



Investigation of the Actual Issue of Material Grinding and Ways to Reduce the Energy Consumption of Equipment










INTRODUCTION

The issue of creating all-new technologies and improving existing ones through the introduction of innovations and modernization of equipment for grinding that take into account individual texture and physical and mechanical properties of materials is still relevant.

The grinding process is the mechanical destruction of a solid body under the various external forces.

The efficiency of this process is achieved by applying force to the crushed body. With an increase in the size of the crushed piece, its strength decreases because it largely depends on the direction of application of external forces, especially when grinding materials with anisotropic texture, as well as the size of their pieces.

WORLD'S DATA

According to UNESCO, humanity spends up to 10% of all generated electricity on the process of crushing and grinding. For example, the cost of crushing and grinding in the cost of ore concentrate is up to 40%.

According to the Global Energy Statistical Yearbook, in the period 2019 - 2020, demand for electricity consumption by industry in China accounted for 28% of global electricity consumption and grew by 4.5% compared to 10% from 2000 to 2018.

In the US, demand reduction from the industrial sector contributed to a 2.2% reduction in electricity consumption. Electricity consumption also declined in the EU (-1.4% due to slower economic growth), Japan, South Korea and South Africa.

In this regard, our research aims to address gaps in the issues of reducing the energy consumed for crushing and grinding, to develop and propose new provisions to solve existing and emerging issues in the development of disintegration of materials with a shale texture

MATERIALS




As for the concept of energy consumption, it is necessary to explain the correlation between the energy consumption in the process of crushing rock formations and the value of the specific surface of the crushing products that are shown at analytical mathematical expressions steps 1-4.

1st

$$A_p = K_p \Delta S = K_p \Delta D^2$$

2nd

$$A_k = K_k \Delta V = K_k \Delta D^3$$

3rd

$$A_{Reb} = K_k \Delta V + K_p \Delta S$$

4th

$$A_{Rund} = k\left(\Delta D^{4-n}\right)$$

Russian and foreign scientists made an invaluable contribution to conducting fundamental research in the field of mechanical physics of the brittle bodies. They formed a modern understanding of the formation theory of natural materials with anisotropic texture where much attention is paid to the disclosure of the mechanism of solids destruction by stages, which is important for studying and understanding the deformation process of materials with anisotropic texture.





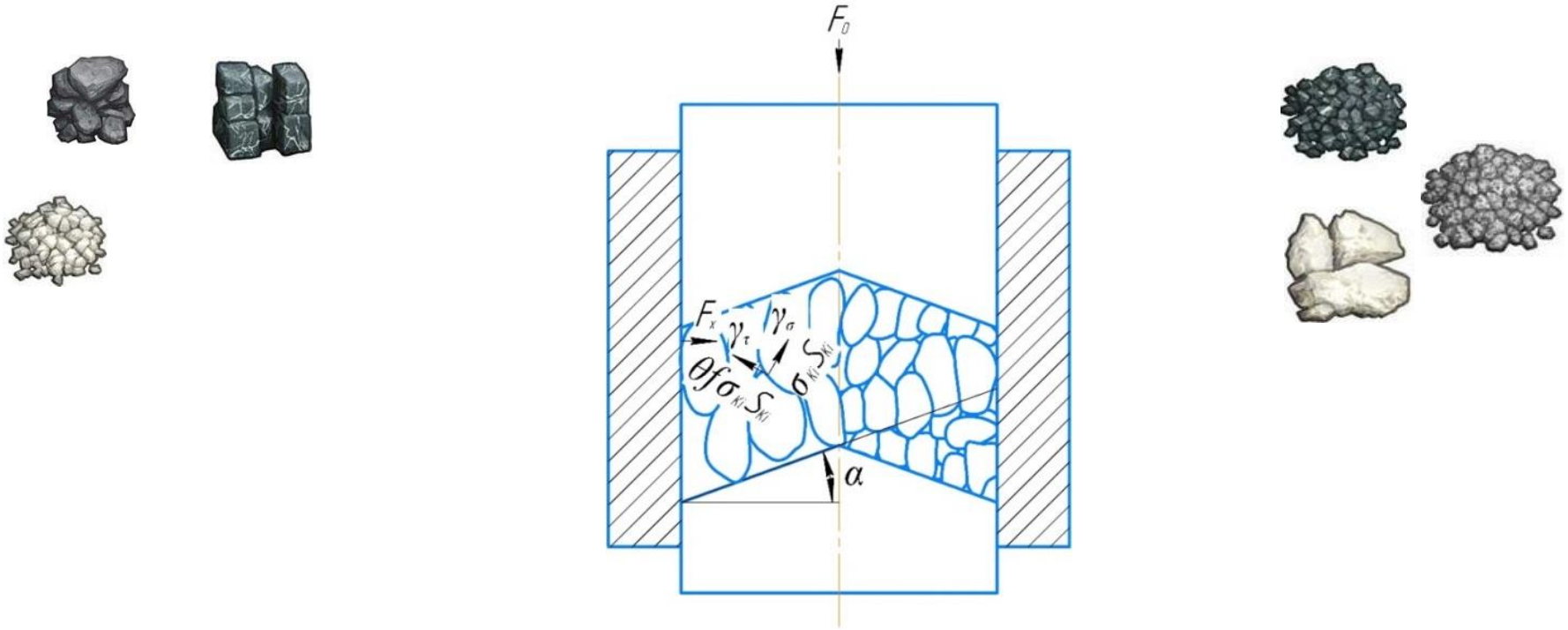
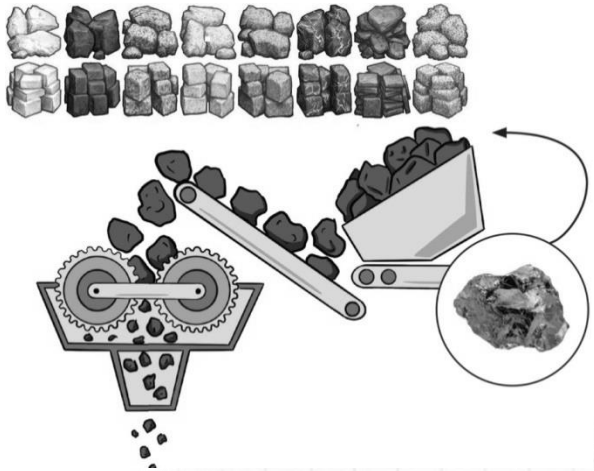


