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NORBERT SKOCZYLAS*, MIROSŁAW WIERZBICKI*

EVALUATION AND MANAGEMENT OF THE GAS AND ROCK OUTBURST HAZARD IN THE LIGHT OF INTERNATIONAL LEGAL REGULATIONS

OCENA ZAGROŻENIA WYRZUTAMI METANU I SKAŁ ORAZ ZWALCZANIE ZAGROŻENIA W ŚWIETLE MIĘDZYNARODOWYCH ROZWIĄZAŃ PRAWNYCH

As part of the present article, the Authors analyzed relevant legal rules that are in force in countries where the gas and coal outburst hazard occurs (Australia, the Czech Republic, China, Germany, Poland, Russia, and Ukraine). Similarities and differences between particular solutions were highlighted. As the subject of the analysis were the original legal standards, the article incorporates the parameter symbols and units adopted in the discussed regulations.

Keywords: gas and rock outburst, categorization of the outburst hazard, legal rules, parameters of outburst risk

W ramach niniejszej pracy poddano analizie obowiązujące rozwiązania prawne z krajów, gdzie występuje zagrożenie wyrzutami gazu i węgla (Australia, Czechy, Chiny, Niemcy, Polska, Rosja, Ukraina). Zwrócono uwagę na podobieństwa i różnice w poszczególnych rozwiązaniach. Ze względu na analizę oryginalnych rozwiązań legislacyjnych w opracowaniu pozostawione zostały stosowane w odpowiednich przepisach oznaczenia parametrów oraz ich jednostki.

Istnieje duże podobieństwo w obrębie przepisów w krajach europejskich. Podobieństwo to dotyczy zarówno ogólnej koncepcji przepisów, w których dąży się do maksymalnego sformalizowania nakładanych wymogów, łącznie ze wskazaniem konkretnych parametrów górniczych oraz ich wartości kryterialnych, na bazie których klasyfikowane są pokłady węglowe, bądź ich części, do poszczególnych klas zagrożenia wyrzutowego. Podobne podejście w ustawodawstwie w zakresie bezpieczeństwa w górnictwie reprezentują Chiny.

W całkowitej opozycji do przepisów europejskich i chińskich znajdują się przepisy amerykańskie i australijskie. W przepisach tych wyraźnie zaakcentowany jest fakt, iż charakter ryzyka wyrzutowego jest bardzo lokalny, więc trudno go uogólniać nie tylko między kopalniami, ale również w poszczególnych wyrobiskach. Jedno, niezmienne podejście do zarządzania ryzykiem, zgodnie z przepisami australijskimi, jest więc niewłaściwe. Przepisy te nie podają szczegółowego opisu, w jaki sposób prowadzić zarządzanie ryzykiem wyrzutu, ale dają natomiast zarys tego, jakie elementy muszą być uwzględnione w rozwoju zarządzaniu ryzykiem.

* STRATA MECHANICS RESEARCH INSTITUTE OF THE POLISH ACADEMY OF SCIENCES, REYMONTA 27, 30-059 KRAKOW, POLAND

Kategoryzacja zagrożenia wyrzutowego w krajach europejskich i w Chinach ma wiele cech wspólnych. Ustalane są najczęściej dwie, lub trzy kategorie zagrożenia. Często incydenty wyrzutów, bądź poważnych symptomów mogących świadczyć o zagrożeniu są podstawą do zaliczenia pokładu do najwyższej kategorii zagrożenia.

Dominującym parametrem w podstawowej ocenie zagrożenia wyrzutowego jest zawartość metanu w pokładzie węgla. Występuje ona w aktach prawnych wszystkich krajów, które narzucają konkretne sposoby określana stanu zagrożenia, jedynie przepisy chińskie nie obligują do badań zawartości gazu w węglu. W przepisach chińskich pojawia się pomiar ciśnienia gazu.

