Centrifugal unit of combined method of grinding for mechanoactivation of technogenical materials

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Centrifugal unit of combined method of grinding for mechanoactivation of technogenical materials

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Abstract. Analysis of the raw material resources of the Russian Federation has shown that the most large-tonnage raw material is the waste of wet magnetic separation (WMS), formed during the beneficiation of ores. A complex of studies on the use of WMS wastes showed that their most effective use is to mechanically activate a mixture of wastes and cement and to prepare a new class of binders — finely ground multi-component cements and binders with low water requirements. To carry out complex experimental studies, taking into account the existing requirements, an experimental centrifugal grinding unit (CGU) with specified trajectories of the grinding chambers was chosen. The developed grinder is intended for mechanical activation of fragile materials with different physical and mechanical properties by the combined method of grinding (dry and wet), both in periodic and in continuous modes. Analysis of the results of experimental studies indicate the effectiveness of the use of centrifugal grinding unit for the wet method of grinding and also allow us to conclude about the significant superiority of wet grinding for the production of fine raw materials.

1. Introduction

Currently, due to the rapidly developing pace of construction, there is an acute problem of a lack of natural raw materials for the production building materials. On this basis, the urgent task of the construction industry is the preservation of natural raw materials, energy saving and environmental protection, recycling production wastes in order to produce high-quality products from them and the creation of non-waste production [1].

Analysis of the identified raw material resources of the Russian Federation showed that the largest volumes fall on the waste of wet magnetic separation (WMS) formed during ore beneficiation.

Possibility of recycling mining waste will have a beneficial effect not only on the environmental situation, but will also allow the production of a wide range of building materials with high performance properties. This provides a significant economic effect in connection with the use of cheap raw materials.

A complex of studies of the use of WMS wastes showed that their most effective use is to mechanically activate a mixture of wastes and cement and to prepare a new class of binders — finely floured multicomponent cements (FFMC) and low water requirements binders (LWRB) [2,3].

2. Developing the design of the grinding unit of the combined grinding method

The analysis of the existing grinding equipment of low-tonnage technological complexes for fine and ultrafine grinding of materials shows that the design of the fundamental grinder unit which is part of the

complex should provide the functionality of the technological process according to different schemes depending on the existing requirements for the final product [4-7].

With this approach to the creation of a technological complex, the developed centrifugal unit of the combined grinding method satisfies the greatest number of requirements, the design of which allows improving the quality of the finished product by combining both the dry and wet methods of grinding the material in one unit, as well as increasing the productivity of the unit by working by continuous grinding process [8-10].

The developed centrifugal unit of the combined grinding method (Figure 1) contains a frame 1 with support columns 3, in which an eccentric shaft 4 with counterweights is fixed, vertical guides 2 connected through sliders 7 with frame 5 and horizontally arranged top 8, middle 9 and bottom 10 cylindrical grinding chambers with restrictive and classification grids and pipes. In the proposed solution, the top grinding chamber 8 has classification grids 11, and the middle and bottom - restrictive 16, 17, 20. The grid of the chambers is connected at the inlet with the loading 12, 18, 21, at the exit - with the unloading transition chambers 13, 19, 22. And the connecting pipes 23, 24 connecting them are rigid and vertical, the bottom 10 grinding chamber has a hinged-mounted damper equipped with an adjustable spring. On the upper outer surface of the middle 9 grinding chamber, fittings 25 are mounted for supplying fluid from the tank 27 with the dispenser 28.

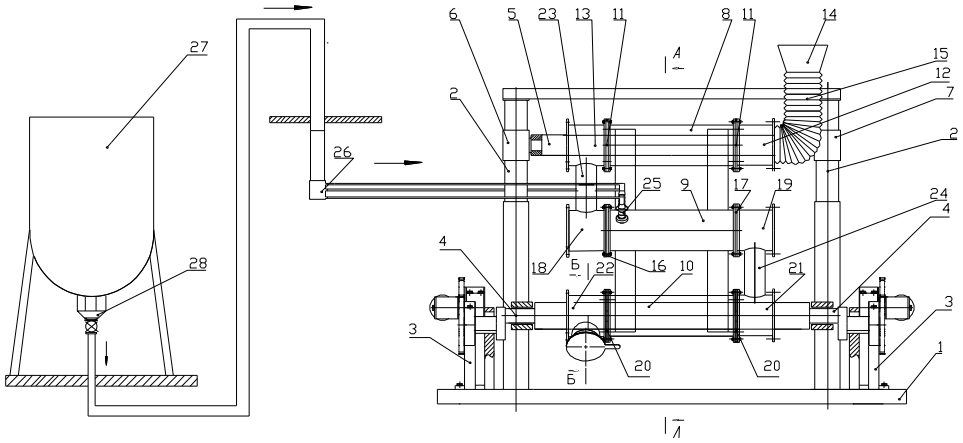

Figure 1. A scheme of the centrifugal unit of the combined method of grinding.

Due to the fact that the wetting of the material occurs in the middle chamber, the combined grinding of the material takes place: preliminary dry – in the top chamber of the unit and subsequent wet – in the middle and bottom chambers. Formed suspension falling into the third chamber is delayed by a special valve at the exit of the mill.

