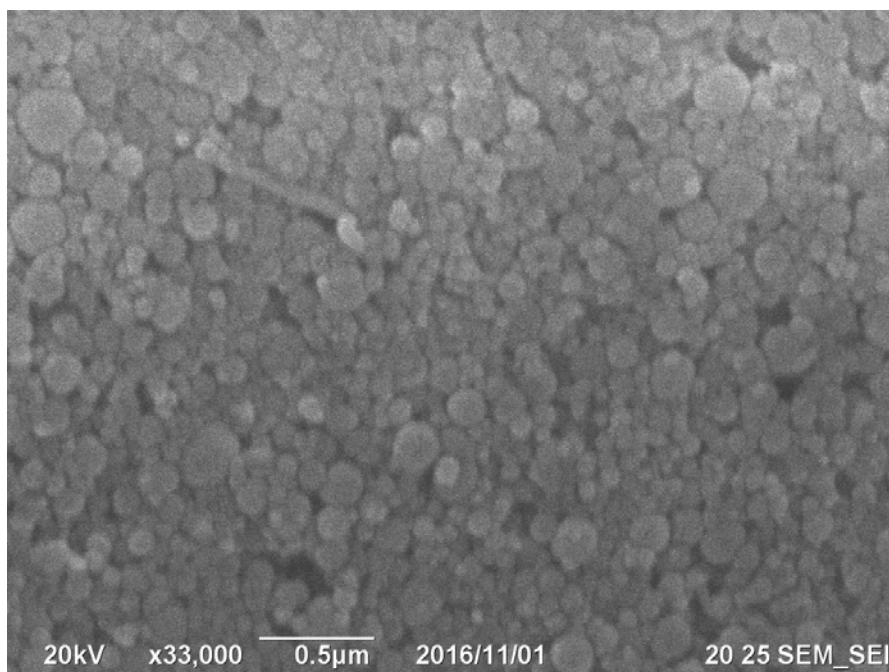


Figure 2. Image of fine dust obtained with the help of JEOL JIB-Z4500 scanning electron microscope.

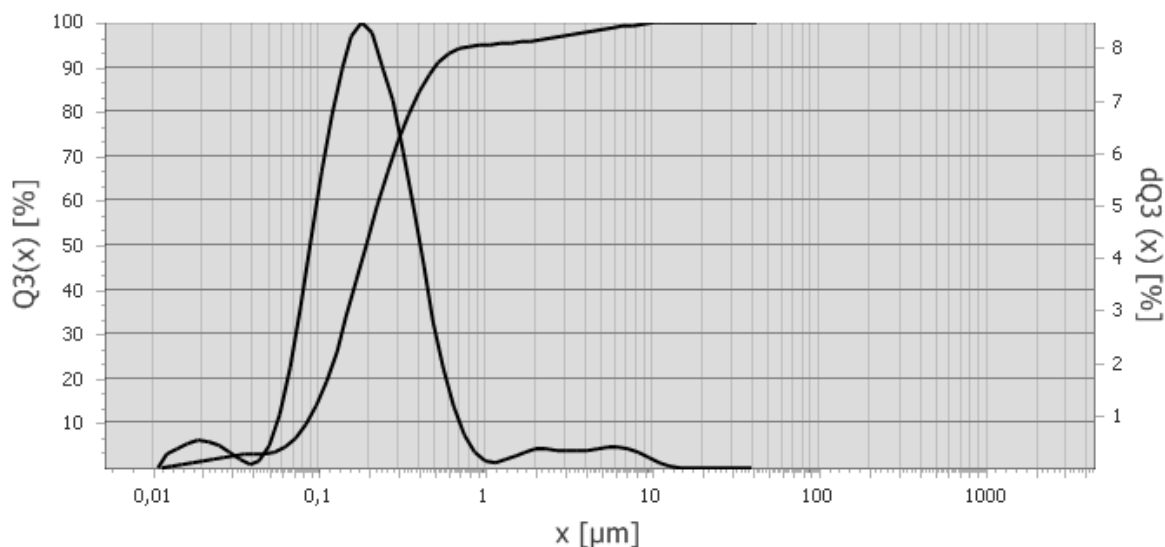


Figure 3. Granulometric composition of fine dust, measured on a laser particle size analyzer “Analysette 22 NanoTec”.