Słowa kluczowe: zagrożenie wyrzutami gazu i skał, regulacje prawne, kategoryzacja zagrożenia, parametry opisujące zagrożenie

1. Introduction

The gas and rock outburst hazard occurs in almost all hard coal mining facilities, in every part of the world, resulting in an increased number of fatal accidents in mines. It is estimated that there have been over thirty thousand such outbursts all over the world to date. Particular states have developed – via their legislative systems – appropriate legal regulations aiming at minimizing the risk of outbursts and reducing the impact of its potential consequences. The present article attempts to analyze legal rules in force in selected countries. Particular emphasis was placed on definitions, symptoms, and categorization of the hazard in question, as well as on parameters applied in the process of evaluating the threat of gas and rock outbursts. This information might prove useful as far as interpreting the results of measurements performed in particular countries is concerned; also, it may be found helpful by these specialists who seek new methods and means of evaluating the outburst risk, alternative to those already applied in a given country.

2. Outburst definitions

The phenomenon of a gas and rock outburst is usually defined in relevant legal acts or national instructions concerning the exploitation of coal and other minerals. Although definitions provided by legal acts of particular countries generally correspond, one can identify certain differences regarding two aspects. One of these aspects is the scope of the definition – starting with its simplest form, in which just the consecutive stages of the outburst are described, and ending with the most complex ones, which also include the causes and the consequences of an outburst. The other deals with the classification method, i.e. establishing if a given phenomenon is an outburst or not on the basis of evaluating its nature or its consequences. Such a complex approach is offered by the Czech legal acts.

The most concise definition is provided by the Australian regulations (Outburst Mining Guideline, 1995): *"Outburst – the sudden release of gas and material from the working place that can vary in magnitude and intensity"*. Similarly, the German regulations (Richtlinien des Landesoberbergamtes, 1996) define an outburst as a sudden release of substantial amounts of gas, accompanied by transportation of the rock mass.

Relevant legal acts of the Czech Republic (Rozhodnutí OBÚ v Ostravě č.j.3895/2002) include information on the minimum mass of the released rock (i.e. 0.5 tonn) as a condition for classifying a given phenomenon as an outburst. Such an approach is quite peculiar, as it is the consequences of a given phenomenon, and not the very fact of its occurrence, constitute a basis for its classification.

The Polish regulations in that matter are quite different when compared with the relatively concise definitions discussed above (Rozporządzenie Ministra Spraw..., 2002): *"Gas and rock outbursts – this shall be understood as a dynamic dislocation of crumbled rocks or coal from the coal solid to excavations, caused by the energy of gases released from the strata as a result of the impact of geological and mining factors, which might produce acoustic effects or an air flow, damage the casing, the tools and the machines, create a post-outburst cavern, distort the process of ventilation of excavations, result in accumulation of methane in the amount sufficient for the occurrence of an outburst, or create an atmosphere in which breathing becomes impossible"*. As can be seen, this definition describes the stages of the outburst phenomenon, as well as its causes and consequences. Similarly, the Russian regulations (Инструкция по безопасному..., 2000) provide a definition in which the outburst is described as a gasogeodynamic phenomenon, a dangerous release of a substantial amount of gas and coal, dynamic in its nature, and resulting in destruction of the coal face and gas release.

3. Symptoms of an increased outburst hazard

In most mining regulations of particular countries, the probability of the outburst hazard is assessed on the basis of parameters determined either at the mine or at the laboratory, as well as on the basis of symptoms which are, in fact, the effects of observing a certain type of phenomena (Skoczylas, 2014). In the Polish regulations, a lengthy list of symptoms indicating a heightened outburst risk can be found. These include:

- an increase in the amount of cuttings,
- cuttings and gas exhaustion,
- blocking or pushing out the drill during the process of drilling boreholes,
- spattering of coal from sidewalls and the coal face,
- cracks within the coal solid,
- an increase in gas exhaustion after blast works,
- an increase in the amount of yield, which is scattered further away from the coal face, with the same blast works technology applied,
- reduced firmness of coal,
- changes in the coal structure during the excavation process.

Due to the adopted definition of an outburst, which determines the mass of the ejected rock, the regulations being in force in the Czech Republic also mention:

- ejection of rock combined with gas outflow (the mass of the ejected rock being less than 0.5 ton),
- an increase in the stress in the casing.

