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COALY ROCKS OF DNIEPROVSKY LIGNITE BASIN AS A RAW MATERIAL FOR POWER ENERGY AND CHEMICAL INDUSTRIES

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A b s t r a c t . Dnieprovsky lignite basin, situated in central part of Ukraine over the area of about 400 km^2, contains more than 150 deposits. About 55 deposits have industrial significance. Their reserves are 2.4 billion tons. Seams and lenses of coaly clays and sands overlay the coal series and occur between coal packets. The coaly clays are classified into this category because their ash content exceeds 40%. Our investigations show that coaly rocks are similar to lignite in composition and properties. They have ash content from 40% up to 60%, the same elementary composition of organic matter. As well as bitumen and humic acids yield. It has been established that coaly rocks can be used as energy and chemical raw material, the basis of good carbon sorbents with high adsorptional capacitance. The recommendation of coaly rocks for mining and processing is difficult because of lack of information in geological reports on their quantity, composition and properties, as they are considered as host rocks but not as mineral resources. If the usable coal limit was accepted at 50% of ash content, the coal reserves of some deposits would have increased 1.5–2 times.

K e y w o r d s : lignite, power energy, chemical raw material, Dnieprovsky basin.

INTRODUCTION

Coaly rocks are high ashes producing part of coal-bearing formations that are mostly deposited at the top of the lignite beds. They constitute up to 50% of the mined coal. They are left in the dumps while coal is being mined.

Dnieprovsky lignite basin is situated in the central part of Ukraine. It contains more than 150 lignite deposits, covering areas from 200 to 400 km^2, and located mostly on the right bank of the Dnieper river. About 55 deposits have industrial value. They are located mostly in Alexandriysky lignite region of Dniepropetrovsk and Kirovograd districs. The explored coal reserves reached 2.4 billion tons.

The industrial coal is related to deposition of Buchaksky formation of Palaeogene (medium Eocene) period. Coal-bearing deposits of Buchack formation are divided into three main lithological horizons: under-coal, coal and pericarbonic ones.

Under-coal layer is composed of medium and large-size grain, grey sands, that transfer in their upper part into fine, dark-brown, coaly clay lenses, kaolin, seldom fine coal interlayers. A maximum thickness of a horizon is 25 m, predominating one is 6–8 m.

The coal rock mass is a unique stock, formed more or less at the same time, that represents one layer of simple or complicated structure, more rarely — 2–3 layers separated by coaly sands, coaly clays, and sand interlayers. The thickness and composition of coal deposits are not stable, sharply changing with the coal transition into coaly rocks, high ash coals (mainly in the upper part of deposit).

A pericarbonic rock mass is composed of coaly clays, coaly sands with clay interlayers, sand lenses, and coal interlayers. A total thickness of Buchack deposits does not exceed 40–45 m, often is in the range of 10–15 m (Radzivill *et al*., 1987).

Coaly clays and sands are included into the mined rocks though their ash content is higher than 40%. If the conventional boundary would be accepted as equal to 50%, then coal resources would increase approximately 1.5–2 times and the thickness of overburden would decrease 2–3 times.

Our investigations revealed that coaly rocks are similar by their composition and properties to lignite, with the ash content from 40 to 60%. They have the same composition of organic matter elements, yield of bitumen and humic acids.

Preliminary investigations revealed that coaly rocks might be used as an energy-producing and chemical resource: the base of good carbon adsorbents.

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EXPERIMENTAL

For the processing of coaly clays (CC), the pyrolysis process was used (Saranchuk *et al*., 2000). Both source CC and CC preliminary treated by 1M solution of NaOH, were decomposed by heating at temperature of 600–900°C, in the reactor without pressure. The resulting steam-gas mixtures were separated into liquid products and gas. Sorbents from CC were received by the activation of CC pyrolysis fixed residues (carbonizates) by water vapour. Methylene blue and phenol determined sorption volume of obtained porous materials. Specific surface of the porous materials was determined by BET-method. This paper shows the results of processing of CC on the example of CC from Verbolozovskiy open pit mine of Alexandriyskiy deposit.

RESULTS AND DISCUSSIONS

Table 1 shows results of pyrolysis products of CC from Verbolozoskiy open pit mine, treated at various temperatures. The yield of liquid products from CC increases up to the temperature of 700°C. At higher pyrolysis temperatures, gases yield from CC increases both for treated coaly clays and for CC, but the liquids yield is constant. At the same time, the latter is about 40% higher from treated CC than from initial CC, gas outlet being by 5–15% higher. Thus, from 1 t of organic mass contained in 1.7 t of dry CC, 80–120 kg of liquid products, 320–610 kg or 250–470 m^3 of gas, and 1,000–1,250 kg of carbonizate (source for adsorbents) may be received.

The use of carbonizates in the power industry is not comfortable because they contain high (58–70%) concentration of ash. Thus the comfort of CC processing depends on the opportunities to receive from them high quality adsorbents. Table 2 demonstrates data on the yield and properties of adsorbents received from CC carbonizates.

Specific surface of adsorbents from CC is lower than from adsorbents received from brown coal. Sorption capacity of adsorbents from CC equals that of adsorbents received in similar conditions from brown coal. Adsorbents from CC, treated by NaOH, have lower specific surface than adsorbents from initial CC. But their use is expedient to receive granulated adsorbents from finely divided fractions (<0.5 mm). The yield of sorbents from CC is 1.5–1.6 times higher then from brown coals. Adsorbents from CC are adequate to requirements for clarifying adsorbents, and can be recommended for the removal of harmful impurities from sewage and air.

The main conclusions from this analysis are:

1. coaly clays are interesting, huge resources for investigations with the aim to receive suitable source of energy (namely — gas) and inexpensive one-time adsorbents for purification of some sewage.

2. Using chemical treatment, it is possible to change the quantity and quality of the obtained products.

Table 1

Yield of CC pyrolysis products

Pyrolysis temperature [°C]	Yield of pyrolysis products				OM conversion degree [%]
	Liquid [% of OM]	Gas [% of OM]	Carbonizate [% of OM]	Carbonizate [% of dry CC]	
Parent CC					
600	8.0	32	60	73	40
700	9.0	44	47	67	53
800	9.0	49	42	65	58
900	9.0	59	32	62	68
CC treated by lM solution of NaOH					
600	11.0	37	52	72	48
700	12.0	45	43	70	57
800	12.0	51	37	68	63
900	12.0	61	27	65	73

Table 2

Adsorbents from CC of Verbolozovskiy open pit mine

Name	Conditions		Yield	Ash content	Specific surface	Adsorption capacity	
	T [°C]	activation time, [min]	[% of dry CC]	[%]	[m^2/g]	of methylene blue, [mg/g]	of phenol [%]
Parent CC	–	–	–	40	3.0	54	–
Carbonizates from parent CC	900	–	63	63	120	52	56
Adsorbent from parent CC	925	30	59	67	205	80	85
Carbonizates from CC treated by NaOH	900	–	58	73	61	58	50
Adsorbent from CC treated by NaOH	925	30	54	79	110	78	72
Adsorbent from brown coal	925	30	38	26	515	77	80

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