MODERN MONITORING METHODS FOR LIGNITE DEPOSIT

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ABSTRACT: In the paper the author presents modern methods to monitor lignite deposits using a thermovision camera. The main modern method in this paper consists of continuous monitoring of the whole lignite deposit with a thermovision camera situated above the deposit at half its height, in its middle and which rotates 360^0 in order to take images from all its surface and process them.

KEY WORDS: lignite deposits, monitoring, modern method, thermovision, rotating camera.

1. INTRODUCTION

Lignite needs to be safely deposited over undetermined periods of time, until it is used as fossil fuel for thermal power stations.

Lignite which is extracted from open mining pits is the main resource in matter of fossil fuel for the thermal power stations in the South-West Region of Romania, as well as in other countries. Lignite or coal in general, needs to be deposited for a while after it was extracted and before it is used as fossil fuel. The deposits are built after a set of rules in order to keep it deposited in best conditions. [1,2,4]

Lignite, coal or any other material deposited in large amounts tends to heat at the bottom. So where there is heat, oxygen and the material to burn, an upcoming fire should be taken into account! When the lignite is deposited following the proper rules, some of them above, heating or self heating appears very difficult.

As a process, self heating is due to lignite oxidation: because the lignite is not perfectly settled in the pile, air and water can run between the pieces. The oxygen contained in the air can make the lignite produce heat and since the heat cannot be exchanged with the environment, it is enhanced within itself and exchanged with neighbors, creating a burning point and leading to self ignition.

Usually, both chemical structure of lignite and because the rules mentioned above are not always or rigorously respected as such, lead at one point in time or another to self heating and to self ignition of lignite, which have major consequences over human health, environment and production:

- after lignite reaches a certain temperature, its caloric power becomes lower (the higher temperature gets, the lower its caloric power becomes, and could decrease with 50-70% [2,4]), so a certain lignite quantity would produce in these conditions less energy than that produces by the same quantity, but in normal depositing conditions;
- increasing temperature makes lignite release toxic gases, such as carbon monoxide (CO) during self heating process and sulfur dioxide (SO_2) during the self ignition process, which are harmful for humans living in the surroundings of the deposits, and also for environment;
- toxic gases released by self heating and self igniting lignite also directly affect the surrounding environment and indirectly affect it by the extra excavations that are needed to replace the lost lignite.

So if lignite self heats, its caloric power decreases; if it self ignites, it affects a considerable amount of lignite in its surroundings, making it lost for the energy production. Also, human health and environment suffer.

So, these are the reasons why the state of a lignite deposit must be known at any moment in time in order to avoid self heating and most important, self ignition.

2. MONITORING A LIGNITE DEPOSIT

2.1. Current monitoring methods

Current methods to monitor the temperature in lignite deposits and diagnose their state are:

- checking periodically (each day for deposits with temperature over 35^0C, and from 6 to 25 days for deposits that are better build) suspicious areas with a special thermometer (figure 1) or
- with metallic bars for higher depths.

Current methods to keep temperature in desired ranges are:

If temperature indicated by thermometers or metallic bars is over a desired value or if an employee working at the lignite deposit observes steam getting out of a deposit's part (which is already too late, because deep down temperature is over 60^0C and may rise up to 70^0C), they call it in and: 1. either that part of the deposit is sent to production or 2. that part of the deposit is being moved from one place to another with an excavator (figure 2), operation which can take up to 1 or 2 days, depending of the area the heating is extended, until production requires it.

Figure1

Figure2 Excavator removig burning point

2.1. How it should be done

In order to define the state of a lignite deposit, imagine we have such a deposit, as presented in figure 3 below, and an imaginary thermometer that would gather temperature data from each point of the deposit and display it every time when a temperature value changes with a given constant as an average maximum of temperature over an area (user defined dimensions) and the x, y, z coordinates of its location. There can be an unknown number n of areas within the deposit where temperature can rise independently, areas which can become burning points with different maximum temperature simultaneously.

The variation in time of heat inside a lignite deposit follows the pattern[2,3,4]: it reaches 35^0C slowly (in about two months), it continues heating until 45^0C, it passes through the burning point creation state, and in about 15 days, around that burning point temperature can reach the self ignition value of 65^0C.

So, when the imaginary thermometer shows areas with a maximum temperature under 35^0C, the deposit is under no danger; when the thermometer shows for certain areas an average temperature of 55^0C to 65^0C, there is a burning point already; when the thermometer shows for certain areas an average temperature of over 65^0C, the self ignition appears shortly.