The German regulations add to that list a number of symptoms not mentioned above. These include:

- tectonic distortions,
- sites characterized by increased gas pressure,
- sites as yet unidentified, i.e. new coal seams.

In the Russian regulations, one can find some more observations on symptoms indicating an increased outburst hazard, namely:

- appearance of a large amount of coal dust,
- pushing or pulling in drilling tools,
- reduced coal strength accompanied by a simultaneous increase in gas pressure.

The Chinese regulations additionally introduce a division into degrees of damage to the original coal structures. The degrees of structural changes of coal are thoroughly described.

4. Categories of the outburst hazard

The Czech regulations distinguish between the coal seams that are not subject to the hazard and the coal seams that are subject to the hazard. In the latter case, there are two degrees of risk. The factors taken into account in the process of categorization are past outburst occurrences, identification of symptoms associated with the hazard and mentioned in the rules, and carrying out mining activities in as yet unexplored parts of the seam.

In Germany, legal regulations concerning mining introduce two categories of the outburst hazard, which are connected with the value of the desorbable methane content in a seam. A given seam is classified as subject to the hazard when the value in question exceeds 9 m^3/ton or 5.5 m^3/ton, and when some additional symptoms are observed.

The Russian and Ukraine mining regulations mention the following categories of the outburst hazard:

- outburst-prone coal seams (or their parts),
- coal seams (or their parts) subject to the outburst hazard,
- coal seams (or their parts) not subject to the outburst hazard.

The seams subject to the outburst hazard are these where an outburst has already occurred, where outburst symptoms can be observed, or where a possibility of an outburst is indicated by prognostic analyses. The seams located beneath a seam where an outburst has already occurred are also classified as dangerous ones. Outburst-prone coal seams are these where, in the light of investigations, an outburst might occur. In the case of outburst-prone seams and seams subject to the outburst hazard, it is necessary to monitor the risk constantly.

The Polish mining regulations introduce categories that are analogical to the Russian ones; however, including a seam in a given category depends on some precisely defined parameters. The outburst-prone seams are the ones where the methane content in coal exceeds 8 m^3/ton and the firmness of coal is less than 0.3, or the ones where the methane content in coal exceeds 8 m^3/ton and the desorption intensity index exceeds 1.2. In the seams subject to the outburst hazard, a methane and rock outburst, or a sudden methane outflow, has already occurred (also, some other symptoms mentioned in the regulations might have been observed). The Chinese regulations introduce as many as three categories of the outburst hazard: areas not subject to the hazard, areas subject to the hazard, and outburst zones.

The mining regulations in the USA and Australia do not provide a precise description of the aspects of outburst hazard categorization, nor do they mention any obligatory measurements to be carried out in mines where the outburst hazard is present. What they do determine is a number of obligations imposed on mining facilities with the aim of ensuring safety and proper risk management.

5. Parameters applied in evaluating the outburst hazard

As a result of an analysis of the parameters whose determination is required or recommended by the mining regulations of particular countries, three parameter types can be distinguished: parameters describing the properties of the coal-gas system; parameters describing the properties of coal (in particular, the mechanical ones), and the complex parameters.

5.1. Parameters related to gas phenomena

5.1.1. Gas content in coal

The gas-bearing capacity of a seam is usually defined as the volume of CH_4 (or CO_2) of natural origin per unit weight within the coal solid. In all the world's coal basins, it is one of the most important parameters deciding about the outburst hazard. Frequently, it constitutes a basis for categorization of the outburst hazard. The criterial values for selected countries oscillate between 9 m^3/ton ± 1 m^3/ton (Beamish & Crosdale, 1996; Lama & Bodziony, 1996): 9 m^3/ton for Australia; 9 m^3/ton for Bulgaria; 10 m^3/ton for China; 8 m^3/ton for Ukraine; 8 m^3/ton for Hungary; 9 m^3/ton for the Czech Republic. The findings of Brandt (1987) and Lama (1995) indicate that outbursts occur in coals whose gas-bearing capacity exceeds 8m^3/ton.

