PROSPECTS FOR THE INDUSTRIAL USE OF COAL IN THE WORLD AND ITS PROCESS OF REPRODUCING

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ABSTRACT:

Coal quality indicators Coal is formed from the decomposition products of organic residues of plants that have undergone changes in the conditions of high pressure of the surrounding rocks of the earth's crust and relatively high temperature. When the coal-bearing layer is submerged to a depth under conditions of increasing pressure and temperature, the organic mass is gradually transformed, its chemical composition, physical properties and molecular structure are changed. All these transformations are referred to by the term "regional coal metamorphism". Coal extraction methods vary depending on whether the mine is an underground mine or a surface (also called open cast) mine. Additionally coal seam thickness and geology are factors in selection of a mining method. The most economical method of coal extraction for surface mines is the electric shovel or drag line. Many coals extracted from both surface and underground mines require washing in a coal preparation plant. Technical and economic feasibility are evaluated based on the following: regional geological conditions; overburden characteristics; coal seam continuity, thickness, structure, quality, and depth; strength of materials above and below the seam for roof and floor conditions; topography (especially altitude and slope); climate; land ownership as it affects the availability of land for mining and access; surface drainage patterns; groundwater conditions; availability of labor and materials; coal purchaser requirements in terms of tonnage, quality, and destination; and capital investment requirements.

KEYWORDS: Coal, processing, industry, thermo physical processes, technological classification.

INTRODUCTION

Coal is the most common type of solid fuel on Earth. Its geological reserves are projected to be 11,270 billion. Tons of conventional fuel (UT). More than half of them are located on the territory of the CIS countries.

At the final stage of metamorphism of coal is transformed into anthracite with a pronounced crystalline structure of graphite. In addition to regional metamorphism, sometimes there are transformations under the influence of heat of igneous rocks located near coal-bearing strata — overlapping or underlying them) — thermal metamorphism, and also directly in coal seams-contact metamorphism [1].

Coals vary in appearance. These are solid substances of black or gray-black color, which differ in gloss and composition: shiny (vitrin), semi-shiny (claren), matte (Duren) and wavy (Fusen). The ratio of these components that make up the organic mass of coal determines their structure, chemical and mineralogical composition, and the variety and difference of their properties. The organic mass of coal consists of bitumens, humic acids and residual coal.

The coal industry is a branch of the fuel industry that includes open-pit mining or in mines, enrichment and processing (briquetting) of brown and hard coal. The method of coal mining depends on the depth of its occurrence [2]. Development is often carried out in an open way, which is preferable because of its cheapness and greater security. The underground method is used if the layer is too deep. Sometimes, when a section (coal pit) is deepened, it becomes more profitable to develop the field underground. Coal extraction methods vary depending on whether the mine is an underground mine or a surface (also called open cast) mine. Additionally coal seam thickness and geology are factors in selection of a mining method. The most economical method of coal extraction for surface mines is the electric shovel or drag line. The most economical form of underground mining is the long wall, which is a shear blade that runs along sections of the coal seam [3]. Many coals extracted from both surface and underground mines require washing in a coal preparation plant. Technical and economic feasibility are evaluated based on the following: regional geological conditions; overburden characteristics; coal seam continuity, thickness, structure, quality, and depth; strength of materials above and below the seam for roof and floor conditions; topography (especially altitude and slope); climate; land ownership as it affects the availability of land for mining and access; surface drainage patterns; groundwater conditions; availability of labor and materials; coal purchaser requirements in terms of tonnage, quality, and destination; and capital investment requirements.

Surface mining and deep underground mining are the two basic methods of mining. The choice of mining method depends primarily on depth, density, overburden, and thickness of the coal seam; seams relatively close to the surface, at depths less than approximately 55 m (180 ft), are usually surface mined [4]. Coal that occurs at depths of 55 to 90 m (180 to 300 ft) are usually deep mined, but in some cases surface mining techniques can be used. For example, some western U.S. coal that occur at depths in excess of 60 m (200 ft) are mined by the open pit methods, due to thickness of the seam 20–25 metres (60–90 feet). Coals occurring below 90 m (300 ft) are usually deep mined. However, there are open pit mining operations working on coal seams up to 300–460 metres (1,000–1,500 feet) below ground level, for instance Tagebau Hambach in Germany [5].

