ANNOTATION

dissertation work on the topic:
«Development and justification of mill parameters for bulk materials grinding» submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D071200 – «Material science and technology of new materials»
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Relevance of the research topic. The processes of grinding various bulk materials are widespread in construction, mining, chemical, food and other industries.

Ultra-fine grinding of bulk materials has already established itself in the beneficiation technology market as a critical method for increasing recovery. In the production of chemical products such as dyes, pigments, plastics and rubbers, fine grinding of bulk materials is used to obtain the desired texture and particle size. In construction, it allows one to obtain concrete and other mixtures with improved quality and cost characteristics. In the production of metal powders to create alloys, fine grinding of bulk materials is an important step. In the energy sector, it is used in processes for the production of fuel materials, as well as in the processing and preparation of solid fuels.

At the same time, the quality of the resulting products, problems of increasing productivity, and issues of reducing energy intensity and the cost of technological processes come to the fore. Within the framework of the Concept for the Development of the Manufacturing Industry of the Republic of Kazakhstan for 2023-2029, the Concept of Industrial-Innovative Development of the Republic of Kazakhstan for 2020-2025, all conditions have now been created for solving the above issues in the field of production and processing of various bulk materials, using ultra-fine grinding.

Among the previous scientific studies conducted in the world related to the topic under study, we can list the works of the following scientists:

Akunov V.I., Bogdanov V.S., Bashkirtsev A.A., Bond F.S., Blakemore J., Balovnev V.I., Verigin Yu.A., Golosov S.I., Gordievsky L.A., Gardner R.P., Goden A.M., Davis E., Ermilov P.I., Eltsov M.Yu., Zhukov V.P., Karpachev D.V., Morgulis M.L., Moshkovsky E.I. , Morozov E.M., Osokin V.P., Olevsky V.A., Parton V.Z., Pirotsky V.Z., Poturaev V.N., Rumpf G., Rundkvist A.K., Rose G. E., Rebinder P.A., Sidenko P.M., Sevastyanov V.S., Sergeev K.F., Sapozhnikov M.Ya., Uvarov V.A., Hirt J., Khodakov G.S., Shulyak V.A. ., Shuvalov S.I., Shreiner L.A., Yudin K.A., Yashin V.V., Yazea V.A., Steidl D., Boulton A.J., Cahn J.W., Richter D., Dianoux A.J., Petry W., Griffiths A.A., Snow R.H., Cottrel A.N., Raasch J.

Despite many years of research into the problems of grinding processes, they cannot be considered completely solved from the point of view of meeting modern requirements for the quality of the resulting materials and the energy efficiency of the operation of process equipment. It should be noted that in Kazakhstan, which has

developed mining, processing and construction industries, clearly insufficient attention is paid to research in the field of grinding bulk materials.

Currently, the sharp increase in the volume of processed materials, the variety of their types, and the requirements for equipment have led to the fact that the previously acquired operational experience no longer satisfies the needs of consumers. Existing theoretical models cannot answer some of the questions that arise during the operation and design of grinding equipment.

The complexity of the theoretical consideration of the operating processes of grinding equipment determined the fact that the problem of creating a process model and methods for controlling grinding modes (which would allow creating the most efficient technological modes of operation of production lines) remains relevant. Grinding each specific material has its own characteristics. The efficiency of the grinding process is determined by the dynamic parameters of the impact on the bulk material. In this case, the most pressing issues are the control of grinding process modes.

In connection with the above, there is a need to develop a new approach to organizing the grinding process, which helps to increase the grinding fineness with rational energy consumption, a new grinder design to implement this approach, as well as a mathematical model to justify grinding modes.

Thus, we can conclude that the topic of the dissertation is relevant.

The aim of the work is to increase the efficiency of the process of fine grinding of materials by developing a new design of a fine grinder.

Research objectives

- analyze the problems existing in the field of fine grinding of materials;
- develop a grinding unit with improved performance indicators;
- develop a mathematical model of the grinding process and, based on it, justify the parameters of the new grinder;
- experimentally investigate a new design of a prototype fine grinder;
- conduct an analysis of experimental studies, check the adequacy of the developed mechanical and mathematical model and, if necessary, introduce appropriate adjustment factors;
- carry out a feasibility study of the research results.

The object of the research is a grinder for fine grinding of bulk materials.

The subject of the research is the process of material destruction under the influence of the destructive force of the working parts of the grinding unit.

The research novelty

- it has been established that the double-sided effect on the particles of the grinding material, provided by the new design of the vibration-rotational type grinding unit, makes it possible to increase the grinding fineness and reduce the energy intensity of the grinding process;
- a theoretical dependence of grinding fineness on the operating parameters of the design of a vibration-rotary grinder with a double-sided effect on the crushed material has been established;
- a theoretical dependence of power consumption on the geometric and kinematic parameters of the new grinding design has been established;

- the dependence of grinding fineness on the geometric and kinematic parameters of the new grinder design was experimentally established.