In the Polish regulations, the gas-bearing capacity is a basic parameter deciding about classifying a given coal seam under one of the three categories of the outburst hazard. The limit value of this parameter was set as 8 m^3/ton. The gas-bearing capacity is most frequently determined on the basis of an analysis of a grain sample collected from a prospect hole. The sample, placed in a hermetic container, is crushed. Subsequently, the amount of the gas that was released from the sample is assessed, with free gas and gas loss modifications allowed for (the amount of gas between the crushing of the coal during the drilling and placing the coal in a hermetic container). In the case of the German regulations, the limit value of the methane content in coal was set as 9 m^3/ton, which is the so-called desorbable methane content in coal (the difference between the total content and the gas content under the pressure of 1bar). In the Russian regulations concerning exploitation of coal seams under the conditions of the gas and rock outburst hazard, the limit value of the gas content in coal depends on parameter V^{daf} and the depth at which the seam is located. For a change, the Chinese regulations do not treat gas content in coal as such a significant outburst parameter. Finally, in Australia, analyses of gas content in coal and of the composition of coal are performed by means of the AS 3980 method (a core sample), or some other equivalent method which has been officially approved of. The limit values are not determined by legislative bodies – it is the duty of particular mining facilities working on systems for the outburst hazard management.

5.1.2. The seam pressure of methane in a coal seam

The seam pressure of methane in a coal seam is most commonly defined as the pressure of free gas in coal's large pores and fissures. In steady states, it is related to the amount of the absorbed gas (the relationship is described by means of the sorption isotherm). Determining the parameter in question might pose considerable difficulties from the perspective of metrology. Direct methods of determining the seam pressure usually involve placing a measuring probe inside a prospect hole and registering the pressure values after the probe has been sealed up (Skoczylas, 2012). The registered values might be lowered due to a substantial number of factors, such as strata fracturing, high seam humidity, or low permeability of coal. In mining regulations of particular countries, a requirement to determine the seam pressure is not as common as a requirement to establish the gas content in a seam. According to the Czech regulations, a heightened risk occurs at the values exceeding 0.15 MPa, and the highest degree of risk is already when the value of the seam pressure is 0.25 MPa. In China, the criterial value of the seam pressure was set as 0.74 MPa. In the light of the standards of the Russian mining industry, the value of the seam pressure considered dangerous is 1 MPa. The seam pressure is also determined in Australia, where the criteria value is defined not by the state-level regulations, but internal regulations being in force in particular mining facilities.

5.1.3. The desorption parameters

In numerous countries, relevant mining regulations mention parameters defined on the basis of analysis of the kinetics of methane release from a granular coal sample. They are commonly known as desorption intensity. Desorption intensity is influenced by a number of factors, out of which the most important ones are the seam pressure of gas in a coal seam, the index of gas diffusion in coal, and the sorption isotherm (Wierzbicki, 2013a,b).

In Poland, the *dP* desorption intensity index is applied, measured on coal samples whose mass is ca. 3g. The measurement is performed by means of a manometric desorbometer, between the 120th and the 240th second from the start of the process of drilling a given section of a prospect hole. Before the cuttings coming out of the hole are placed in the desorbometer's container, they are sifted, so that a required grain fraction is obtained (0.5-1 mm). The result of the measurement is expressed in kPa. The discussed parameter has a lot of equivalents in various countries. In the Czech Republic, it is the V_1 parameter, denoting the intensity of desorption from a 10-gram sample representing the 0.5-0.8 mm grain fraction, measured in 35 s (Toran et al., 2012). In Germany (*Richtlinien*… 1996), the $q_{0\text{-}1}$ parameter was introduced, expressed in m^3 per ton of coal (the measurement procedure lasts one minute). In Australia, the common practice is to the determine Hargraves' emission velocity (gas release from a 4-gram coal sample; grain fraction 0.125-0.5 mm; measurement between the 2nd and the 6th minute). In China, the ΔP index is used, which denotes the initial speed of gas desorption from coal (a parameter similar to the *dP* index used in Poland).

