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INVESTIGATION OF THE PROCESS OF GRINDING OF SOLID OIL REFINERY WASTE IN THE IMPACT CENTRIFUGAL MILL

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Annotation: The article presents the results of research of the process of petroleum coke grinding in the impact centrifugal mill. The aim of the work was to find optimal technological parameters for obtaining petroleum coke powders of a given granulometric composition. Experimental studies were carried out, including the analysis of the influence of the mass flow rate of the material, the rotor speed of the mill and the granule size of the initial material on the disperse composition of the product. The results have shown that the increase of rotor speed and reduction of initial granule size contribute to the increase of material grinding degree. Technological schemes of petroleum coke processing have been developed, which can be used in various industries.
Keywords: Petroleum coke, impact centrifugal mill, grinding, particle size distribution, rotor speed, disperse composition.

Introduction

Petroleum coke is one of the main wastes of the oil refining industry. Its utilisation and processing represent an important task, as improper handling of this material can lead to negative environmental consequences. One of the promising directions of petroleum coke utilisation is its grinding to powdery state with subsequent application in various industries, such as metallurgy, production of construction materials and chemical industry.

The purpose of this work is to study the process of grinding petroleum coke in an impact centrifugal mill and the development of technological solutions for obtaining powders with a given particle size distribution. Within the framework of the research the following tasks were set:

1. Determination of the minimum (critical) speed of the process of impact-centrifugal grinding.
2. Calculation of the expected particle size distribution of petroleum coke powders after the grinding stage.
3. Analysis of the influence of technological and design parameters on the grinding process.

Methods and Materials

An impact centrifugal mill equipped with an electric motor, inverter, feed material hopper, cell feeder and bag filter was used for experimental studies. The petroleum coke samples obtained from the delayed coking unit were examined by scanning electron microscopy (SEM) on a JEOL JSM-5610 LV microscope with an EDX JED-2201 chemical microanalysis system. This allowed qualitative and quantitative analysis of the chemical composition of the samples.

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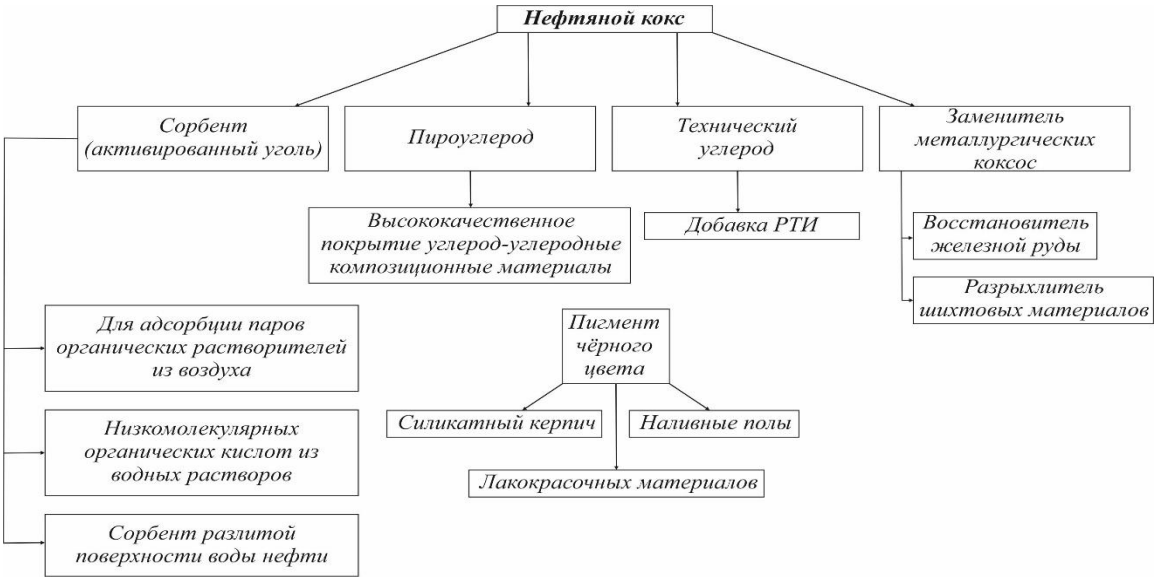

Figure 1 - Scheme of petroleum coke application areas.

