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PRELIMINARY TREATMENT OF MINING WASTE FOR THE PURPOSES OF ITS FUTURE UTILIZATION

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Abstract

The extraction of minerals in an open way inevitably leads to generation of large amounts of mining waste for storage and disposal. The last require vast areas. And although the present priority continues to be prevention of already generated waste it is important to try to cease pollution by achieving the requirement of getting to the process of 'end of waste'. Typically, this conversion of waste into materials is matched with the process stage of pre-treatment ensuring reliable recovery. Mining waste contains valuable and often searched substances that can be used as an alternative to natural materials.

Key words: classification of mining waste, clay minerals, pre-treatment of mining waste, separation of clay materials.

Introduction

European Union has a very ambitious policy and legislation for waste management by seeking to change the traditional thinking of waste as an unwanted burden in perspective thinking about waste as a raw material and energy resources, especially in the last five years. The long-term aim of EU is to become a 'recycling society', which seek to improve efficiency of resource use to reduce the overall use of non-renewable natural resources, respectire environment (Anonimous 2004, 2006).

Methods for treatment of mining waste from different minerals aiming production of one or several products are known (Fall et al. 2005, Kyoseva et al. 2009, Li et al. 2006, Li at al. 2010, Pelovski et al. 2003, Yossifova 2007). These methods correspond to different degrees of Reference Document of Best Available Techniques for Management of Tailings and Waste Rock in Mining Activities. To achieve compliance with EU objectives for recovery of mining waste (Anonimous 2004, 2011), it is necessary to investigate the properties and possibilities for utilization of coal mining wastes.

According to the National Statistical Institute, of the total hazardous wastes, generated in 2011 in Bulgaria, 92.7 % are generated by mining industry. The amounts of hazardous waste are 174,692,154 t, of which less than 0.1 % are delivered for recovery. The remaining part is a subject of disposal operations on the territory of enterprises, which generated the waste (Anonimous 2012).

In our previous studies are discussed the chemical properties of mine waste generated in some of the fields of Pernik Province. These studies are related to classification of mining waste and methods of its utilization. The current article is a continuation of this development in the utilization (Kostadinova and Todorova 2010, 2014).

Mining waste mining in an open way, for the most part contains clay material that this rate of production in foreseeable future will prove demand, insufficient material. Conditional provision with kaolin raw material in the country, based on objects in operation is 20 years in these rates of production and not more than 80 years on the basis of all the stocks in the country (Anonimous 2012).

In order to replace more natural materials with waste, method for separation of water aiming to get a second material – clay minerals and rocks, were developed.

The aim of this paper is to develop a process for separation of different minerals from mining waste. To achieve the objective the following has been done: sampling from the same field in different time periods of mine operation; mineralogical analysis of samples; waste classification; developing a methodology for water separation and quantification of separated fractions.

Table 1. Distribution of samples by year of formation.

Sample	Year of formation
Sample 1	2012
Sample 2	2010
Sample 3	1990
Sample 4	2000
Sample 5	1965

Materials and Methods

Object of analysis and characterization of the waste is given in Table 1. The purpose of sampling is to identify changes in the qualitative composition of geological substrates in different periods of time. Samples were taken by criteria 'during formation', regardless of how coal mining was performed.

The method of water separation has been developed with mining waste taken from Mini Otkrit Vagledobiv JCS, section Teva (Fig. 1), which previous studies have shown that contain clay minerals (Fig. 2).

Fig. 1. Location of sampling points in Mini Otkrit Vagledobiv JCS, section Teva.