In Russia in 2005, the share of coal in the country's energy balance was about 18 percent (the world average is 39%), and in electricity production-just over 20 percent. The share of coal in the fuel balance of RAO UES was 26 % in 2005, and gas — 71 %.

The growth in the degree of metamorphism of organic matter of coal observed a consistent increase in the relative content of carbon and less oxygen and hydrogen. The yield of volatile substances is consistently reduced (from 50 to 8 % in terms of dry ash-free state), the heat of combustion, the ability to sinter and the physical properties of coal also change. In particular, the gloss, reflectivity, bulk weight of coal and other properties change linearly. Other important physical properties (porosity, density, sinterability, heat of combustion, elastic properties, etc.) change according to pronounced parabolic or mixed laws [6].

MATERIAL AND METHODS

As an optical criterion for the stage of coal metamorphism, the reflectivity index is used; it is also used in petroleum Geology to determine the stage of catagenic transformations of sedimentary strata. The reflectivity in oil immersion (R0) increases sequentially from 0.5-0.65 % for d-grade coal to 2-2. 5 % for t-grade coal. The density and porosity of coal depends on the petrographic composition, the amount and nature of mineral impurities, and the degree of metamorphism. The highest density (1300-1500 kg/m^3) is characterized by the components of the fusinite group, the smallest (1280-1300 kg / m^3) - the vitrinite group. The change in density with an increase in the degree of metamorphism occurs parabolic law with inversion in the transition zone to the group of fat; in low-ash manifestations, it decreases from coal grade D to grade W on average from 1370 to 1280 kg/m^3 and then increases sequentially for coal grade T to 1340 kg / m^3. Dense breed of black, sometimes gray-black color [7].

The gloss is resin or metal. The organic matter of coal contains 75-92 % carbon, 2.5-5.7 % hydrogen, 1.5-15 % oxygen. Contains 2-48 % volatiles. Humidity 1-12 %. The highest calorific value in terms of dry ash-free state is 30.5-36.8 MJ/kg. Coal refers to humilitas; the sapropelites and sapropelites gomito the present in the form of small lenses and layers. The formation of coal is characteristic of almost all geological systems - from the Devonian to the Neogene (inclusive); it was actively formed in the Carboniferous, Permian, and Jurassic. Bitumens of coal, in contrast to brown coal, are mainly represented by compounds of an aromatic structure. There are no fatty acids and esters found in coal, and there are few compounds with the structure of paraffins [8]. Coal substance is non-ferromagnetic (diamagnetic), mineral impurities are characterized by paramagnetic properties. The magnetic susceptibility of coal increases with their metamorphism stage. All these enterprises largely borrowed the experience of German chemists and engineers accumulated in the 1930s and 40s. The discovery of vast oil fields in Arabia, the North Sea, Nigeria, and Alaska has sharply reduced interest in FT synthesis. Almost all existing factories were closed, and the only major production remained in South Africa. Activity in this area resumed by the 1990s. In 1990, Exxon launched a pilot plant for 8 thousand tons / g with a Co catalyst. In 1992, the South African company Mossgas built a plant with a capacity of 900 thousand tons/year. Unlike Sasol technology, natural gas from an offshore field was used as a raw material. In 1993, Shell launched a plant in Bintulu (Malaysia) with a capacity of 500 thousand tons/g, using a Co-Zr catalyst and the original technology of "medium distillates". According to its thermal properties, coal is close to thermal insulators.The most important properties of coal are ash content, humidity, sulfur content, the amount of volatile, as well as sinterability and cookability[9].

The raw material is a synthesis gas obtained by partial oxidation of local natural gas. Shell is currently building a plant using the same technology, but with an order of magnitude greater capacity in Qatar. Chevron, Conoco, BP, ENI, Statoil, Rentech, Syntroleum and others also have their projects in the field of FT synthesis of various degrees of development **(**tabl.1.1).