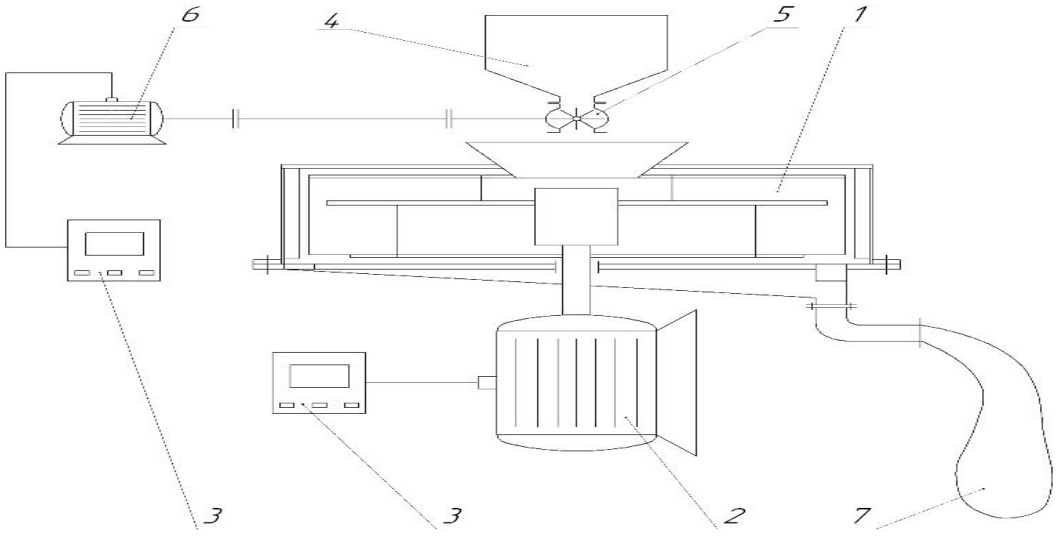

Figure 2 - Schematic diagram of the experimental setup.
1 - impact centrifugal mill; 2 - electric motor of the mill drive;
3 - inverter; 4 - hopper of initial material; 5 - cell feeder;
6 - feeder drive electric motor; 7 - bag filter

The main parameters varied during the experiment:
- Mass flow rate of the material (from 6.42 to 13 g/s).
- Mill rotor speed (from 1330 to 2950 rpm).
- Granule size of the feed material (from 1 to 6 mm).

The particle size distribution of grinding products was analysed by mechanical classification (sieving) on sieves.

Results and discussion

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1. Effect of rotor speed on the degree of grinding
Experimental data showed that an increase in the rotor speed of the mill leads to an increase in the degree of grinding of the material. **Figure 3** shows the fractional composition curves at different rotor speeds (1330, 1770, 2360 and 2950 rpm) at a constant mass flow rate of 6.50 g/sec. It can be seen that the amount of fine fraction (less than 0.1 mm) increases significantly with increasing rotor speed.

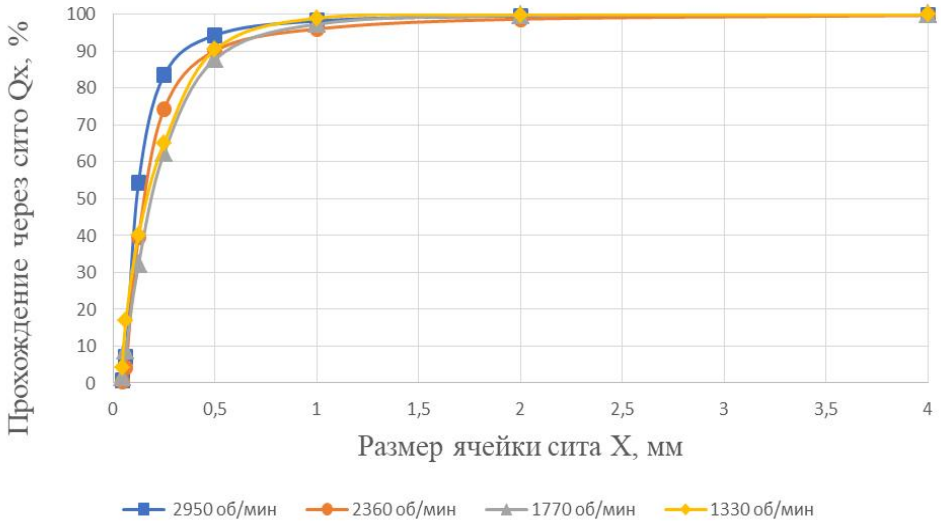

Figure 3 - Fractional composition of products of impact centrifugal grinding of petroleum coke at different rotor speeds at G = 6.50 g/s. Analysing the obtained dependence, we can conclude that with increasing rotor speed the degree of material grinding increases, as the amount of finer fraction increases.

2. Influence of mass flow rate of material
Figure 4 shows the dependence of the fractional composition on the mass flow rate of the feed material at a rotor speed of 1770 rpm. Increase in mass flow rate from 6.50 to 11.20 g/s leads to a decrease in the degree of grinding, which is associated with a decrease in the residence time of the material in the mill.