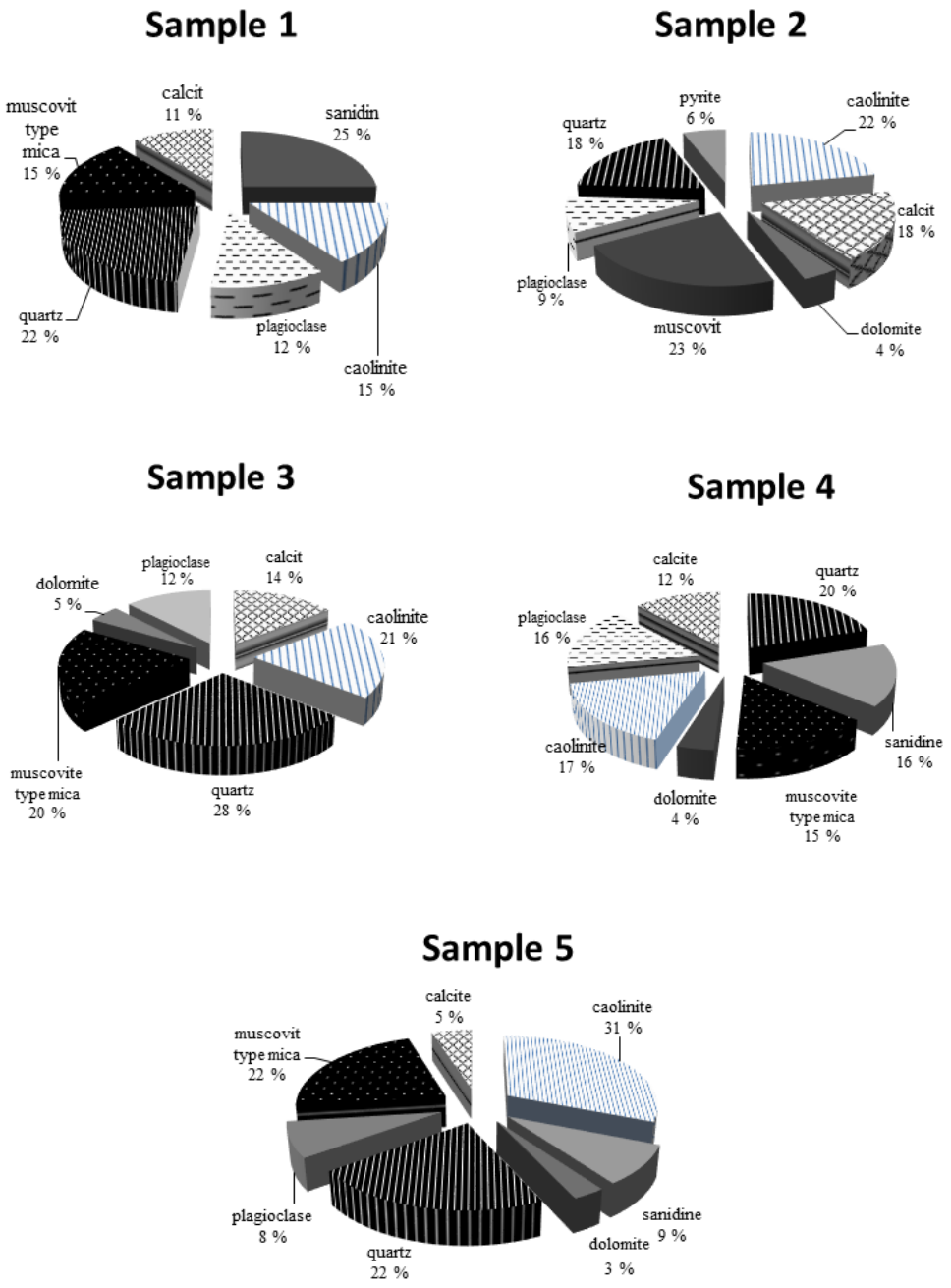

Fig. 2. Content of minerals in the samples.

When one talks about waste utilization and reaching 'end of waste', it is important to know the content of harmful, toxic and other elements and substances which would give them hazardous properties. In order to determine the waste properties characterization and classification was made by analyzing five samples generated during different periods of mine operation.

The waste is classified based on legal documents:

• Regulation for specific requirements for management of mining waste (Anonimous 2009);

• Regulation 2/2014 on waste classification (Anonimous 2014b).

The mining waste generated by Mini Otkrit Vagledobiv JCS, section Teva is classified according to legal documents as: 01 01 02 – wastes from exploration and extraction of non-metallic minerals.

The waste complies with the requirements of the National Regulation for specific requirements for management of mining waste category 'inert waste' and though it has been shown that in the analyzed samples there are coal impurities, which are flammable waste thus allowing its classification as non-hazardous non-inert waste (Anonimous 2009, 2013, 2014a, 2014b).

Methods of water separation

A method has been developed with the main aim of separation of clay minerals and rock mass in mining waste using the characteristics of the clay to absorb water and this way to achieve destruction of the particles resulting from the conjugation/adhesion of clay minerals in dry condition (Fig. 3), and to investigate the possibility of their separation (Anonimous 1987, Kovachev et al. 1991).

Necessary equipment for testing the methodology for water separation consists of:

- electronic scale, with 1 g accuracy;
- sieve in size 0.045 mm;
- measuring cylinder with accuracy 2 cm;
- drying oven with the temperature range 60–80 °C;
- suitable container of 10 l;
- hose for decanting.

