Research on factors affecting auto-ignition of coal energy

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Abstract: - This paper is based on a case study on reducing the risk of ignition of coal energy by monitoring the temperature of coal deposits. The deposit of coal on wich were researched mine belongs wolf, providing coal for Turceni Energy Complex. For temperature monitoring during storage, temperature recording solution was used in 13 measuring points and the average temperature every minute. For this we used a system of measuring and recording temperature type SQ Squirrel 2020 Data Logger. By processing the infrared images obtained with the thermal imager FLIR Systems T200, determined temperature the surface deposit of coal.
Key-Words: - auto-ignition energy coal, thermal imager, thermal sensors, data logger.

1 Introduction

The reference of this case study presented in this paper reference was to the technological process of extraction and storage of lignite mining in the she-wolf. Monitoring temperature coal deposit has been made continuously for a period of 24 days between October 2010 and November 2010.

To monitor the temperature in carbon storage have been established in 13 points of temperature measurement at different depths: 9m, 6m, 3m and 1m as follows:

- 2 measuring points at a depth of 9m;
- 3 measuring points at a depth of 6m;
- 5 measuring points at a depth of 3m;
- 3 measuring points at a depth of 1m.

For temperature measurement were used temperature sensors type K thermocouple probe inserted into a measuring tube made of special head for the introduction to the desired depth (Figure 1).

To monitor temperature during storage (24 days) recording solution was chosen temperature all 13 measuring points and the average temperature every minute, with a system of measuring and recording temperature type SQ Squirrel 2020 Data Logger.

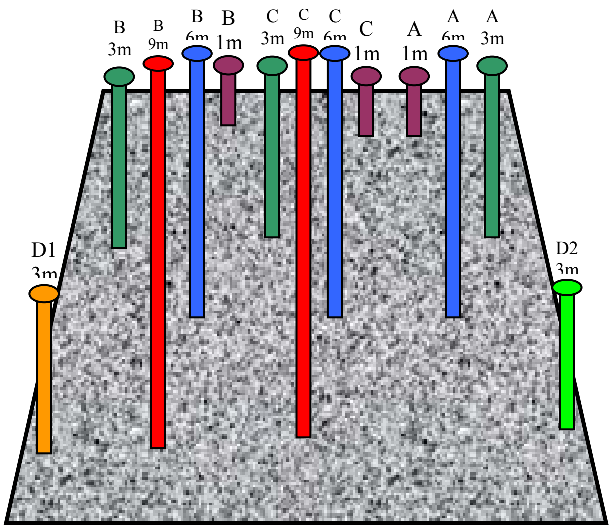

Fig.1 Location of temperature probes in the coal deposit

Data Logger configurable analog inputs:

- thermistors
- thermocouples
- Pt100/Pt1000 (maximum 4-wire RTD with 3 or 4 wires)
- Tensiune, curent, rezistență

Figure 2 shows the programming window data logger for measuring all channels with the K type thermocouple input with measuring range between -200 0 C and 13720C by measuring and storing data every minute.

Fig.2 Cofigurare Data Logger

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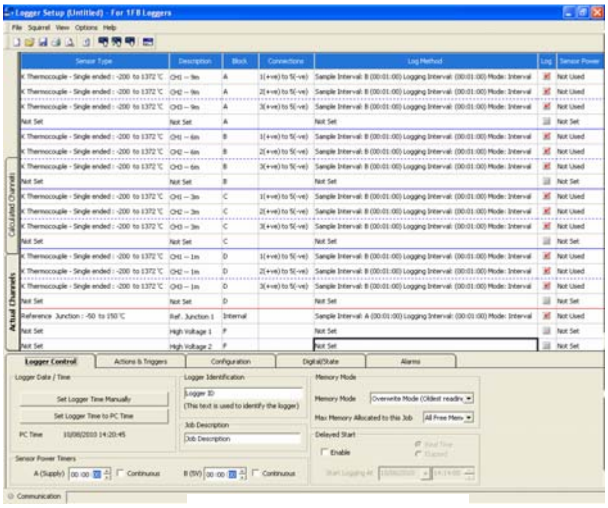

