MODIFICATION OF THE LABORATORY EQUIPMENT USED TO ASSESS THE SPONTANEOUS COMBUSTION SUSCEPTIBILITY OF COAL

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INTRODUCTION

The self-heating process and, as a consequence, the spontaneous combustion of coal is associated with the sorption of oxygen on the surface of grains, in the porous structure of the carbonaceous matter. If the heat generated during the process is not sufficiently discharged outwards, ignition occurs. Endogenous fires in the coal mines, caused by this phenomenon, have a negative impact on the natural environment, as well as on the mining industry, raising the cost of fire prevention and coal extraction. Nowadays, in order to assess the spontaneous combustion susceptibility of coal, fully automated methods and instrumental techniques are used. First of all they allow to determine the self-heating rate, the amount of heat generated, and to estimate the concentration and composition of gases emitted during the oxidation. The presented research focuses on Örsat gas analyzer (Fig.1.) which was patented in 19th century but still is considered a reliable measurement method non inferior to modern techniques. The analyzer is based on the selective absorption of individual gas component especially CO_2, O_2 and CO in the adsorption pipettes containing appropriate solutions[1]. Coal samples from Sobieski, Brzeszcze and Pniowek coal mines with the grain size 0.1-0.7 mm were used in the analysis. In order to obtain post-reaction gases, the coal samples were submitted to low-temperature oxidation with a hydrogen peroxide solution, as in reported method [2].

EXPERIMENTS

The difference between the most commonly used Örsat gas analyzer and the apparatus described in this research was the method of sample delivery. Thus, in order to test the reaction gasses obtained after the oxidation of coal, a reactor in form of a beaker with rubber cork was added to apparatus and then attached to the burette. 3 grams of coal was placed in beaker, next the 1 cm^3 of distilled water and 9 cm^3 of 20% hydrogen peroxide solution was added. A thermometer was placed in the reactor via a fitted slot and the burette was filled to approximately 100 cm^3 with saturated NaCl solution. During the reaction, the temperature on the thermometer was read every five minutes, and the evolution time of post-reaction gases was also noted. When the reaction was over, the sample of gas was pushed to the first absorption bulb filled with potassium hydroxide solution to absorb CO_2. The bottle filled with NaCl solution was brought down so that the

Figure 1: Örsat gas analyzer used during the research

gas was rushed to the burette and the volume increase of liquid in burette was measured.

RESULTS AND DISSCUSION

Coal sample	Content of element C [%]	Moisture content [%]	Volume of post-reaction gas [cm^3]	Concentration of CO_2 in gas [%]
Sobieski	66.85	6.13	11	1.76
Brzeszcze	77.53	2.3	0	0
Pniowek	81.17	0.68	0	0

Table 1. Basic specification of coal samples and the results obtained after using Örsat analyzer

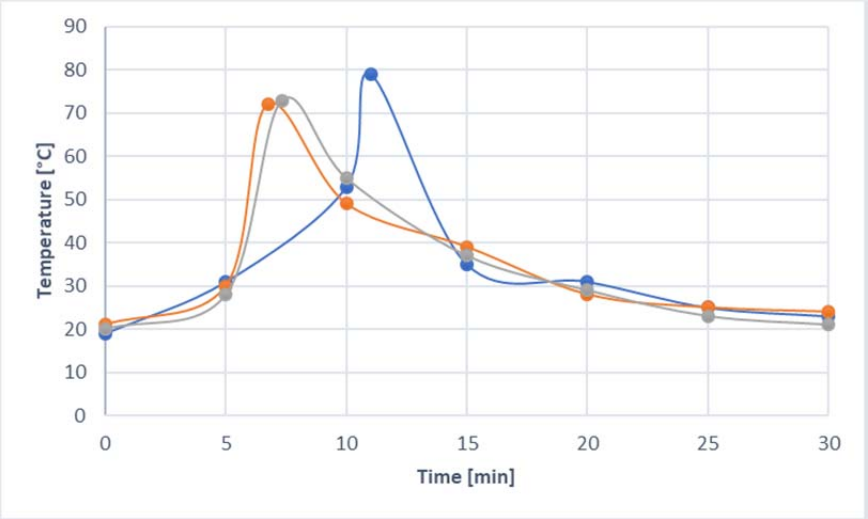

Figure 2: The rate of temperature change for samples from the Sobieski coal mine

Due to the use of the Lasoń method, the tendency of the coals to spontaneous combustion was determined[2]. Figure 2 shows a rapid increase in temperature in the Sobieski coal and perhydroxic acid system (reaching almost 80°C). Also in the case of coal from the Sobieski mine, the gas bubbles evolved in the beaker from the very first moment of measurement. However, the collection of reaction gases to the burette was observed for a very short time, which was related to the rapid decomposition of hydrogen peroxide. The concentration of carbon dioxide in the gas was significant. Neither for coal from the Brzeszcze mine nor for the coal from the Pniowek mine, no signs of the reaction of carbon with hydrogen peroxide were observed, including a lack of the emergence of post-reaction gases (Table 1.) and constant temperature in the rector.

CONCLUSIONS

The results obtained suggest that coal from the Sobieski mine shows a significant tendency to self-ignition. However, the Brzeszcze and Pniowek coals did not show a similar susceptibility as a temperature during the measurement remained constant and no gas was emitted. The Örsat analyzer presented in the research is relatively easy to use and can be successfully used as a replacement for automatic apparatus.

REFERENCES

[1] Cygankiewicz J., *Prognozowanie procesu samozapalania węgla w podziemiach kopalń,* Główny Instytut Górnictwa, Katowice (2018)

[2] Brzóska K., Ceglarska-Stefańska G., Małysa E., Marecka A., Orzechowska-Zięba A., *Wybrane zagadnienia z fizykochemii węgla kamiennego,* Wydawnictwo AGH, Kraków (2003)