The source material is primarily subjected to intense impact of the grinding bodies in the top chamber of the unit during dry grinding as a result of which microcracks are actively formed in the material particles. The process of formation of microcracks with a further connection of the comminuted material with the liquid phase in subsequent chambers of the unit contributes to a significant increase in the specific surface and, consequently, the quality of the finished product. The possibility of continuous combined grinding of the material while ensuring its movement along the chambers and controlled unloading of the finished material significantly improves the performance of the unit.

3. Experimental studies

Preliminary studies on their grinding in the CPA dry and wet method to assess the possibilities of grinding waste of WMC were conducted. WMC waste is a loose, fairly dispersed material. Indicators of specific surface and density were determined experimentally. The specific surface of the waste is 250 m^2/kg, the bulk density is 1460 kg/m^3, the true density is 2530 kg/m^3.

The experiment was made as follows: the grinding chambers were loaded for 30% with grinding bodies. Grinding took place at a frequency of rotation of the eccentric shaft of the unit – 480 rev / min. For the wet method, water was supplied to the second grinding chamber during each experiment (50% of the total volume of the material). The samples were taken and conclusions were made on the results of the grinding process after every 15 min. The results of the analysis of changes in the characteristics of the material crushed by the dry method are shown in Figures 2-4, and in the wet method in Figures 5-7.

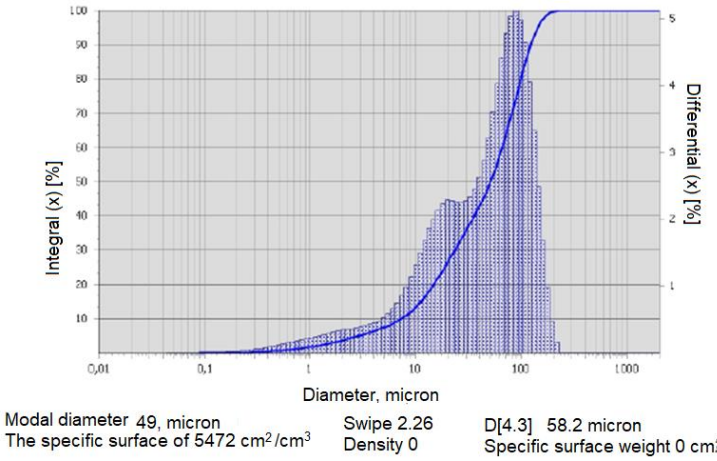

Figure 2. Histogram of grinding waste of WMC with dry method after 15 min.

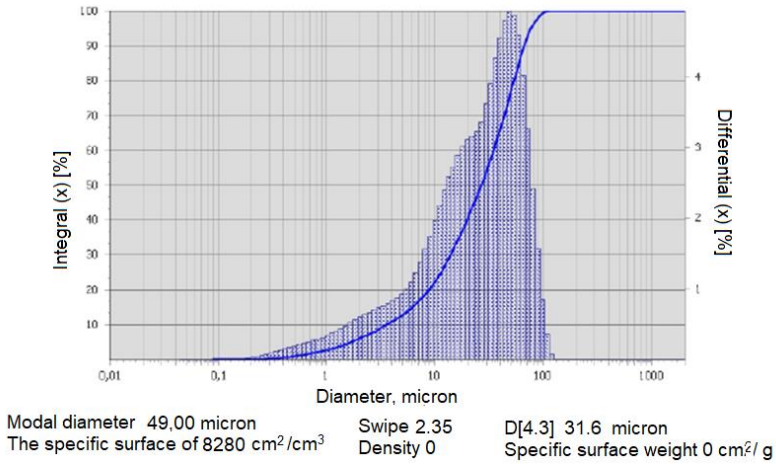

Figure 3. Histogram of grinding waste of WMC with dry method after 30 min.

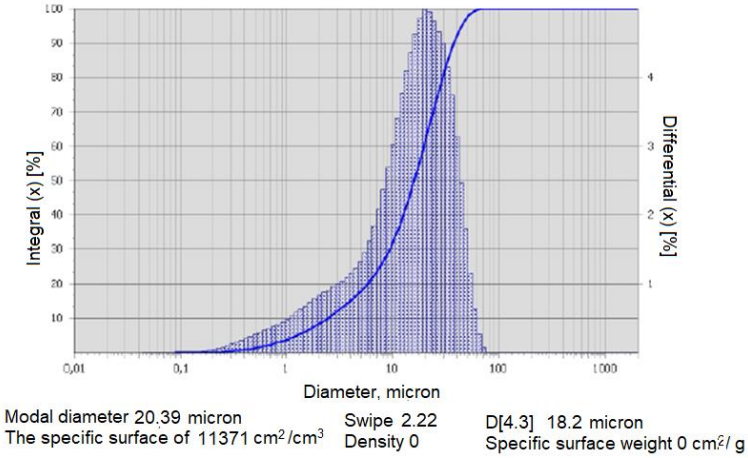

Figure 4. Histogram of grinding waste of WMC with dry method after 45 min.

