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ADVANTAGES FOR THE ENVIRONMENT BROUGHT UP BY THE HOT SPOT DETECTION IN LIGNITE DEPOSITS USING THERMOGRAPHY

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ABSTRACT: In this paper, the authors wish to underline how can the environment benefit from the detection of the hot spots in the lignite deposits from the mining pits. The detection can be made with a thermovision camera. Also, there are presented some results of the application.

1. INTRODUCTION

From [1], it is known that the complete combustion of carbon and hydrocarbons described above rarely occurs in nature. If the temperature is not high enough or sufficient oxygen is not provided to the fuel, combustion of these materials is usually incomplete. During the incomplete combustion of carbon and hydrocarbons, other products besides carbon dioxide and water are formed. These products include carbon monoxide, hydrogen, and other forms of pure carbon, such as soot.

During the combustion of coal, minor constituents are also oxidized (meaning they burn). Sulfur is converted to sulfur dioxide and sulfur trioxide, and nitrogen compounds are converted to nitrogen oxides. The incomplete combustion of coal and the combustion of these minor constituents results in a number of environmental problems. For example, soot formed during incomplete combustion may settle out of the air and deposit an unattractive coating on homes, cars, buildings, and other structures. Carbon monoxide formed during incomplete combustion is a toxic gas and may cause illness or death in humans and other animals. Oxides of sulfur and nitrogen react with water vapor in the atmosphere and then settle out in the air as acid rain. (Acid rain is thought to be responsible for the destruction of certain forms of plant and animal—especially fish—life.)

In addition to these compounds, coal often contains a small percentage of mineral matter: quartz, calcite, or perhaps clay minerals. These components do not burn readily and so become part of the ash formed during combustion. This ash then either escapes into the atmosphere or is left in the combustion vessel and must be discarded. Sometimes coal ash also contains significant amounts of lead, barium, arsenic, or other elements. Whether airborne or in bulk, coal ash can therefore be a serious environmental hazard.

From [2] Freshly mined high volatile coal when stored in bulk undergoes low temperature atmospheric oxidation due to the presence of methane and other volatile matter on the surface.

This exothermic oxidation causes the rise in temperature of the coal and if the heat is not removed, a stage comes when coal begins to burn on its own. This is called Spontaneous Combustion which leads to outbreak of fire in the stored coal.

If the temperature rise due to oxidation does not exceed a critical value (500 C for Lignite and about 800 C for bituminous coal), spontaneous ignition does not take place but the quality of coal is affected depending on the degree of oxidation. Spontaneous oxidation can cause:

• Decrease in Calorific value
• Decrease in Carbon and Hydrogen content and increase of Oxygen %
• Size grading may get reduced (due to crumbling, the coal lumps gets broken down into small pieces)
• Fire, if the temperature exceeds the critical value

As the maturity of coal increases, its tendency to catch fire during storage decreases. It should be noted that for every 10 degree Centigrade increase of storage temperature the rate of oxidation gets doubled. Self Ignition or Spontaneous Oxidation is usually predominant in fresh coal. If the material is mined one to four months back and stored then it is less susceptible to Self Ignition. Coal already stored longer than six months with exposure to air are usually not liable to Self Ignition. However, if the coal is stored over six months on economical front blockage of large money and increase of handling cost may arise. Further wind loss, Oxidation loss of coal (weathering of coal), Carpet loss are bound to a happen.

Coal stored over longer period absorbs oxygen as explained above and its calorific value decreases. For every 1% increase of oxygen content the CV of coal decreases by 1% like increase of ash. However if the temperature of storage is not allowed to go more than 600 C, High volatile coal suffers less depreciation in heating value. Carpet loss is the loss of material stored on the unprepared ground. The soil and clay matter mix up with coal and some quantity of coal is lost by this. Our country deals with the problem of instantaneous coal ignition in big coal deposits, because a significant part of the energy produced is from coal burning.