FIGURE. Diagram for calculating the disintegration force

The mathematical model of pressure destruction of anisotropic materials used in this work is of particular interest in comparison with the other existing ones. Since, despite the difference in approaches, this issue still remains poorly investigated, especially in the field of the disintegration process in the press-roll shredder of anisotropic materials.

Considering the scheme for calculating the mathematical model of disintegration in this process, we identify new solutions to the problem in the press matrix, which has a beveled working surface of the punch at an angle of α.



RESULTS AND DISCUSSIONS

1

By summing results of the research and results obtained by scientists, we can conclude that the authors do not take into account the special influence of the gas-hydraulic damping device, which creates the necessary pressure during the material grinding as well as do not consider the specifics of the destruction of shale rocks with an anisotropic texture.

2

This is practically and technologically justified that when using this method of grinding, the process of reducing the specific energy consumption by 20-25% is achieved, while the productivity of the final unit, for example, a ball mill increases to 30%.

3

New provisions were developed and proposed to resolve existing issues in the development of technology for the disintegration of materials with a shale texture. They will also enable to establish the relationship between the energy costs in the crushing process and the value of the specific surface of the crushing products and address gaps in the reduction of electricity consumed in the processes.


RESULTS AND DISCUSSIONS


After calculation we inducted the following analytical mathematical expressions

- Calculation of the force in the direction of the shale line:

$$\sigma_{avg} = 0.71 \cdot 1 \cdot \frac{\cos 25 \cdot 55 \cdot (1.1 - 0,4)}{0.24} = 112.9 \text{ MPa}$$

- Calculation of the force in the perpendicular direction:

$$\sigma_{avg} = 0.71 \cdot 1 \cdot \frac{\cos 25 \cdot 85 \cdot (1.1 - 0.4)}{0.24} = 174.5 \text{ MPa}$$

In the process of studying various anisotropic materials, we obtained the final calculations, which revealed that the directional grinding of anisotropic shale materials will require less effort and will enable to save energy.

CONCLUSION

New provisions were developed and proposed to resolve existing issues in the development of technology for the disintegration of materials with a shale texture. They will also enable to establish the relationship between the energy costs in the crushing process and the value of the specific surface of the crushing products and address gaps in the reduction of electricity consumed in the processes.

1. Industrial mining enterprises will be able to improve the process of destruction, crushing, grinding and it will lead to a reduction in electricity consumption;
2. The obtained equations in the course of analytical studies enables to calculate the required force of anisotropic rocks;
3. To identify the origin of rocks in the result of various formation processes.






The presentation was created by group of authors

M A Romanovich[1], E I Evtushenko[1], S A Schastlivenko[1], E I Vyskrebentsev[1] and E Amini[2]

[1]Department of Hoist transport and road machines, Belgorod State Technological University named after V.G. Shukhov Belgorod, Russia

[2]K.N. Toosi University of Technology, Tehran, Iran