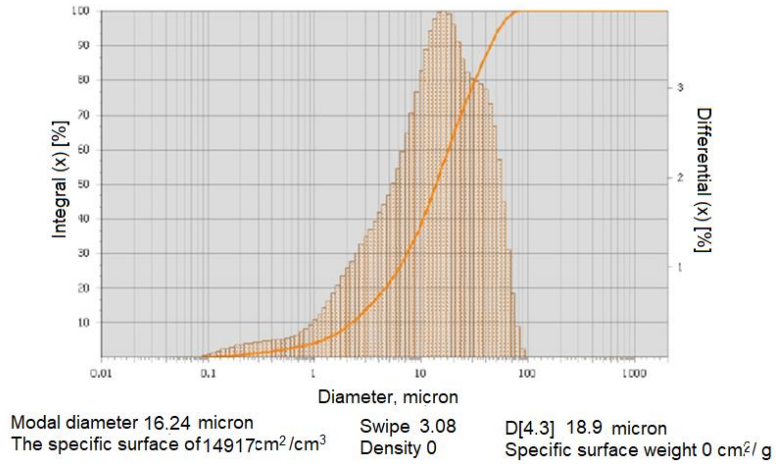

Figure 5. Histogram of grinding waste of WMC with wet method after 15 min.

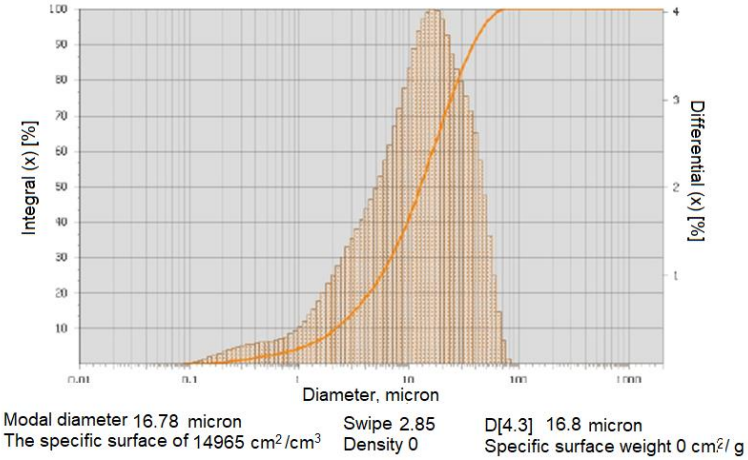

Figure 6. Histogram of grinding waste of WMC with wet method after 30 min.

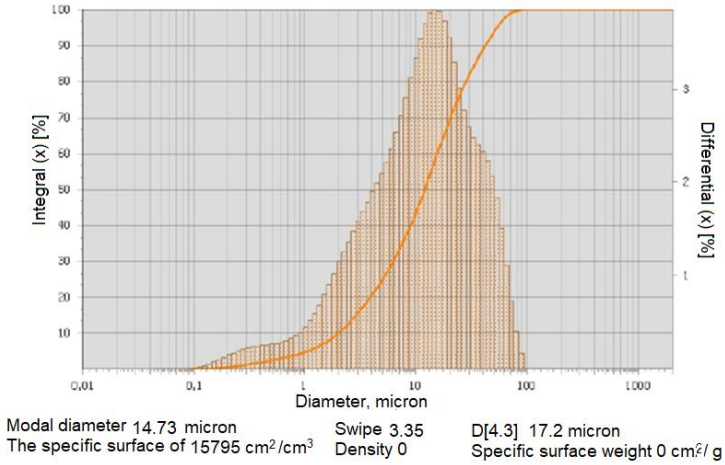

Figure 7. Histogram of grinding waste of WMC with wet method after 45 min.

Analysis of the specific surface area (cm^2/cm^3) shows that the intensity of its increase with the dry method of grinding is higher than that with the wet. After 45 min of grinding, the specific surface area with the dry method increased 2.1 times compared with the value determined after 15 min. With the wet

method the specific surface area increased 1.05 times. The absolute value of the specific surface when grinding by the wet method is significantly higher than that obtained with the dry method at the same time. After 15 min of grinding, its value increased 2.7 times. The results obtained testify to the efficiency of using a centrifugal grinding unit in the wet grinding method.

In addition to mechanical, hydrodynamic effects of grinding media are observed when grinding the material in water. Grinding of the suspension is carried out in the form of a powerful turbulent flow in which elastic mechanical vibrations arise under the action of a grinding load.

4. Conclusion

Experimental studies on the grinding of materials in a centrifugal grinding unit in various ways allow us to conclude that wet grinding is significantly superior to producing fine-ground raw materials.

Using the developed grinder in various technological lines can reduce energy consumption by 15-20% and also allows you to improve the physical and mechanical properties of the final product.

The simplicity of the design allows for quick replacement of the working elements of the grinding chambers and significantly reduces the cost of machine downtime during repair or maintenance.

The design of the centrifugal unit of the combined method of grinding developed by us is the basic for the realization of other technological operations in it.

Acknowledgments

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