Tabl.1.2-Coal mining in the world and in individual countries

Countries	Coal production per year (million tons)												
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**Share**	**How long will the proven reserves last (years)**
China	1722,0	1992,3	2204,7	2380,0	2526,0	2782,0	3050,0	3240,0	3520,0	3650,0	3874,0	46,9 %	38
USA	972,3	1008,9	1026,5	1053,6	1040,2	1062,8	973,2	984,6	992,8	922,1	906,9	12,9 %	245
India	375,4	407,7	428,4	447,3	478,4	521,7	557,6	569,9	588,5	605,8	536,5	3,9 %	105
EU	638,0	628,4	608,0	595,5	593,4	587,7	536,8	535,7	576,1	580,7	491,5	7,1 %	55
Australia	351,5	366,1	378,8	385,3	399,0	401,5	409,2	423,9	415,5	431,2	644,0	6,2 %	186
Indonesia	114,3	132,4	146,9	195,0	217,4	229,5	252,5	305,9	324,9	386,0	458,0	7,2 %	17
Russia	276,7	281,7	298,5	309,2	314,2	326,5	298,1	316,9	323,5	354,8	357,6	4,3 %	420
SA	237,9	243,4	244,4	244,8	247,7	250,4	250,0	253,8	255,1	260,0	260,5	3,8 %	122
Germany	204,9	207,8	202,8	197,2	201,9	192,4	183,7	182,3	188,6	196,2	185,8	1,1 %	37
Poland	163,8	162,4	159,5	156,1	145,9	143,9	135,1	133,2	139,2	144,1	137,1	1,4 %	56
Kazakhstan	84,9	86,9	86,6	96,2	97,8	111,1	101,5	110,8	115,6	116,4	108,7	1,4 %	308
World production	**5187,6**	**5585,3**	**5886,7**	**6195,1**	**6421,2**	**6781,2**	**6940,6**	**7273,3**	**7995,4**	**7864,7**	**8164,9**	**100 %**	**119**

According to its thermal properties, coal is close to thermal insulators. The most important properties of coal are ash content, humidity, and sulfur content, the amount of volatile, as well as sinter ability and cookability.

In this industry, electricity is produced by thermal power plants (TPP) that use chemical energy from organic fuels. Heat energy is the predominant type of traditional energy on a global scale: coal gener ates 46% of the world's electricity, gas-18 %, and about 3 % — due to burning biomass, oil is used for 0.2 %. in Total, thermal power plants provide about 2/3 of the total output of all power plants in the world. As of 2013, the average efficiency of thermal power plants was 34 %, while the most efficient coal-fired power plants had an efficiency of 46 %, and the most efficient gas-fired power plants-61 %[10].

RESULTS:

Humidity Moisture, as a ballast, increases the cost of transporting coal, complicates its preparation for coking, storage and dosage, and increases the cost of the coking process. Humidity of coals is allowed in the amount of no more than 7 %.

The sulfur content of coals consists of Pyrrhic, sulphate and organic sulfur. The proportion of sulfur in coals varies widely (0.4-8 %). During the coking process, most of the sulfur passes into coke and when iron is smelted, it can pass into metal, causing its redness. Desulphurization of coal is carried out by enrichment.

Volatiles are substances that are formed in the form of gases and vapors by heating coal without access of air (gasification). The percentage of volatiles is determined by the degree of coalification and depends on the brand of coal.

The technological classification of hard coals is based on such indicators as the yield of volatile components and the thickness of the plastic layer formed when the coals are heated (tabl.1.2).

Tabl.1.2-Technological classification of coals

Brand of coal		Volatile output,% weights'.	Thickness plastic layer, mm
Name	Designation		
Flame types of coal	D	42	–
Gas	G	35	6 – 15
Fatty	J	27 – 35	13 – 20
Coke	К	18 – 27	14 – 20
Waxed, sintering	OC	14 – 22	6 – 13
Skinny	T	17 – 19	–
Anthracite	A	9	–

A significant part of the coal is subjected to high-temperature (pyrogenetic) chemical processing. The purpose of this processing is to produce valuable secondary products that are then used as fuels and intermediates for organic synthesis. According to the purpose and conditions of pyrogenetic coal processing processes are divided into three types: pyrolysis, gasification, hydrogenation [11].