Diversity of metrological devices and measuring techniques does not allow direct comparison of the threshold values of the investigated parameters. For example, in Poland, the maximum safe value of the dP index, measured by means of a manometric desorbometer (Lama & Bodziony, 1998), was set as 1.2 kPa. In the Czech Republic – as in the case of the seam pressure – two threshold values were established: the range of 1.0-1.5 cm^3 corresponds to the first hazard level, whereas any value exceeding 1.5 cm^3 indicates the second hazard level. In the light of the German regulations, the dangerous value is $q_{0\text{-}1} > 2.3$ m^3/ton.

5.1.4. Other parameters related to gas phenomena

This group comprises parameters describing gas release from prospect holes, or gas release occurring after blast works. The Chinese regulations introduce a parameter denoting the initial speed of gas outflow from prospect holes (q), as well as the α index, determining the speed with which the measured gas release is diminishing. The results of the method depend on the gas pressure, sorption isotherm, and coal permeability (also, indirectly, on the degree of coal microfissuring). If the value of q equals or exceeds 5 dm^3 / (min · m), and α is equal to or less than 0.75, the examined coal is classified as. The Czech regulations use the $q_{p\max}$ parameter, which is gas release from a prospect hole. The authors of the legislation discriminate between two hazard levels: the value range of 3-8 dm^3/m corresponds to the first hazard level; the second hazard level occurs when $q_{p\max} > 8$ dm^3/m. Finally, the German legal regulations concerning the outburst hazard introduce a parameter known as V_{30}, which is the amount of gas coming out of coal for 30 minutes after blast works per one ton of yield. It is expressed in m^3/ton.

5.2. Parameters related to strength and structural properties

The most obvious parameter determining the mechanical properties of coal is its resistance under compression and stretching (Bukowska et al., 2012). However, in the case of weak coals, determining these parameters poses certain difficulties, which are due to the loss of tenacity by the core sample (this might also concern a sample cut during the preparation for the examination). As a result, alternative parameters are being searched for.

5.2.1. Firmness of coal

In a lot of countries, the main parameter used for describing the mechanical properties of coal is firmness. The methodology of determining firmness index f is based on the proposition that the total work consumed in rock breakage is proportional to the newly generated surface area and the volume of the crushed material (Rittinger's law and Kick's law) (Lindqvist, 2008). The application rules, together with the original method of determining firmness, were formulated by Protodiakonow in 1951 (Protodiakonov, 1964). The procedure of determining the value of f assumes extracting a coal sample from a spot where coal firmness is potentially the lowest. Subsequently, the samples are comminuted into grains of 10-20 mm in size. The 50-gram portions of samples are placed in appropriate cylindrical containers, and crushed with a beater of a given mass, dropped from a proper altitude. The comminuted coal material is sifted, and then the volume of the 0,5-1 mm grain fraction is determined. On this basis, the firmness index in the Protodiakonov scale is calculated. The same (or analogical) procedure of determining the discussed index is applied in the Polish, Russian, Ukrainian, and Chinese mining industries. The threshold value in Poland, in the light of the mining regulations, is 0.3, and in China it is 0.5. In the case of Russia and Ukraine, the threshold value is determined for a combined parameter, which takes into account both coal firmness and the seam pressure.

5.2.2. Disintegration index

Disintegration index F_3 is a parameter applied in evaluating the mechanical properties of rocks. It is determined by means of placing a 1-kilogram coal sample in a measuring device in the form of a rotating barrel equipped with four blades. The barrel rotates for 5 minutes, and then the granulometric composition of the coal is analyzed. Disintegration index F_3 and resistance under stretching are interrelated. The discussed index is widely used in the Czech Republic.

5.2.3. Cutting yield from prospect holes

This parameter indicates low resistance of coal under stretching and compression. A potentially dangerous situation occurs when the total volume of cuttings obtained during the drilling process exceeds considerably the volume of the drilled prospect hole. In the Polish regulations, the cutting yield – together with the methane content in coal and desorption intensity – constitutes one of the most important parameters in evaluating the outburst hazard. The threshold value for classifying a given coal seam as dangerous is 4 dm^3/m, with the diameter of the drill being 42 mm. The German regulations mention three threshold values: 8 dm^3/m (the prospect hole diameter being 50 mm), 50 dm^3/m (the prospect hole diameter being 95 mm), and 90 dm^3/m (the prospect hole diameter being 140 mm.) In the Chinese legal regulations, one can encounter a parameter known as S_{max}, determining the amount of cutting yield from a meter-sized fragment of a 42-milimiter prospect hole. In this case, the threshold value indicating the outburst hazard was set as 5.4 dm^3/m.

