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SELF-HEATING AND SPONTANEOUS COMBUSTION ANGREN BROWN COAL

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Abstract. *The article presents the issues of prevention and prevention of processes related to ensuring safe and comfortable working conditions in the development of coal deposits, namely the study of spontaneous combustion of coal Angren deposit. Chemical activity of coals at low temperatures contributing to spontaneous combustion is emphasized, as well as the influence of hot climate in the region on the increase in chemical activity of coals. In this connection, climatic conditions of the region have been studied, i.e., increased temperature (from +250 to +500C) gives a sharp increase in the chemical activity of Angren coal. The main parameter that characterizes reservoir properties and filtration coefficient, showing the ability of the reservoir to let fluid through under the influence of the applied pressure gradient, is determined. The causes of spontaneous combustion are studied, depending on the rate of oxygen sorption by coal, reducing its pre-injection of water into the coal bed before excavation, the method of calculation of determining the incubation period of spontaneous combustion of coal is given.*

Keywords: *endogenous fires, coal spontaneous combustion, chemical process, chemical reactions, geological features of coal, chemical activity of coal, sorption rate constant, coal metamorphism, air inflow, heat exchange, solar radiation.*

INTRODUCTION. The coal industry is an integral part of the fuel and energy supply of the Republic and is one of the most important sectors of the economy and social life of the population. In our country, 1 million tons of coal is delivered annually to the apartments of the population, and 400 thousand tons to social facilities. The new Angren and Angren thermal power plants burn 4 million tons of coal to generate energy. The demand for coal in the national economy is increasing, and in order to ensure them, it is intended to accelerate the extraction of browncoal in Angren, stone coal in Shargun and Boysun coal mines. The main attention in solving this issue will be paid to the Angren coal deposit, where it is planned to conduct production by open and underground methods.

Research and analysis of mines that develop powerful coal seams allowed us to identify the causes and the most fire-dangerous areas, and to conclude that it is possible to significantly reduce the fire hazard of coal mining by optimizing the parameters of treatment faces.

Low rates of coal face movement allow coal losses in the developed space to interact with air leaks for a long time and very often leads to endogenous fires in the developed spaces. Thus, an increase in the rate of movement of the treatment face to the minimum critical value, which corresponds to the incubation period of coal oxidation, makes it possible to stop the access of oxygen to the depth of the worked-out space by compacting the depleted rocks and thereby prevent the occurrence of endogenous fire. Since the speed of moving the treatment face depends on the duration of the processes and the operation of extracting coal in the coal face, it is also necessary to optimize its length in terms of the time spent on performing these processes and operations.

METHODS. The whole ecosystem is poisoned when brown coal is produced in an open way. First of all, during the main processing processes during the activity of the coal deposit, the whole atmosphere is adversely impacted by dust and gas emissions. Sources of major release of hazardous substances (carbon monoxide, sulfur dioxide, etc.) are endogenous fires that occur during open-pit brown coal mining in areas where the heat concentration conditions are most favorable. It is widely agreed that, as a result of spontaneous combustion, up to 7 percent of brown coal supply is lost annually. If mining operations are carried out in the presence of technical breaches, the emissions of hazardous substances from fires could surpass more than 2 times the

emissions from the machinery, which can paralyze the activities of the business and, thus, emissions must be prevented or minimized.

Coals of all stages of metamorphism are subject to spontaneous combustion, but brown and long-flame coals are most prone. In the process of spontaneous combustion of coal seams, the main role is played by their geological structure and the quality of coal, so it is relevant to study the geological factors of spontaneous combustion of coal that differ in the geological structure and quality of coal and develop a new concept on the problem of spontaneous combustion of coal in layers in the geological aspect and its practical justification.

- study and review of genetic features of formation of coal seams prone to spontaneous combustion;
- development of methods for research and forecasting of spontaneous combustion of coals;
- study of the geological structure, quality of coal and processes of spontaneous combustion of coal seams in the field;
- selection of the optimal complex of geological factors of coal spontaneous combustion;
- creation of methods for predicting coal spontaneous combustion using geoinformation technologies;

The causes of spontaneous combustion of coals can be divided into three groups:

The first group is genetic causes, which include conditions for the formation of powerful coal seams, increased content of iron sulfides, genetic humidity, the presence of methane in coals, tectonic ruggedness, etc.