Fig.2 Configuation data logger

2 Determination of carbon storage temperature at different depths

Figures 3,4,5,6,7,8 and 9 presents variation diagrams of temperature inside the coal deposit in the 13 measuring points throughout the monitoring period

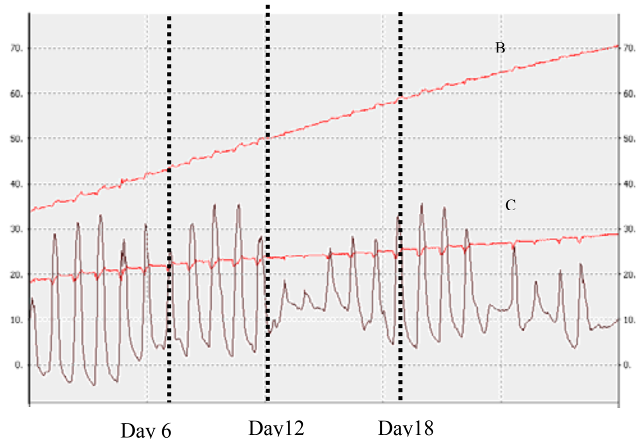

Fig.3 . Changes in storage temperature at a depth of 9m, the points B (eastern side) and C (center)

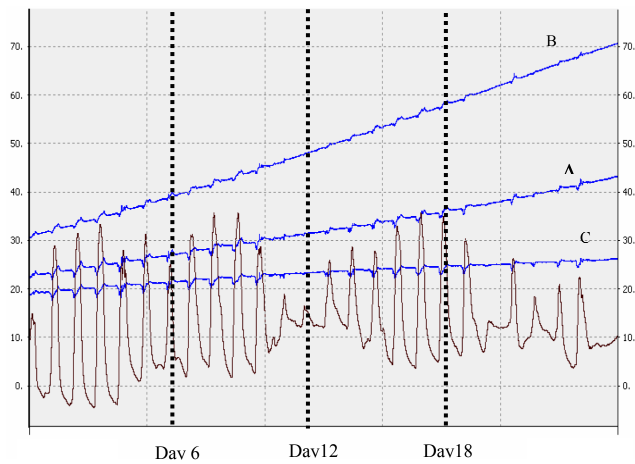

Fig.4 Changes in storage temperature at a depth of 6 m in A, B and C

