The technology of receiving finely dispersed powders of magnetic materials in the screw drum

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Abstract. It is experimentally shown the possibility of obtaining a finely dispersed powder using mills of non-impact type on the basis of the screw drum. The dependence of grinding the powder to the weight of the load is proved.

1 Introduction

Magnetically hard materials are widely used for the manufacture of sources of permanent magnetic fields, which in some cases are technically and economically more advantageous than DC electromagnets. By the method of production, the permanent magnets are divided into cast and powder ones. The requirements of miniaturization of modern magnetic elements, as well as the possibility of variation of their physical properties in a large range, have determined the wide spread of powder technology for manufacturing permanent magnets. While coarse grinding, the proportion of energy consumption to the cost of the final product is negligible. For many technical details it is necessary to have powders with a very small particle size, of about 10^{-8} m. For this purpose, fine grinding is used, which is produced in spherical vibrating, rotating or planetary centrifugal, vortex and hammer mills [1]. The production of highly dispersed powders, which is always associated with higher energy costs, simply cannot afford to use inadequate methods of dispersion. However, the moving elements of the mills used in industry today bear their negative significance: due to vibration, large shock loads, and also a complex control device for such mills, the quality of the powders obtained and the reliability of the grinding units themselves are significantly reduced. In impact mills, the destruction of material particles occurs as a result of impact loads. These loads can occur in a wide variety of conditions and circumstances. For example, when the grinding bodies fall, when a particle collides with a fixed obstacle, mutual collisions of particles in flight are also possible. But in any case, a piece of material or the self-grinding body must have such kinetic energy that it would be enough to overcome the internal bonds between the particles. Obviously, in such a field of technology as shock disintegration, there can be no final solutions. Modern equipment that implements the centrifugal-impact crushing-grinding method is also just another stage in the development of the technique of shock disintegration of solid materials.

2 Objective

Experimental study of the effect of the weight of the load of the powder charge on the granulometric composition of ferromagnetic materials by grinding by magnet-wave technology in a screw drum.

3 Main part

A block diagram of the experimental setup is shown in Fig. 1

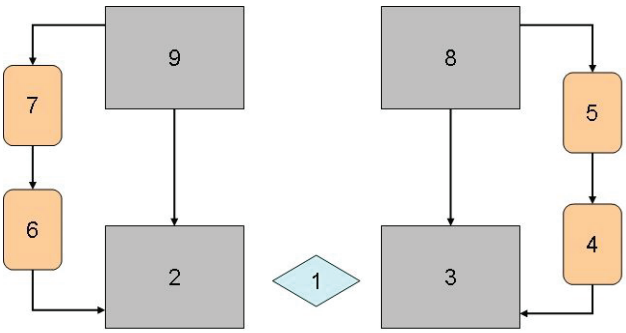

Fig.1. Block diagram of a mill based on a screw drum. 1 - screw drum, 2 - permeameter, 3 - permanent magnet, 4 - direct current ammeter, 5 - DC voltmeter, 6 - AC ammeter, 7 - AC voltmeter, 8 - magnet power supply 3, 9 - power supply of permeameter.

Appearance and type of the inter-pole space of the experimental setup are shown in Fig.2

A screw drum [5] is placed in the common inter-pole space of permanent field of electromagnets and permeameter [5], the circuit of which is shown in Fig.3. The drum is made of steel grade 12X18HT GOST 5582-75 and had a working chamber volume of 290 cm^3.

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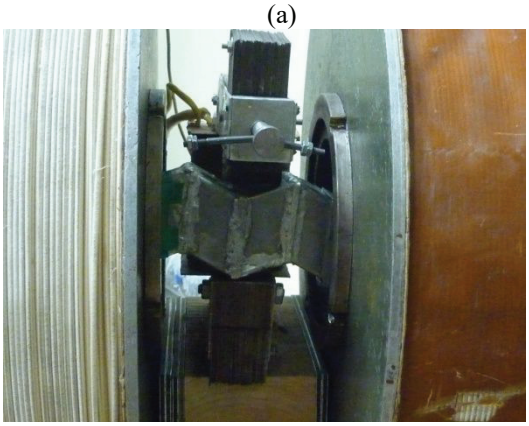
(a)



(b)

Fig. 2. Appearance (a) and type of the inter-polar space (b) of the experimental setup.

The shape of the drum makes it possible to keep the charge in a magnetic field until a predetermined granulometric composition is obtained. The charge is placed in the drum, the magnetic fields of the specified induction values and induction gradient are switched on.