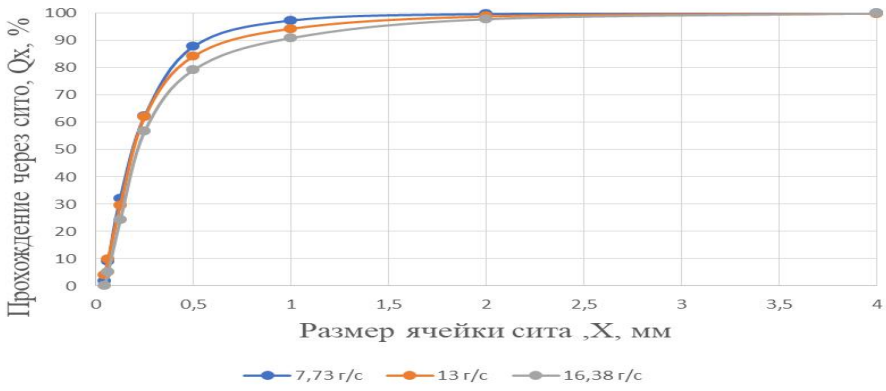

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Figure 4 - Dependence of fractional composition on mass flow rate of the fed material at rotor speed n=1770 rpm

3. Influence of the size of initial granules.

Figure 5 shows the dependence of the particle size distribution of the crushed material on the size of the initial granules. Reducing the size of initial granules from 6 to 1 mm leads to an increase in the share of fine fraction in the grinding product. This is due to the fact that smaller granules are more easily subjected to destruction under the action of impact and centrifugal forces.

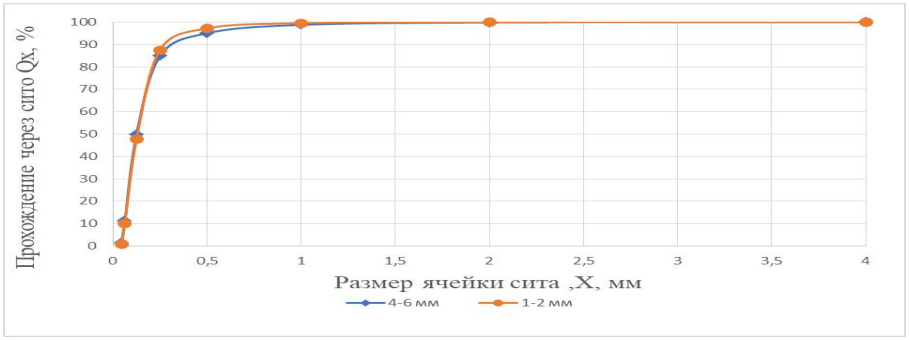

Figure 5 - Dependence of particle size distribution on the size of initial granules.

4 Technological scheme of petroleum coke processing

On the basis of the conducted research the basic technological scheme of petroleum coke processing into powders of the required disperse composition was developed **(Figure 6).** The scheme includes the following stages:

1. Rough crushing.
2. Mechanical removal of surface moisture.
3. Crushing.
4. Fine grinding.
5. Pneumatic classification.
6. Gas cleaning in cyclone and bag filter.

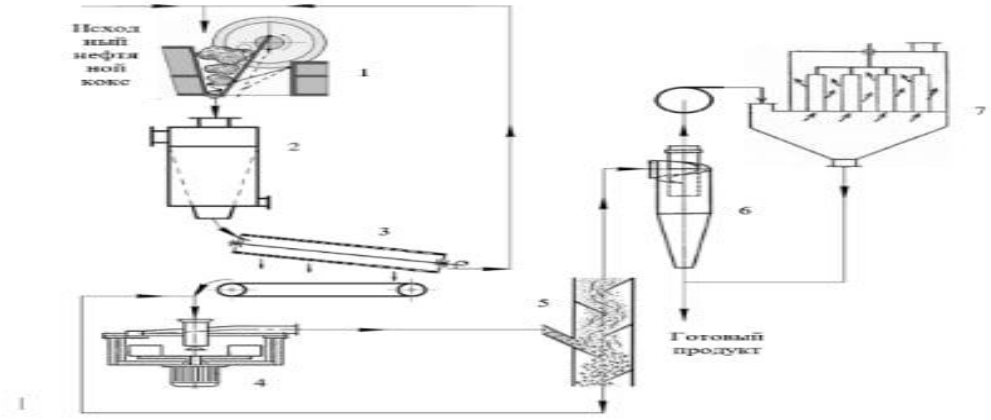

Figure 6 - Technological scheme of petroleum coke processing.

Conclusion

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The conducted studies have shown that the process of grinding petroleum coke in the impact centrifugal mill is effective for obtaining powders with a given particle size distribution. It is established that increase of rotor speed and reduction of initial granule size contribute to increase of material grinding degree. The developed technological scheme allows to optimise the process of petroleum coke processing and can be used in various industries.

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