In the case presented, it would be ideal that the temperature in a lignite deposit should only be found before it reaches 35^0C. When it increases to 65^0C, authorized personnel should be warned to take proper actions in order to return the temperature of the deposit below 35^0C.

2.3. Proposed modern monitoring method1

In figure 3 the picture shows a side of a lignite deposit. Figure 4 shows the same side of the lignite deposit in infrared. The picture in figure 4 is taken with a Flir Systems thermovision camera, model T200 (figure 5).

Figure 3 Lignite deposit

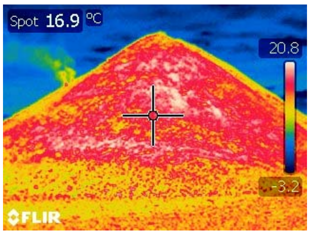

Figure 4 Lignite deposit in infrared

Figure 5 Flir T200 thermovision camera

A thermovision camera absorbs the thermal energy or radiation emitted by the surface of the „viewed" or monitored objects and transforms it into color maps or thermographic images in which white means hottest and black means coldest. The colors between white and black are temperatures between the maximum values of hottest and coldest [4].

In the research project [3], and in [4] I wanted to find out whether the state of a lignite deposit can be determined by monitoring the surface temperature of the deposit with a thermovision camera, using only 8 positions of monitoring, like in figure 6.

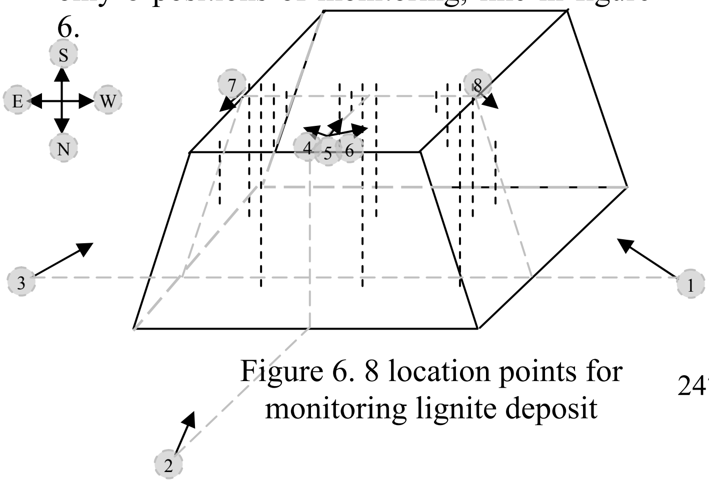

Figure 6. 8 location points for monitoring lignite deposit

Unfortunately, the results were not as expected because 8 locations were not enaugh, the monitoring wasn't continuous and it didn't catch the whole surface that was supposed to be monitored [4].

2.3. Proposed modern monitoring method2

So, the second proposed method, which is the main method for this paper consists of a continuous monitoring of the whole lignite deposit with a thermovision camera situated above the deposit at half its height, in its middle and which rotates 360^0 in order to take images from all its surface, like in figure 7, only imagining in the center being the lignite deposit.

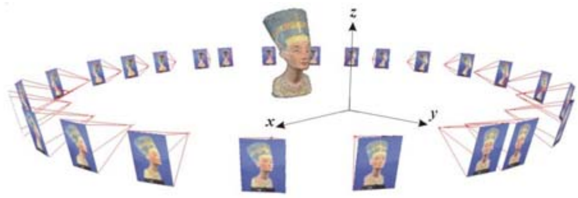

Figure 7 [5]

This method, during the real-time process of taking thermographic images of the deposit, should also process the images in real-time like in [6] and alarm if a burning point appears.

Also, the mechanical and electrical part of the assembly must be carefully chosen in order for the thermovision camera to be situated in certain predetermined positions, and every time it rotates 360^0, to hit the same initial position. This would work with a stepper motor.

The data transfer should be on optic fiber and the processing software should be installed on a real-time operating computer.

The image processing algorithm should detect the contour of the image and exclude the background, and after that to be able to identify the different in color burning points, point them out and determine if they are over a predetermined value of 35^0C, and only then to alarm working personnel to take appropriate measures.

3. CONCLUSION

The second method is not tested yet, but because of the better view of the thermovision camera and due to continuous monitoring it should offer better results regarding faster identifying of the burning points in order to be able to prevent self ignition in the deposit.

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