Pyrolysis or dry distillation is the process of heating solid fuel without air access in order to produce gaseous, liquid and solid products for various purposes. There is high-temperature pyrolysis (coking) and low-temperature pyrolysis (semi-coking).

Hydrogenation and gasification processes are used to produce liquid products used as motor fuel and combustible gases from coal.

Coking of coal is carried out at a temperature of 900 – 1200 ^{o}C in order to obtain coke, combustible gases and raw materials for the chemical industry.

Enterprises that carry out coking of coals are called coking plants. There are separate coking plants with a full cycle of coking production, located separately from metallurgical enterprises, and coking plants as part of metallurgical plants.

The diagram shows: OKG-reverse coke gas; PKG-direct coke gas; CUS – coal tar; SB-crude benzene. By its physical and chemical nature, coking is a complex two-phase endothermic process in which thermophysical transformations of the coked raw material and secondary reactions involving organic intermediates of the first stage of coking take place. Coking of coal is carried out in batch coke ovens, in which heat is transferred to the coked coal charge through the reactor wall. Coal is divided into shiny, semi-shiny, semi-Matt, and Matt. As a rule, brilliant types of coal are low-ash due to the low content of mineral impurities. There are 4 types of coal organic matter structures (telinite, post-telinite, precolinite and colinite), which are successive stages of a single process of decomposition of lignin — cellulose tissues. In addition to these four types of coal, leiptinite coal is also included in the genetic groups of coal. Each of the five genetic groups is divided into corresponding classes according to the type of substance of the micro-components of coal [12]. There are many types of coal classifications: by material composition, petrographic composition, genetic, chemical-technological, industrial and mixed. Genetic classifications characterize the conditions of coal accumulation, material and petrographic - its material and petrographic composition, chemical and technological-the chemical composition of coal, the processes of formation and industrial processing, industrial-technological grouping of types of coal depending on the requirements of industry. Classification of coal seams used for the characterization of coal deposits. Thermophysical processes during coking include:

– Heat transfer from the wall to the charge material;

– Diffusion of pyrolysis products (water vapor and volatile substances) through the charge layer;

– Removing these products from the charge.

In the steady state coking mode, the heat transfer equation is described by the well-known equation:

$$Q = K_т \cdot F \cdot \Delta T, \quad (1.1)$$

Where Q is the amount of heat to be brought to the system, kJ;

F – heat transfer surface, m^2

$K_т$ – heat transfer coefficient, kJ/(m^2. deg. h);

$\Delta T = T_г - T_ш$ – temperature gradient of gases and heated charge that heat the furnace chamber wall (coking temperature).

The heat transfer coefficient is calculated using the formula:

$$K_т = 1/(1/\alpha_1 + \delta_1/\lambda_1 + \delta_2/\lambda_2 + 1/\alpha_2), \quad (1.2)$$

Where α_1 and α_2 are the heat transfer coefficients from the heating gases to the furnace wall and from the wall to the charge, respectively, kJ /(m^2. deg. h);

δ_1 – wall thickness, m;

δ_2 – wall thickness half the thickness of the charge loading layer, m;

λ_1 and λ_2 – the thermal conductivity of the wall and charge, respectively, kJ /(m^2.grad.h).

Chemical transformations during coking are of two types: primary and secondary. Primary reactions occur in the volume of the charge when it is heated. These include:

– Reactions of destruction of complex molecules;

- Phenomenalization reactions;

– Reactions of splitting of hydrogen atoms, hydroxyl, carboxyl and methoxyl groups.

In the process of primary transformations, primary gas and primary resin vapors are released from the coal charge and coke is formed. Secondary reactions include– alkane cracking reactions:

$$C_nH_{2n+2} \longrightarrow C_mH_{2m+2} + C_pH_{2p}; \quad (1.3)$$

– alkene polymerization reactions:

$$C_nH_{2n} \longrightarrow (-CH_2-)_n; \quad (1.4)$$

– naphthene dehydrogenation reactions:

$$C_nH_{2n} \longrightarrow C_nH_{2n-6} + 3H_2; \quad (1.5)$$

– condensation reactions of aromatic hydrocarbons, for example:

$$2C_6H_6 \longrightarrow C_{10}H_8 + C_2H_4. \quad (1.6)$$

Coal is deposited in the form of layers and lenticular deposits of various capacities (from tens of centimeters to several tens and hundreds of meters) at different depths (from outcrops to 2500 m or deeper). Coal is characterized by a neutral composition of organic mass. It does not react with weak alkalis under normal conditions or under pressure.