5.2.4. Structural parameters

Hard coal seams are characterized by the presence of highly dangerous areas, which are particularly prone to the occurrence of hazards related to gas and rock outbursts. Such areas reveal a different (weakened) structure of coal. Such forms may appear in the areas of geological distortions, created as a result of stresses in the strata. Tectonic phenomena influencing a hard coal seam might lead to the emergence of a network of fractures, comminution, or even grinding of the material. In extreme cases, the original coal structure becomes totally blurred (Fig. 1) (Cao et al., 2000; Shepherd et al., 1980; Wierzbicki & Młynarczuk, 2006). In most countries' regulations concerning safety of mining works, one can find information on how essential the discussed parameter is for the process of evaluating the outburst hazard. The **Chinese** regulations are especially precise when it comes to stages of destruction of the original number of coal

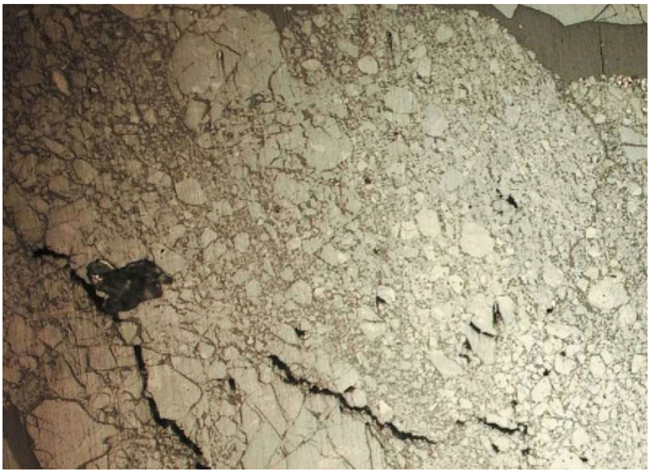

Fig. 1. Microscopy images – optical magnification 200X, reflected light – a chunk of the vitrinite coal – it can be observed that the original structure has been totally blurred

– i.e., they distinguish 5 such stages, marked as I, II, III, IV, and V. The coal is classified under a given type on the basis of its color (lightness), structure and structural properties, cracks, and durability (tenacity). Type I is defined as coal that has not been damaged; strong; light or half-light; with a discernible, characteristic structure. Type V is the so-called coal dust – soft, dark and with no characteristic structure (or with a muddy-like structure). Types II, III i IV are placed between types I and V.

5.3. Combined parameters

Combined parameters seem to represent a very rational approach to the question of evaluation of the outburst hazard. The two which are most frequently combined are: the gas factor, whose intensification increases the outburst hazard, and the resistance factor. A case in point is a Chinese index expressed by means of the formula: $K = \frac{\Delta P}{f}$. The parameter in question is a highly intuitive one – a similar degree of outburst hazard K can occur with coals that have different ΔP desorption intensity indices (on condition that a change in coal firmness f is proportional to the ΔP change). Parameter Π_B, to be found in the Russian regulations, is similar in its nature; however, in this case, the gas factor is represented by the seam pressure of the gas: $\Pi_B = P_{\max} - 14 f_{\min}$. P_{max} [bar] shall be understood as the maximum measured gas pressure, whereas f_{min} is the minimum measured firmness of coal (in the Protodiakonov's cale). If $\Pi_B \le 0$, the outburst conditions are deemed safe. Also, in the Russian regulations, one can find information about an index determining the degree of coal's metamorphism M, which depends on the value of V^{daf} and the depth at which the seam is located. If the value of V^{daf} falls in the range of 9%-29%, then $M = V^{daf} - 0.16$. For V^{daf} > 29%, in turn, $M = ((4V^{daf} - 91)/(y + 2.9)) + 2.4$. The Russian mining industry uses also the P_a index describing the state of stresses in excavation, which takes into account the gas pressure in $P_{\text{г}}$ seam and the depth of extraction H: $P_a = P_{\text{г}} + 0.04\delta H$ (δ is the mean density of rocks, equalling $2{,}5 \cdot 10^{-3}$ kg/cm^3). Another combined parameter is the Chinese index R, whose value depends on the maximum initial speed of gas outflow from the prospect holes $q_{\max}$ [L/(min · m)], as well as on the maximum amount of cuttings coming from a prospect hole of a given length (S_{max} [L/m]). The value of R is expressed by means of the following formula: $R = (S_{\max} - 1.8) \cdot (q_{\max} - 4)$. If it is equal to or greater than 6, the coal is classified as coal conducive to outbursts. In the Chinese regulations, one will also encounter index $D = \left(\frac{0.0075H}{f} - 3\right) \cdot (P - 0.74)$, combining the depth of the coal occurrence (H), the firmness index (f), and the seam pressure of gas (P). A given coal seam is classified as endangered with an outburst only when $D \ge 0.25$ and $K \ge 20$.

