EMERGENCY PREVENTION AND OCCURRENCE: COORDINATION IN MEASURES FOR COAL MINE SAFETY SYSTEMS

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Risk management, coal mine, methane, preventive measures, compensative measures, coordinating measures, coordination in measures for coal mine safety systems, economic effectiveness safety measures.

Abstract:

The paper describes division of management techniques for methane isolation at coalmines in terms of time and purpose. The paper suggests that forecasting and projecting methane extraction from coal mines being potentially dangerous emergency objects, are the subject of taking into account valuation of economic effectiveness methane extraction at different stages of deposit exploration.. Economic effectiveness will be ensured by coordination of all functional elements in safety systems at all hierarchical levels and various measures through hierarchical levels such as preventive, compensative and coordinating measures. The papers introduces indicators for measure coordination such as indicators for spatial coordination, temporary coordination and overall coordination.

Introduction:

To maximum methane usage and recycling methane degassing facilities are chosen on the basis of creation of whole effective usage assessment system. This system can be created only on the basis of technical and economic classification provides decisions optimization of gas emission control. In this regard commonness element is considered to be an economic element. Entering economic element is possible only on the basis of all coalmine elements.

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A coalmine is an aggregate of interlinked and interdependent varied technological objects of artificial and natural origin involved by people into purposeful activity to extract mineral products in the safety way [1]. The following objects can be regarded to the objects of classification: extraction districts, mine substructure and a whole mine. A coalmine is a potential object of emergency situation.

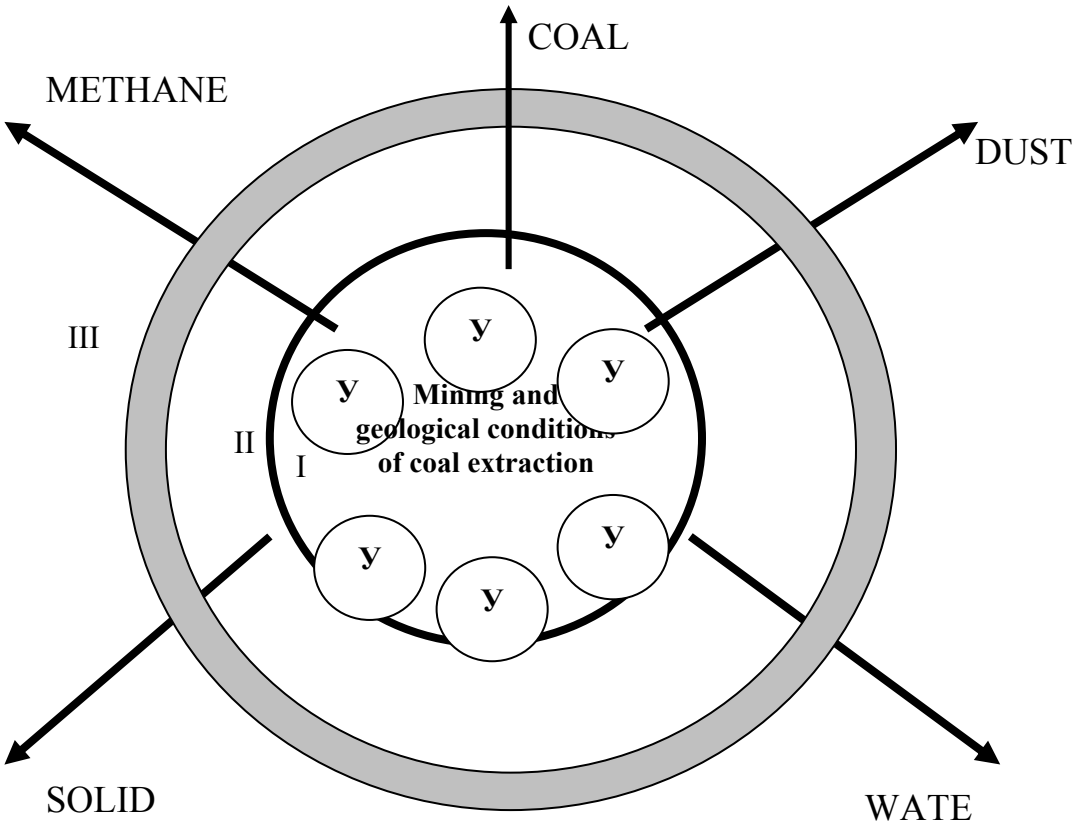

Fig.1 Structure of coalmine

Levels

I – Extracting districts;
II – Substructure of mine;
III – Mine.

To provide maximum economic efficiency of enterprise operating it is necessary to do all-around analysis of methane flows movement (place and time, material and economic balance), their influence on technological and economic efficiency of coal production and provide all economic factors optimization, that in present is absence.

It should be noticed that place and time reduction of methane flows interaction provides not only enterprise functional stability but furthers industrial safety.

As every industrial object a coalmine has several stages: building, starting of designed capacity, operating with minimum load and dismantling.