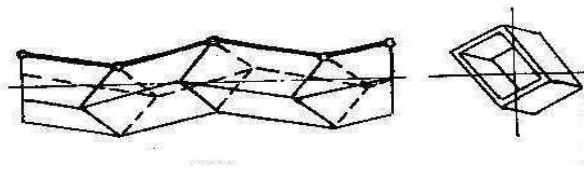


Fig.3. Screw Drum Scheme

In a stationary drum under the action of ponderomotive forces, the powder is transferred to a magneto-vibrating state, in which the particles are destroyed due to their collision with each other and with the walls of the drum. The efficiency of the destruction of particles in the magneto-vibrating layer depends on the material and the granulometric composition of the original powder, as well as on the induction and the gradient of magnetic field induction. When the bodies are destroyed by impact, the process can be represented in two stages. The first begins when the surfaces of the bodies come into contact. By the end of the first stage, the bodies stop coming closer and part of their mechanical energy passes into the energy of deformation. At the second stage, the energy of deformation is transferred to the kinetic energy of the bodies [2]. When the real bodies collide, the mechanical energy is not completely restored. Part of the energy is expended on residual deformation, heating, destruction of bodies, etc. To determine the impact forces, it is necessary to take into account the mechanical properties of the materials of the bodies. The solution of the problem is substantially complicated not only because of the difficulties of a purely mathematical nature, but also because of the lack of sufficient data on the parameters determining the behavior of the materials of bodies under impact loads [3].

All of the above mentioned led to the need to experimentally test the influence of the charge load mass on the granulometric composition of the material obtained after milling. The results of the experiment are shown in Fig. 4.

The analysis of the presented dependences shows that the process of powder grinding with loading masses from 100 grams has little effect on the size of the particles obtained, the optimal loading weight for the chosen parameters of the magnetic field and the geometry of the screw drum is a mass of 30-60 grams, which amounts to 30% of the drum loading.

Fine grinding is one of the most expensive operations in large-tonnage production. Considering the production volumes, even a relatively small increase in the efficiency of the grinding unit can give a significant economic effect. The described mill on the basis of a screw drum, the principle of operation of which is based on the use of magnetic field energy, does not have mechanically moving elements, which reduces energy costs [4].

4 Conclusions

1. It has been experimentally proved that due to a collision between particles of a ferromagnetic material in a magneto-vibrating layer in a screw drum, grinding of $SmCo_5$ powder occurs.
2. When designing the grinding devices which use the impact mechanism of the destruction of particles in the magneto-vibrating layer, the mass of charge to be loaded should be chosen in accordance with the results obtained in the work. In addition, the initial granulometric composition of the material, as well as its mechanical and magnetic properties, should be taken into account.
3. When grinding in the magnetically-vibrating layer of disperse ferromagnets due to impact interaction between particles, the grinding process is accompanied by an aggregation process, which requires additional energy expenditure.
4. Shock grinding in a magneto-vibrating layer in a screw drum allows to obtain a powder of a fine fraction, while an increase in the weight of the charge leads to more intensive aggregation.

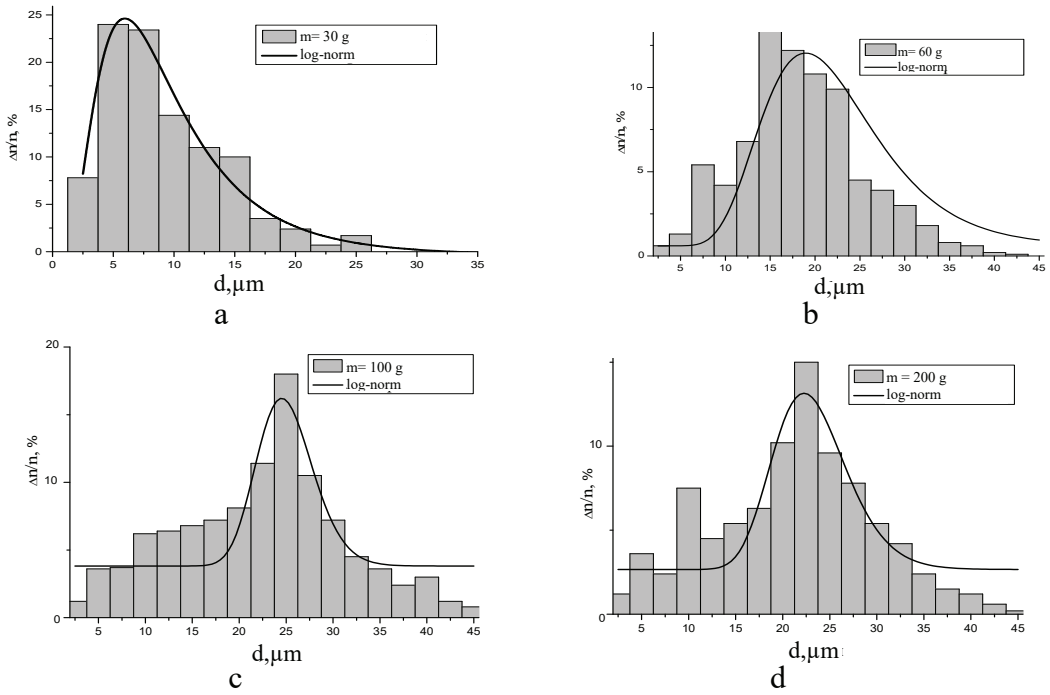


Fig. 4. Histograms and log-normal particle size distribution curves for different load masses

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