Abstract

The phenomenon of coal oxidation with atmospheric oxygen is observed in coal mines. As a result of this reaction the heat is released which, in case of its accumulation, results in self-heating of coal. The spontaneous combustion of coal, which further may lead to endogenous fire, may be the consequence of this phenomenon. Gases, including unsaturated hydrocarbons, like: ethylene, propylene and acetylene, are emitted to the mine atmosphere with the development of coal self-heating process. Their content in mine air is applied to determine the temperature of coal and to estimate the stage of the self-heating process. Early detection of the self-heating process allows us to take actions which may slow down its further development and spreading, and mitigate the risk of fire.

The unsaturated hydrocarbons: ethylene, propylene and acetylene emitted in the process of coal heating are sorbed on coal. The thesis proved that the volumes of unsaturated hydrocarbons sorbed on coal depend on physicochemical properties of coal, its porosity, as well as volume and surface of pores. Low-rank coals of high porosity, high surface and volume of pores and considerable content of oxygen and humidity, were characterized by the highest sorption capacity with respect to hydrocarbons tested. This sorption capacity decreased with the increase in the grade of metamorphism and with the decrease in pore volume. Coals of low porosity, characterized by compact structure, tended to sorb low volumes of hydrocarbons.

Acetylene was sorbed in the largest amounts among the selected hydrocarbons for the majority of hard coals tested. The volumes of acetylene sorbed were approximately 2-3 times higher than the respective values reported for ethylene and propylene.

The volumes of hydrocarbons sorbed on coals decreased with the increase in process temperature from 298 to 373 K. The most significant effect of temperature on the amount of hydrocarbons sorbed was observed for coals characterized by high sorption capacity. This trend was most evident for acetylene, less prominent for ethylene and negligible for propylene.

On the basis of the study of hydrocarbons desorption from coals it was concluded that the levels of hydrocarbons desorption varied from the highest degree of desorption for ethylene to the lowest degree of desorption reported for propylene. It was also observed that the percentage of hydrocarbons volume desorbed from coal structure depended also on sorption capacity of coals; coals of high sorption capacity were characterized by the highest percentage of volume desorbed.

The thesis proved the effect of sorption capacity of hard coals on the assessment of the development of the process of self-heating of coal. The sorption of ethylene, propylene and acetylene on hard coals results in the decrease of their concentrations in mine air, especially in case of coals of high sorption capacity. This, in turn, causes the deviation of fire indicators values, determined on the basis of hydrocarbons concentrations in mine air, from the actual values, which affects the accuracy of the assessment of coal self-heating process progress.