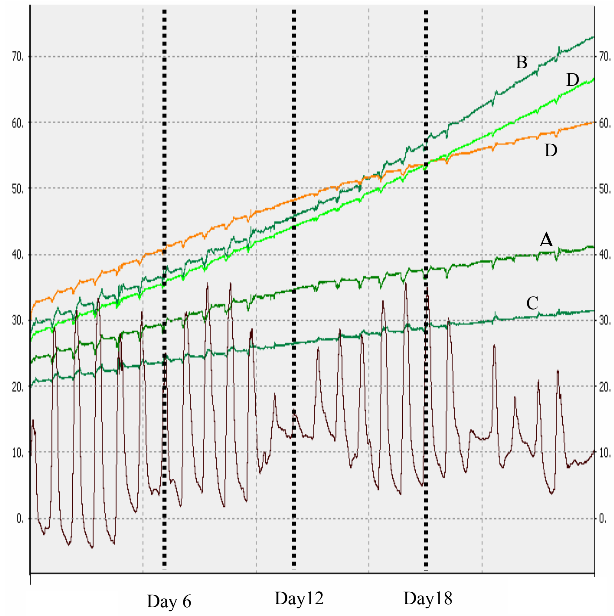

Fig.5 Changes in storage temperature at a depth of 3 m in A, B, C, D1 and D2

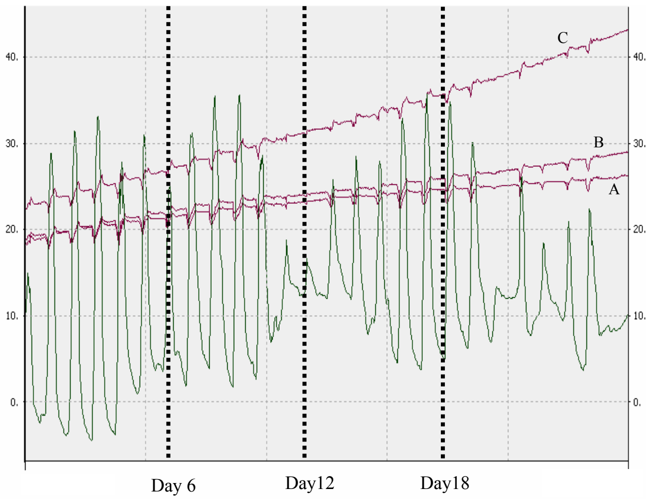

Fig.6 Changes in storage temperature at a depth of 1 m in A, B and C

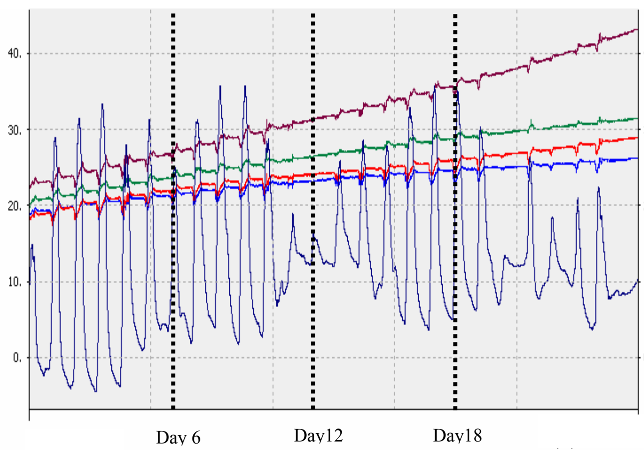

Fig.7 Temperature variation in storage at the point C at a depth

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of 1m, 3m, 6m, 9m

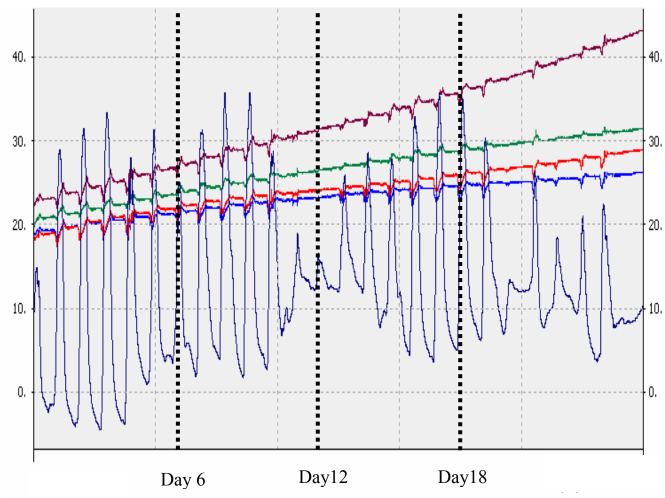

Fig.8 Temperature variation in storage at the point B at a depth of 1m, 3m, 6m, 9m