2. A SUCCESS STORY DEALING WITH THE SAME PROBLEM

As stated in [3], In Czech Republic, at the Nástup Mines Cooperation in Tusimice, there was the same problem and Flir Systems solved it in the following way: For this location, ENELEX supplied a ThermoVision™ infrared camera system from FLIR Systems for continuous and fully automated monitoring of the coal pile. The large size of the storage yard means the use of a portable infrared camera is not a practical solution for this critical task. Only a fully automated system is able to constantly monitor the hundreds of thousands of tons of coal which are stored at this site on an area of approximately 800 x 200 meters.

FLIR Systems infrared cameras were selected because of the company's extensive experience in a wide range of continuous thermal monitoring applications. These range from quality control on printed circuit boards right up to systems designed to operate in harsh industrial environments such as steel mills, glass production lines, waste treatment plans and other industrial processes.

The system is based on the FLIR Systems ThermoVision™ 320C cameras, which are mounted on five steel masts at strategic locations around the site (fig.1). To ensure optimum coverage of the whole area, the cameras are configured to generate a direct alarm output to an operator if previously defined maximum temperature thresholds are exceeded. An acoustic alarm and a display alarm on a monitor will draw the operator's attention to a possible spontaneous fire development. The system allows for an accurate positioning and a detailed analysis of the critical location so that the hot spot can be extinguished and a fire prevented. Because of the extensive size of the storage site, the control and camera signals are transported by fibre-optic cables with a total length of 3 km from the camera mast to the control room.

Fig. 1. Infrared camera from FLIR mounted above the coal deposit of the Nástup Mines Cooperation in Tusimice

3. PROPOSED APPLICATION FOR HOT SPOT DETECTION

We thought of the following logic scheme is found in fig. 2:

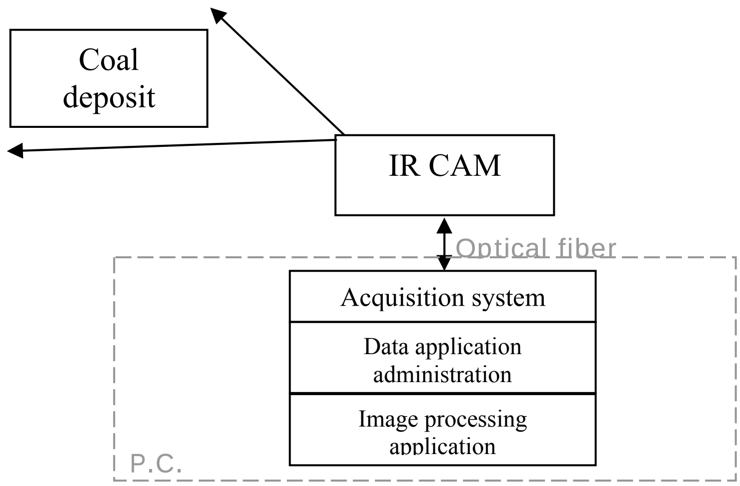

Fig. 2 Logical scheme of the proposed system for hot spot detection

The infrared camera is fixed, it acquisitions data and send it to the acquisition system and offers an image. This image is interpreted by the application which runs on the PC.

The system offers a permanent monitoring and alarms if a value appears in the picture which is over the preset temperature, thus preventing the instant coal ignition and material loss. The images are taken and processed real-time and in fig. 3, upper position, is an infrared image of a coal deposit with two hot spot, and in the bottom position is the same image processed with our application. The algorithm for hot spot detection was found in a template of Candy software for image processing and searches the whole image pixel by pixel. When it finds a pixel or more of a certain value which is over a preset threshold, the alarm goes on to announce a hot spot appeared in the coal deposit.

If necessary, an algorithm can be added to count the hot spots, that is for an eventual archive with information about the evolution in time of the coal deposit.