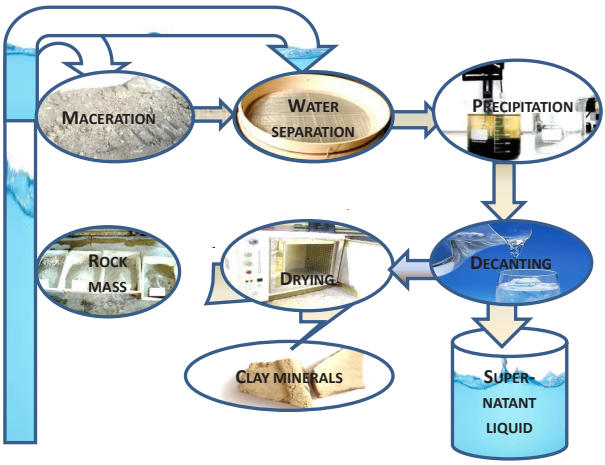

Fig. 3. Methodology for water separation.

Approximately 150–200 g of geological substrates was used depending on the type of sample and the content of clay minerals in it. The sample is placed into a suitable container and 1.5 l of water was added on top of it. Incubation for about 1–2 h followed with frequent stirring. This assures breaking of the already formed coarse particle clays.

The resulting mixture after water addition is transferred

Table 2. Results from the developed methodology for water separation.

Sample	Sample weight, g	Water consumption for separation, l	Quantity decanted water, l	Quantity over sieved fraction, after drying, g	Quantity under sieved fraction after drying, g
Sample 1	200	12.0	10.8	28	168
Sample 2	202	5.5	4.7	187	11
Sample 3	200	9.5	9.1	28	167
Sample 4	158	8.0	7.1	40	114
Average	190	8.75	7.92	70.75	115

to a sieve (0.045 mm) for the process of separation and water is added gradually. The process continues as long as clear water starts passing. The final separation is reported based on the color of the effluent on a white background. The amount of liquid used depends on the content of clay minerals in the sample and varies widely (5 to 15 l sample of 200 g). Liquid passed through the sieve, together with the clay minerals, is collected in a suitable container and allowed to precipitate within 12–24 h. After it, the supernatant liquid is decanted, and thus about 80–90 % of the input to flush water is recovered and is available for re-use in the process of separation.

Thus the divided fractions – above and below 0.045 mm after decanting are carried in a suitable container, placed in a drying oven to complete drying

Results

In that methodology are processed four composite laboratory samples of mining waste from open pit mining. The test results are presented in Table 2.

In accordance with The Opinion of the European Economic and Social Committee on 'Processing and exploitation, for economic and environmental objectives of waste industrial and mining waste in the European Union' to avoid disposal of mining waste, developed methodology trying to turn mining waste into raw material is applicable in various economic fields.

The results show significant abnormalities due to inhomogeneity of the samples. To implement the experiments laboratory samples taken were not subjected to a pretreatment to modify the particles' size.

For separation finely dust particles and clay particles in samples of mine waste with total weight of 760 g, 35 l of water were used, which gives an amoun
t of approximately 42 l/kg. Suitable for reused liquid in the process of water separation is 31.7 l, which is 90 % of the original quantity.

Conclusion

From the experiments on the proposed methodology following conclusions could be drawn:

1. Wastes generated in Mini Pernik, in different periods of its activity, have similar mineral content regardless the method of mining. They are classified as waste from exploration and extraction of non-metallic minerals, which is non-hazardous non-inert.

2. Mineralogical analysis suggests the presence of pyrite in only one of the tested samples. Due to the fact that mining waste from coal industry is expected content of coal impurities, it is an advantage for their future utilization, for example for production of bricks.

3. A methodology for waste utilization has been developed on the basis of water separation to clay minerals. It was found that:

● clay minerals in mining waste from Mini Otkrit Vagledobiv JCS, section Teva reach 31 % with an average content of 21 %;

● the quantity of clay minerals and particulate matter is diverse and ranges from 5.4 % to 84 % by weight of individual samples in water separation;

● the under sieved fraction can be utilized as raw material for production of bricks and tiles;

● the over sieved fraction is suitable for back backfill underground workings, concrete additives, etc.;

● for separation of fine dust particles and clay particles in samples of mine waste with total weight of 760 g, 35 l of water are used, which gives an amount of approximately 42 l/kg;

● liquid suitable for reusing in the process of water separation is 31.7 l – 90 % of the original quantity.

Pre-treatment of mining waste in the developed methodology allows utilization of clay as an alternative to natural resources and utilization of rock mass as an alternative to crushed stone as raw materials.

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