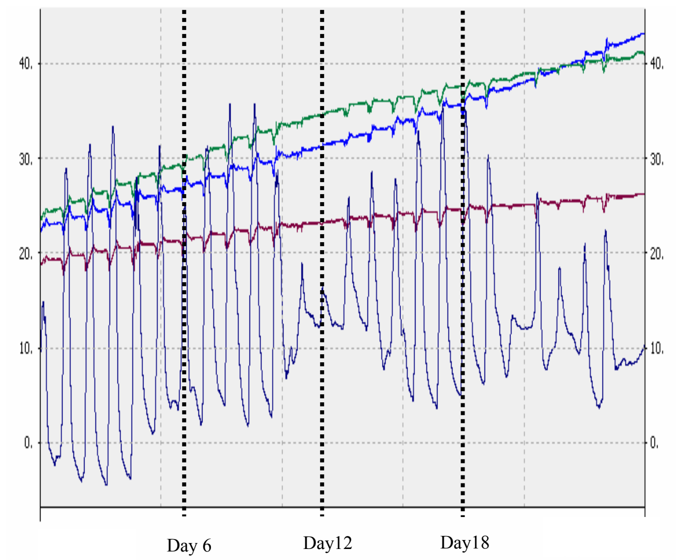

Fig.9 Temperature variation in storage at the point A at a depth of 1m, 3m, 6m

After monitoring the temperatures for a period of 24 days, you can draw the following conclusions:

- Increasing the temperature inside the stack occurs at large depths (9m, 6m, while the stack is about 10.5 m) depth at which the influence of environmental parameters on the temperature outside is almost nonexistent.
- The temperature close to the outer layer of the stack is different from the temperature inside the stack, with a much slower growth due to better heat exchange with ambient air. This is seen on the charts at the temperatures recorded at 1 meter depth (Fig. 6). Also on this figure can be seen that due to a lower possibility of the central (C) to achieve a heat transfer through covecției depth of 1 m the temperature is higher than in A and B (west side, that side east), points where temperatures do not exceed 280C.
- Temperatures measured on the east side(the prevailing wind direction) reached values of 70 ° C, while in the central and western temperature is (20 ÷ 40) ° C, higher values being for the West. This is due to the surplus of fresh air (oxygen default) brought the wind on the exposed coal oxidation reaction is accelerated. The stack of coarse lignite favors the creation of channels through which air enters the layers within it.

3 Determination of deposit surface temperature, determining areas of potential outbreaks

8 points have been established for measuring surfaces including: East (points 3 and 7), West (points 1 and 8), North (point 2) and areas where groups were introduced pipe thermal sensors (points 4, 5 and 6) (Figure 10).

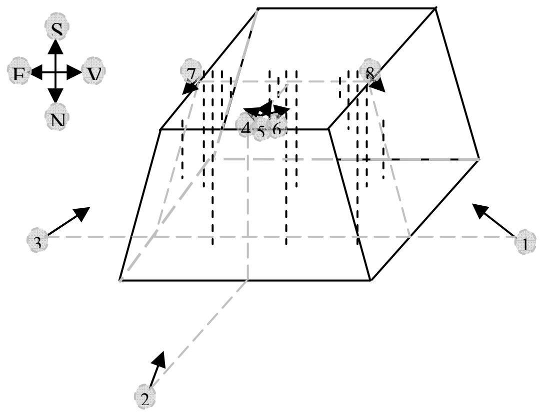

Fig.10 Items selected for measurements of surface temperature deposit

Measurements were made between the hours 1000 to 1900. After analyzing thermal images taken with the thermal imager for all measurement points were identified areas where there have been any self-ignition of coal. In Figure 11 are images taken with infrared thermal imager to

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the area where the outbreak occurred first potential and temperature variation in Figure 12 while for these area.