6. Recapitulation

The analysis of legal regulations which standardize safety means concerning mining activities conducted in areas endangered with coal and gas outbursts, as in force in countries being the world's largest coal extractors, leads to the following conclusions:

The regulations in various European countries reveal a high degree of similarity, which concerns the general concepts on which these regulations were based – as all of them aim to formalize, as much as is possible, the imposed requirements, and determine specific mining parameters, together with their criterial values, on the basis of which coal seams or their parts are classified under particular types of the outburst hazard. A similar approach to the issue of safety in mining, as expressed by means of legislative acts, can be observed in the case of China.

The American and Australian regulations stand in total opposition to the European and Chinese ones. They strongly emphasize the fact that the outburst hazard is local in its nature and, what follows, it is difficult to apply any general procedures in managing this risk, not only on the level of mines, but also on the level of particular excavations. In the light of the Australian regulations, a standardized and unchangeable approach to the risk management is something wrong. The regulations do not provide any specific instructions in this aspect; however, they mention some factors that need to be taken into consideration when developing risk management strategies.

Selected European countries and China apply similar means of categorization of the outburst hazard. Usually, two or three categories of that hazard are specified. It is often the case that a particular coal seam is categorized as one with the highest degree of risk on the basis of outburst occurrences, or symptoms indicating imminent danger.

The main parameter used in the basic evaluation of the outburst hazard is the methane content in a coal seam. It is mentioned by legal regulations in all the discussed countries. These regulations impose specific means of assessing the degree of risk; only the Chinese ones do not obligate mining facilities to investigate the gas content in coal. Instead, they recommend measuring the seam gas pressure.

According to the analyzed regulations, the permissible content of gas in coal is within the 8-10m3/tonne range. However, in case of the Polish regulations, the lower value is recognized as the critical point of this parameter.

The authors believe that the value of the depositional pressure of gas is a crucial parameter of an outburst risk. The parameter may be determined both in direct and indirect methods. The first option is relatively difficult to carry out, while the second one is time-consuming. Despite those difficulties, depositional pressure is used for example in the Czech Republic and China.

The gas and strength parameters used for the current assessment of risk, despite being based on the use of similar physical and chemical processes, are determined by means of different devices, in different time frame, with the use of different grain class etc. Those factors make the comparison inadequate; however, it is necessary to assume that long-standing observations (of many years) of the changeability of the registered parameters which resulted in establishing the proper threshold values, can undoubtedly guarantee a proper level of safety.

In the authors' opinion, Polish regulations give a relatively broad definition of an outburst, describing both the reasons and the course, as well as the result of outburst. Taking into consideration the definitions taken from the official documents of different countries, the Polish one seems to be the most complete and unambiguous. It is hard to judge whether its form is the most appropriate in the act regulating the aspects of a safe exploitation, nevertheless, there is no doubt it does not leave any room for inappropriate classification of an event as an outburst.

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