Table 2. Disperse composition of fine dust.

Number of particles in the sample (%)	5	10	25	50	75	90	95	99	100
Size, less than μm	0.06	0.09	0.1	0.2	0.3	0.5	1	6.6	103

Nanodisperse spherical silica with a high mass fraction of dioxide has become widely used as a modifying additive in the production of construction concretes and high-strength composite alloyed metal alloys. In addition, it is used in the production of rubber products, and it is a filler in the production of paints, ceramics, etc. [4-7]. Consequently, for further use of dust of fine cleaning of silicon production furnaces, its enrichment to a SiO_2 content of not less than 98% is required. In the process of processing fine dust, it is equally important to provide for the possibility of obtaining a fraction of a product with a high content of carbon nanostructures. The carbon nanostructured material itself is an interesting and promising material, and is also widely used as modifying additives.

There is a flotation method for separating dust from the removal of silicium production furnaces [3, 8]. In detail, this method was considered in articles [1, 9, 10]. The flotation method makes it possible to separate with high efficiency the microsilica remaining in the chamber product from the carbon fraction, separated out as a foam product. However, flotation method has a number of disadvantages associated with the progress of the separation process in the liquid medium. This circumstance entails further drying and disintegration of the obtained product. This increases energy costs and, as a consequence, the cost of the final product.

We considered the possibility of dry separation of microsilica on devices of gravitational centrifugal dust collection (cyclones). Carbon and silicon dioxide have a different density, that's why, provided that the particles have the same dimensions, they will be deposited differently in the cyclones. To test the hypothesis, a stand consisting of 5 successively mounted cyclones (figure 4) was constructed. Dusty gas stream was created with the help of a compressor and a dust-collecting device, which activated a slotted shutter. As raw materials, dust of furnaces, caught in bag filters, taken from a pipeline that carries a dust and gas stream from silicon furnaces was used. The separation process on gravitational-centrifugal dust-collecting devices was mathematically modeled, and predicted the possibility of gravity-centrifugal separation of particles of dioxide and carbon.

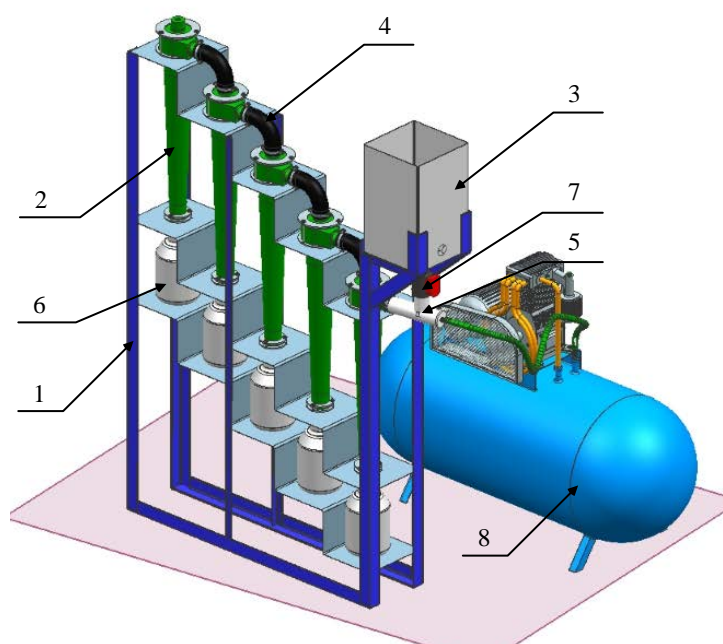


Figure 4. Installation of dry dust separation of silicon production furnaces: 1 – frame; 2 – cyclone; 3 – loading hopper; 4 – elbow flexible; 5 – slit dispenser; 6 – capacity; 7 – disk shutter with the electric drive; 8 – compressor.

4. Conclusion

As a result of a series of tests, it was possible to achieve an increase in the concentration of microsilica from 93% to 98% with a yield of up to 35% by weight. It was possible to achieve an increase in the concentration of the carbon fraction from 6% to 24% with a yield of 10%. Mathematical calculations and results of mathematical modeling testify to the possibility of increasing the separation characteristics of the installation, in case of a change in the geometric dimensions of the dust-collecting devices, and the operating conditions of the draft equipment of the stand.

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