The practical importance of the research lies in:

- highly efficient design of a vibration-rotary grinder;
- a theoretical calculation model that allows the determination and selection of grinder parameters to obtain an effective result;
- regression model of the process of fine grinding of materials, allowing to predict the fineness of grinding;
- implementation of research results into production.

The following scientific provisions are submitted **for defense**:

- original design of a vibration-rotary grinder, which allows to increase the grinding fineness and reduce the energy intensity of the grinding process;
- a mathematical model of the process of material destruction, which allows one to determine rational design parameters of a new grinder;
- results of experimental studies confirming the effectiveness of the proposed design of a vibration-rotary chopper.

The validity and reliability of scientific provisions is confirmed by the adequacy of the developed mathematical model, verified by the results of experimental studies, as well as the use of modern measuring instruments that helped determine the particle sizes of the grinding material with high accuracy.

The author's personal contribution lies in setting the goals and objectives of the research, creating the design of a new fine grinder, developing a mathematical model of the process of material destruction in the new grinder, organizing and conducting experimental studies of the effectiveness of the design of the new grinder.

Testing the work. The results of the research were reported and discussed at:

- III (April 12-13, 2017) international scientific and technical conferences of students, undergraduates and young scientists "Creativity of the young - innovative development of Kazakhstan" (EKSTU, Ust-Kamenogorsk, Kazakhstan);
- international scientific conference "Global Science and Innovations (GSI-2018)" (Jäger, Hungary, February 28, 2018);
- international scientific and practical conference "Modernization and scientific research in the transport complex" (PNRPU, Perm, Russia, November 9-10, 2017);
- meetings of the scientific seminar of the department "Mechanical Engineering and Tribology" of the Wroclaw University of Science and Technology (Wroclaw, Poland) in 2017 and 2019;
- extended meeting of the international school of engineering of the East Kazakhstan Technical University named after. D. Serikbaev in 2024.

The research work on the topic of the dissertation took 1st place in the Republican competition of scientific research works of students in 2018-2019.

Realization of research results. The results of the dissertation research were introduced into the production process of UA Transstroy LLP, Ust-Kamenogorsk in 2019.

Publications. The main results of the dissertation work were reported and discussed at various international conferences and published in 8 scientific papers:

3 articles in publications recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan:

1) Сулейменов А.Д., Гурьянов Г.А., Васильева О.Ю. Предварительная экспериментальная оценка интенсивности измельчения в вибровращательной мельнице новой конструкции / Вестник ВКТУ. №1, 2018. С. 80-86;

2) Сулейменов А.Д. , Гурьянов Г.А. Результаты экспериментальных исследований некоторых параметров новой вибровращательной мельницы // Труды университета (Карагандинский государственный технический университет). - №3, 2019. - С.109-112;

3) Байгереев С.Р., Г.А. Гурьянов, А.Д. Сулейменов, В.А. Ким. Установление зависимости энергии измельчения от геометрических и эксплуатационных параметров в новой вибровращательной мельнице / Вестник ВКТУ. – №2, 2022. – С. 40-52.

1 article in international peer-reviewed journals with a non-zero impact factor and indexed in the Scopus database (percentile of at least 25):

1) Baigereyev S., Guryanov G., Suleimenov A., Abdeyev B., Kim V. New Method for Materials Comminution Using Grinding Balls // International Review of Mechanical Engineering. – 2023. – Vol. 17, Iss. 2. – P. 71-79.

Domestic and international scientific and practical conferences:

1) Suleimenov A.D., Bekbolatov K.S., Kumykova T.M. Analysis of constructions of milling machines for fine grinding // Творчество молодых – инновационному развитию Казахстана: материалы III Международной научно-технической конференции студентов, магистрантов и молодых ученых. – Усть-Каменогорск: Изд-во ВКГТУ, 2017. – С. 219-223.

2) Сулейменов А.Д., Кумыкова Т.М., Гурьянов Г.А. О некоторых принципах создания эффективных помольных агрегатов / Международная научно-практическая конференция «Модернизация и научные исследования в транспортном комплексе», ПНИПУ, г. Пермь, Россия, 2017. 188-191 с.

3) Suleimenov A.D. Innovative design of vibrational and rotational mill for materials breakage/ Materials of the International Scientific Conference «Global Science and Innovations 2018» – Eger: Eurasian Center of Innovative Development «DARA», 2018. – P 93-95. http://ecir.kz/GSI2018.html

1 RK patent for utility model:

1) Патент РК № 2017/0343.2, 29.12.2017. Устройство для тонкого измельчения материалов // Бюл. №26(II). / Гурьянов Г.А., Кумыкова Т.М., Сулейменов А.Д.