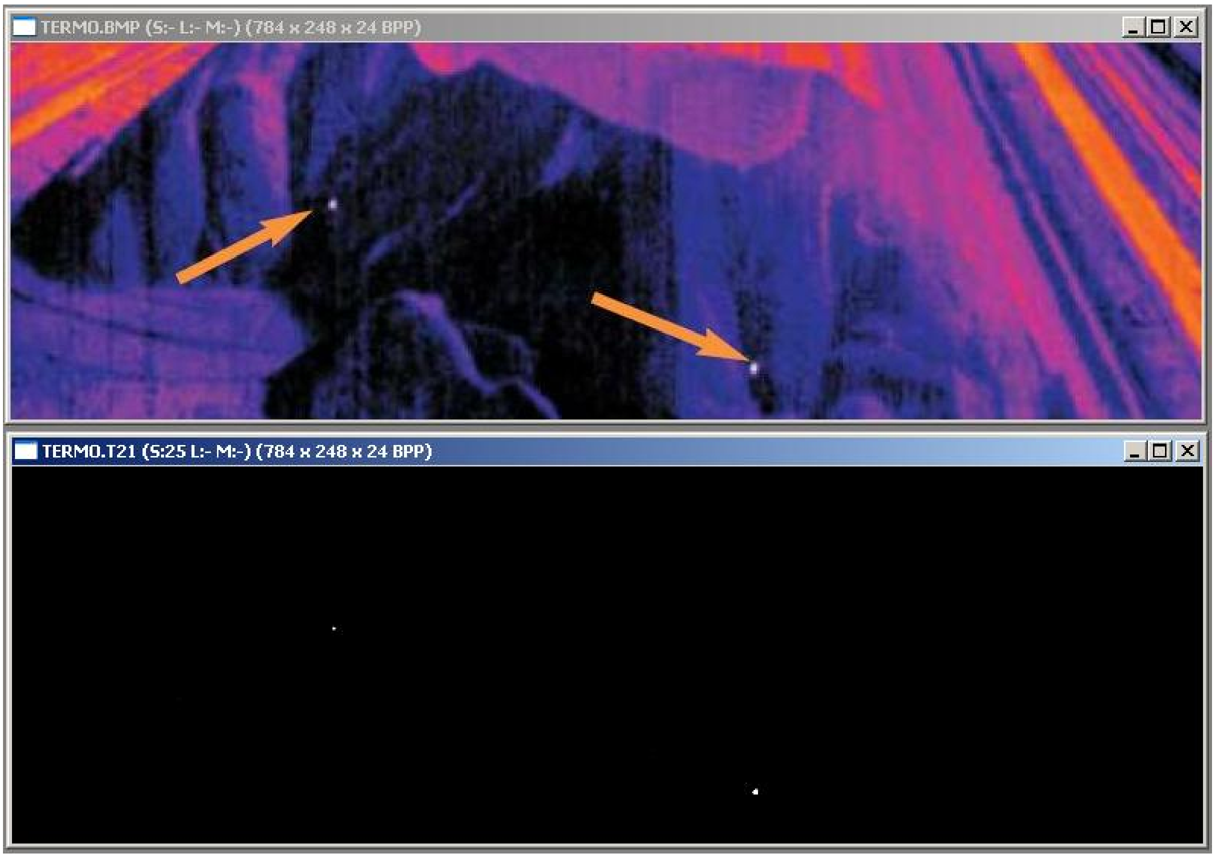

Fig. 3. The results the authors obtained

CONCLUSIONS

So, from two points of view the environment can be affected by the unsupervised coal deposits, meaning that if coal burns outside the purpose it was meant to burn, first it pollutes the air, and second, more coal will be needed, thus more land will be destroyed with excavations. Also, the risk of consequential damage that can be caused by fires, including loss of property, water damage resulting from fire-fighting and standstill of production lines. In view of these real risks, the cost of an automated temperature monitoring system using infrared cameras is a modest and very worthwhile investment. After the experience in [4], as a conclusion, the authors state that a continuous coal deposit monitoring with a thermovision camera (or with a system of thermovision camers) which is connected to a computer which takes decisions and alarms if necessary is of the essence for the environmental protection. Algorithms should be developed in order to make the hot spot detection even earlier than the techniques succeed today.

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