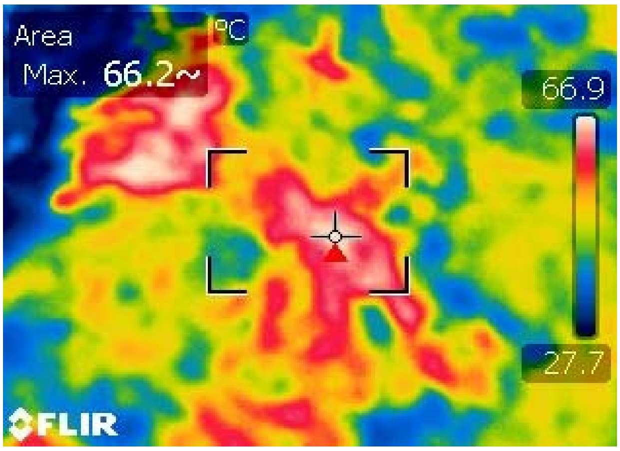

Fig.11 The area of the potential first outbreak

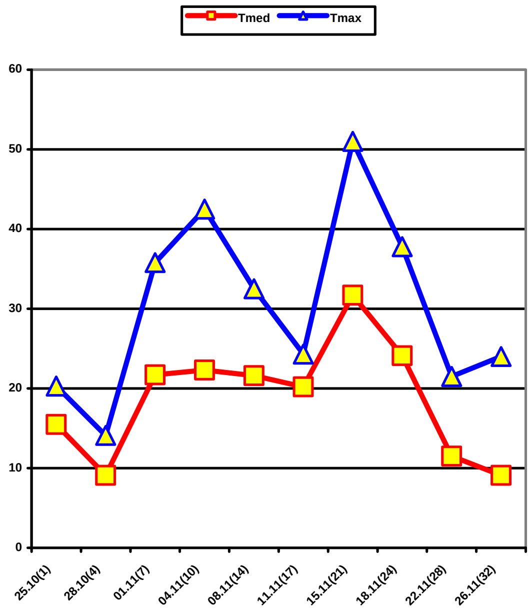

Fig.12 Surface temperature variation in time to deposit for the first outbreak potential

Also measurements were made in two areas:

- ➢ The area where the temperature is close to the average temperature of the stack face
- ➢ Zone B where the temperature is the highest value on the stack

Measurements were made at different depths, the vertical point, progressively removing quantities of coal until it was identified that the depth from which coal has remained virtually constant temperature (no longer influenced by weather conditions). The results of these measurements are found in Table 1 and Figures 13 and 14.

Table 1

Depth in the stack [cm]	Temperature [^{0}C]	
	Zone A	Zone B
0	23,5	45,7
10	28,3	47,5
20	35,2	51,2
30	44,5	55,5
40	49,6	58,3
50	50,8	60,1

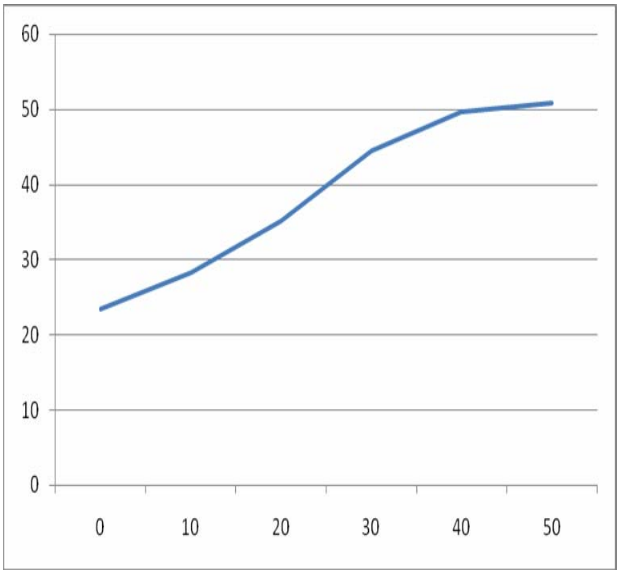

Fig.13 Variation of temperature on vertical of zone A

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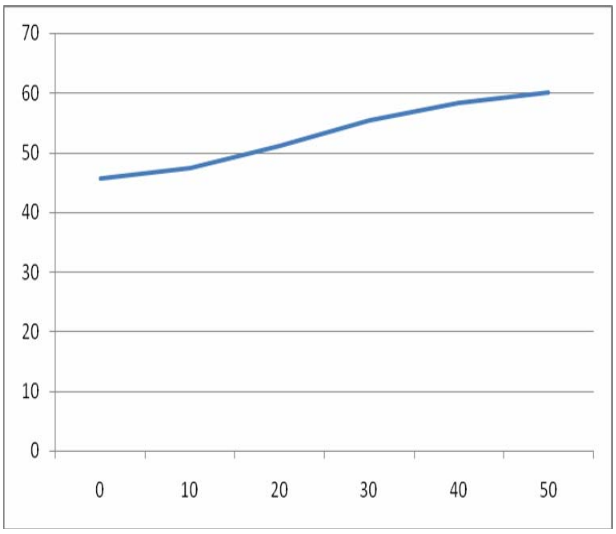