The product of secondary transformations of the coking process is a composition of gaseous and vaporous substances of different nature-direct coke gas (PCG). The order of processes occurring in the charge when the coking temperature increases in the furnace is shown in the table 1.3.

Table 1.3- The order of processes occurring in the charge when the coking temperature increases in the furnace is shown

Temperature	Processes
Before 250 °C	removal H_2O, CO_2, CO, H_2
300 – 350 °C	start of CUS allocation, pyrogenetic water release
350 – 500 °C	plasticization of coal charge
500 – 550 °C	decomposition of the organic mass of coal with the release of primary gas and primary resin vapor, sintering solid residue with the formation of a semicox
550 – 700 °C	decomposition of char and complete the emission of volatile substances
Over 700 °C	enhancing solid mass and the formation of coke

The coking process includes several stages.

1. Download batch.
2. Coking.
3. Unloading of coke.

DISCUSSIONS:

When the coking period is 13-16 hours and the number of furnaces in the coke battery is 68-78 PCs. unloading of coke is carried out in 10-12 minutes. Therefore, a coke battery can be considered as a continuous-action ideal displacement reactor, although each furnace operates periodically. Coal refers to humilitas; the sapropelites and sapropelites gomito the present in the form of small lenses and layers. The formation of coal is characteristic of almost all geological systems - from the Devonian to the Neogene (inclusive); it was actively formed in the Carboniferous, Permian, and Jurassic. Extinguishing of coke. Coke with a temperature of 950-1100 °C is unloaded from the furnace into the coke drying car[13]. Therefore, to prevent Gorenje coke in the air, it is cooled to 100-250 °C wet or dry. In the wet method, the red-hot coke is irrigated in the extinguishing chamber with water. In the dry method, cooling is carried out by circulating inert gases, which are used as flue gases (CO_2 + N_2).

Sorting of coke. After extinguishing, the coke is sorted into classes of cereals by screening. For the domain process, a coke of class more than is used

40 mm, in non-ferrous metallurgy-class 10-25 mm, for the production of calcium carbide-class 25-40 mm. Coke fines (less than 10 mm) are used in the process of agglomeration of iron ores.

CONCLUSIONS:

The use of jets as a tool of destruction in the Executive bodies of cleaning and sinking combines is of particular interest. At the same time, there is a constant growth in the development of equipment and technology for destroying coal and rocks with high-speed jets of continuous, pulsating and pulsed action. The energy industry of countries such as Poland and South Africa is almost entirely based on the use of coal, and the Netherlands — gas. The share of heat power in China, Australia, and Mexico is very high [14].

Ash content determines the proportion of non-combustible part of coals. The ash contains oxides of aluminum, silicon, calcium and magnesium. The presence of ash components reduces the calorific value of coal and the quality of the coke obtained from it. The ash content of coals is in the range of 3-30 % and can be reduced by enrichment. Coking coals must have an ash content not higher than 7.5 %.

ACKNOWLEDGEMENTS

At the beginning of the 2020s, there is extremely high uncertainty about the prospects for the international coal market: the decline in demand for coal in the EU economy will be offset by an increase in imports in South and South-East Asia (where the demand for high-quality coal will increase), as well as in the Middle East and Africa. The volume of trade and prices on the market will depend primarily on the political decisions that will be taken with regard to coal consumption by China and India: in China and developed countries in Asia (Japan, South Korea), the volume of coal imports may be stabilized. However, due to the fact that a number of producers for various reasons plan to reduce their export volumes in the future (Colombia, in the future, until 2030, will exhaust the main fields, and Indonesia will be forced to redirect part of the export coal to meet domestic demand), the main suppliers of coal to the world market will remain Australia and Russia.

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