The second group of physical and chemical causes of spontaneous combustion, which can include the degree of coal metamorphism, the chemical composition of coals, host rocks and rock layers, their strength properties, porosity, fracturing, etc.

The third group is the tectonic causes of spontaneous combustion of coal, which result in the destruction and grinding of coal, which leads to easier access of oxygen inside the coal seam and increases the interaction surface of oxygen-active substances.

Such research involves solving a number of problems.

Taking into account the leached research of fire hazard and measures to combat them, they are one of the most important tasks in the development of self-igniting brown coals of the Angren deposit. In this regard, the main objectives of research in the conditions of the Angren brown coal deposit were:

- to study the prevalence of fires in the quarry, taking into account the specific mining and geological, mining and technical and climatic conditions of the Angren brown coal deposit and their classification.
- study of the impact of fires on atmospheric and hygienic conditions in the quarry.
- economic assessment of fire hazard.
- for reasons of occurrence, fires at the Angren coal deposit are subdivided:
- from spontaneous combustion of coal or endogenous.
- from external causes or exogenous.

RESEARCH. In our research, endogenous fires were the focus of study. In this situation, spontaneous coal combustion caused by oxidation is the cause of fires. It begins with self-heating, which, when the critical temperature is reached, easily transforms into spontaneous combustion.

A variety of hypotheses exist to describe the occurrence of spontaneous combustion. Currently, Prof. V. S. Veselovsky 's theory of spontaneous combustion of coal has gained the greatest attention and dissemination. Spontaneous combustion is regarded, according to this definition, as a chemical reaction occurring in an industrial environment. Chemical reactions, the movement of oxygen to the reaction site and thermal phenomena are involved in this dynamic process.

In the presence of three physical conditions , it is possible to draw on this principle of spontaneous combustion:

- the ability of coals to oxidize quickly enough at low temperatures;
- air flow to the mass of coal;
- hindered heat transfer to the environment;

Coal mining has an immense detrimental effect on the natural environment and induces the most serious injury rates. In the coal mining industry, one of the most dangerous situations is endogenous fires. Endogenous fires associated with the spontaneous combustion of coal pose a great risk to mining workers' health and lives. Endogenous fires also result in the extended suspension of mining activities and the protection of reserves, resulting in a reduction of the technological and economic indicators of the mining enterprise. Therefore, one of the key tasks is the study and production of steps to reduce fire hazards from coal deposits. Various natural and mining-technical variables cause spontaneous coal combustion and the occurrence of endogenous fires. The geological properties and chemical activity of coal explain the natural causes. Mining variables are related to the actions of mining technology.

The chemical activity of coal during oxygen oxidation is the main factor of spontaneous combustion of coal and is characterized by the propensity of coal to spontaneous combustion.

Self-ignition of coal also depends on the presence of oxygen flow outside and heat exchange. Therefore, the chemical activity is a relative indicator of the propensity of coal to self-ignition. The higher the chemical activity under the same external conditions, the faster the coals ignite. When describing the propensity of coal to self-ignite, it is necessary to take into account the high chemical activity of coal at low temperatures.

The main indicator of the propensity to spontaneous combustion of coal is the chemical activity of oxidation in a temperature environment, characterized by a constant sorption rate. The sorption rate constant is related to the degree of decomposition and the moisture content of the material in the constant. The chemical activity of coals varies depending on the level of their metamorphism and decreases as the level of metamorphism increases. [1, 2, 3]

Before spontaneous combustion of coal, there is a hidden period of coal combustion. Heating and igniting coal is the process of increasing its temperature as a result of its oxidation. The rate of heating and ignition depends on the chemical activity of the coal, the air flow conditions, and the possibility of heat transfer to the environment.

An increase in temperature from 25^0 to 50^0C and above gives a sharp increase in the chemical activity of Angren coals, which is essential in the hot climate of the region.

Fire hazard, natural ventilation and thermal conditions in the quarry are largely determined by the climate of the field area and the microclimate of the quarry.