Fig.14 Variation of temperature on vertical of zone B

From the results we see that, from a depth of 40 cm, the temperature inside the stack is influenced in a very limited extent by weather conditions.

The temperature of the outer faces of the stack depends on ambient temperature and heat exchange between the stack and the environment.

From the analysis of thermographic images there are areas with temperatures higher than average on these faces and the temperature in the vertical stack area also has higher values. This is because air and volatilele released from outbreaks of ignition are hot and moving towards the outside of the stack. Since the size and form lumps of coal are very different, forming channel movement of these gases with trails that can not be established. Gas circulation channel is achieved mainly with the lowest resistance to flow, which may not coincide with the shortest route to the surface.

It is possible that if the temperature is elevated at the surface of the focus stack to stack to be in any direction.

Since the surface temperature depends on ambient air temperature and solar radiation absorbed, it has a diurnal variation that aims to change the previous factors.

Consequently, the surface temperature is influenced primarily by the environment and to a lesser extent by the temperature of the stack, but the warmest areas on the surface indicates the existence of releases of higher heat in the stack.

The position of these points with large heat release can be approximated but can not pinpoint the depth at which they occur.

4 Conclusions

Monitoring deposits of coal thermal imager can provide information on the level of the stack temperature and indicate the approximate areas where auto-ignition may occur. This is useful to establish the program supplies of coal.

- from measurements made both in terms of measurements on the surface of the stack with the thermal imager and in terms of measuring the temperature inside the warehouse with temperature probes, it was found that the east side (B) is exposed to atmospheric factors, which favors the oxidation of coal and hence ignition. For this reason it is necessary to protect the east side of the coal deposit against the action of atmospheric factors by installing screens and aiming at reducing air entrainment in solids. This requires modeling the flow of air currents, which require further measurements and concentrate on measures aimed at speed and wind direction.
- îin case of positioning the thermal imagers to the stack of coal so as to indicate the surface temperature stack measured from the same angle, one can achieve a surface temperature map of the stack and also provides a online monitoring of stack and recording results to a database constuirii required further interpretation of results.
- Analyzing graphs representing the curves of variation of temperature during storage, we can conclude that the coal temperature varies depending on the depth of the stack, and exposure to wind. Temperature close to the outer layer of the deposit is different from the temperature inside the warehouse, with a much slower growth due to better heat exchange with ambient air. Temperatures measured on the east side(the prevailing wind direction) reached values of 70 ° C, while in central and western area temperature is (20 ÷ 40) ° C, higher values being for the West. This is due to the surplus of fresh air (oxygen default) brought the wind on the exposed coal oxidation reaction is accelerated. Deposit of coarse coal favors the creation of channels through which air enters the layers within it.

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- after rainfall, fine fraction is driven by water gully erosion channels forming in the body that promote aeration coal deposit
- for deposits with bigger storage period than 30 days, monitoring temperature of coal in storage using fixed mounted infrared camera and temperature probes is recomended
- for prevention the ignition phenomenon, coal deposits will be kept under continuous observation, a systematic control of the temperature inside the deposits formed is preferably performed in the early hours of morning. By observing the daily deposits of coal,we will be able to identify portions of the deposit in time that are more likely to self-heating and ignition in that the specific portions warmer , frost and dew disappear faster than the surrounding parts, snow melts more easily, and after rain the portions of the stacks dries before the other.

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