If the heating temperature reaches a critical value, the heating process turns into a self-ignition process. The time spent on the transition from one state – from heating to the second to ignition, is called the hidden period of spontaneous combustion. After studying its duration, you can choose safe ways to extract coal seams, determine measures to prevent spontaneous combustion of coal and the formation of endogenous fires. [4,5]

The duration of the latent period of spontaneous combustion of coal depends on the propensity of coal to naturally oxidize with air oxygen and external conditions. Temperature "the latent period of self-ignition of coal" is an increase in temperature from a state to a critical state equal to $90\text{-}130^0$ C, and this period is considered the initial stage of an endogenous fire. [5]

In order to study the effect of various preventive measures on the oxidation of brown coal in the Angren mine, a study of the rate of sorption of coal with oxygen was conducted. [6]. Research by Prof. V. S. Vasilevsky on the modified method of sealant is based on the reduction of oxygen in a hermetically sealed vessel and the calculation of the oxidation rate of a coal sample installed in it. [7]

The method of studying the chemical activity of coal in production conditions consists in drilling in a non-closed array of wells and supplying them with water at a pressure of 2-3 atm.

According to the results of the study of the air composition, the oxygen concentration was determined by which the sorption rate constant was calculated.

Table 1

The results of the study are presented in the table

	The state of the massif

№ Tests	not moistened		moistened	
	oxygen concentration C_a, %	the rate constant of sorption mg, g / s	the oxygen concentration of the Ca ,%	the rate constant for the sorption of mg, g/s
1	5,2	$85*10^{-4}$	11,6	$21*10^{-4}$
2	2,4	$244*10^{-4}$	5,8	$72*10^{-4}$
3	2,2	$273*10^{-4}$	6,7	$58*10^{-4}$
4	-	-	5,1	$87*10^{-4}$
5	2,1	$307*10^{-4}$	--	--
6	8,2	$48*10^{-4}$	11,6	$21*10^{-4}$
7	--	--	6,3	$64*10^{-4}$
8	3,3	$160*10^{-4}$	11,7	$20*10^{-4}$
9	3,8	$131*10^{-4}$	10,4	$27*10^{-4}$
10	5,0	$89*10^{-4}$	11,3	$23*10^{-4}$
11	--	--	10,5	$26*10^{-4}$
12	2,8	$201*10^{-4}$	2,4	$244*10^{-4}$
13	3,8	$131*10^{-4}$	3,1	$123*10^{-4}$
14	3,1	$123*10^{-4}$	5,1	$25*10^{-4}$
15	3,3	$160*10^{-4}$	3,8	$131*10^{-4}$
16	3,7	$135*10^{-4}$	4,0	$120*10^{*4}$
17	--	--	2,8	$201*10^{-4}$
18	7,0	$54*10^{-4}$	9,6	$78*10^{-4}$

It can be seen that the rate of oxygen sorption in humidified coal is significantly lower (63%) than in non-humidified coal, which indicates the effectiveness of pre-humidification of brown coal in the Angren deposit and pre-humidification of its chemical activity.
The rate constant of sorption in air oxygen (C_S) is determined by the formula

$$Kc = \frac{-V}{H\tau} \cdot ln \frac{(100 - C'_\delta)\mathrm{C_o}}{C'_\delta(100 - \mathrm{C_o})}$$

Where V - the volume of air in the container, m^3;
H - coal mass loaded into the container, kg;

τ - time of air contact with coal, day;

C'_0 - the last concentration of oxygen, %;

$C_к$ - the final concentration of oxygen, %.

After determining the oxygen sorption rate constant for a specific Deposit, the incubation period of spontaneous combustion of coal is determined. [8].

$$\tau_{in} = \frac{C_к\left(T_{кр} - T_\delta\right) + 0{,}6\frac{jw_б}{100} + q_g X}{24\varphi K_c^{0.45} C_{o_2} \cdot q_{o_2}}$$

Here, $C_к$ – the heat capacity of the coal; S_c=0.3 cal / c*K;
$w_б$ – initial humidity of coal, %;

X – natural gasification of coal, ml/g;
φ – the absorption coefficient of oxygen;
C_{o_2} – the oxygen concentration at the entrance to the coal faces;
q_{o_2} – concentration sorption of coal oxygen comparative heat capacity;

CONCLUSION. Therefore, it is possible to effectively solve the problems of detecting endogenous fires and preventative measures in some mining and geological environments by defining the incubation time of self-ignition of coal.

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