To estimate gas emission (the methane flow) dynamic we can see step-by-step flow increasing with peak achievement then the period of stable gas emission and after stop of coal extraction graded flow decreasing. Herewith it doesn't depend on the object size (district, limb or mine).

If we look at mine structure (fig. 1) according to the time factor we can see that the extraction districts conform to the short-range planning (till half a year), the mine substructure to medium-term planning (1-2 years) and the mine to long-term planning (5-15 years).

Theory:

According to this approach we should separate degassing methods as shown at figure 2.

Methane flows control at the extraction district is provided by the degassing methods related to the mine workings at one extraction district. And these methods are divided into in-seam, leading and short-range degassing of minor minerals and mined-out place. Under the types measures can be the following: preventive (preventing degassing) and compensative (leading and short-range degassing).

Degassing methods providing gas emission control at the mine substructure are related to the mine workings of two or more extraction districts or functionality time exceeding terms of one district development. Sometimes to these methods integrated degassing can be related (degassing by tabular wells at the hydrodynamical effect zones), mined-out places degassing by off end wells. Integrated degassing and mined-out places degassing measures are related to the compensative measures.

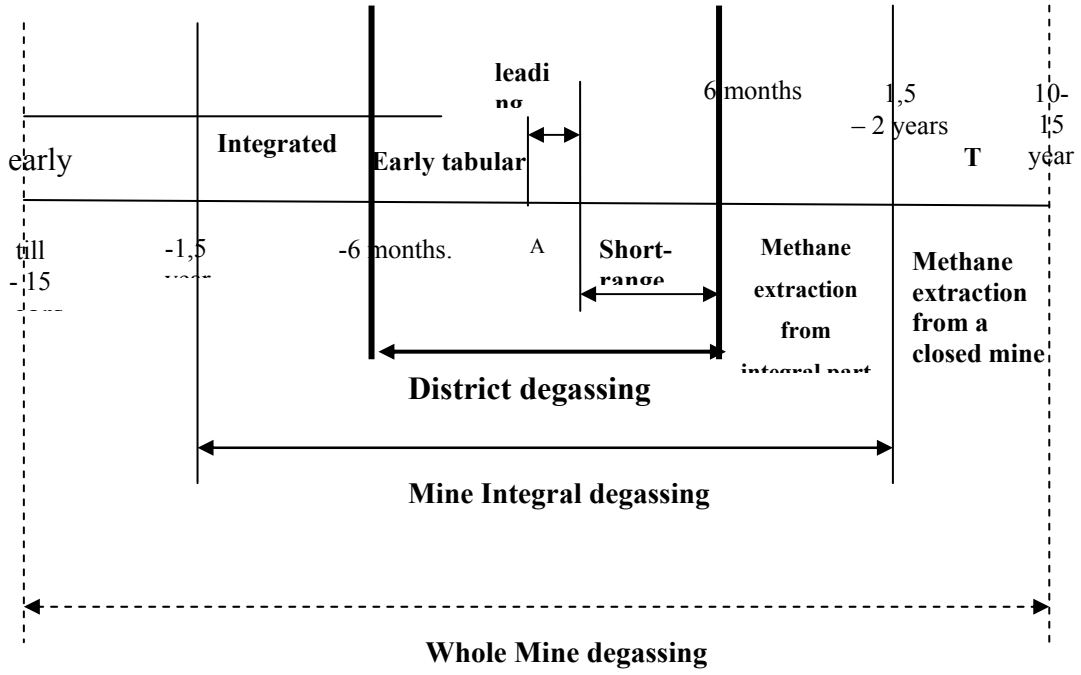

Fig. 2 Degassing methods division under the time factor.

At degassing question consideration we are talking about the regional methods as early degassing preparation of coal layers and methane extraction from the closed mines. (Preventing measures).

It is urgent to mention that in present time the short-range degassing (compensative measures) methods prevail and its tendency of increasing keeps on going. Herewith in spite of high efficiency of short-range degassing existing safety level is not enough. This problem solution (safety and economic efficiency improving) is based on effective gas emission control. An accurate assessment of realization expenses and all economic consequences is one of the required conditions of this control. This assessment accuracy is determined by operations coordination assessment of all safety systems at different hierarchy levels.

After the short-ranged degassing it is possible to refuse layer degassing, fastening rates of preparation workings or load on mining face, etc.

Method

We should use the time factor also for the degassing expenses assessment. Methods of expenses related to the third level (the whole mine) are to consider as capital expenses.

Gas emission control expenses at the first and the second levels should be related to the production cost of appropriate coal extraction. Sum of opportunity loss and all gas emission control measures (considering the time factor) can be used as the basic criteria.

The structural model of coalmine depicted on the figure 1 has the economic classification. The economic classification elements are the following:

1. Production cost of coal extracted

The middle district production cost $\overline{C}_y$, substructure production cost $C_в$, whole mine production cost $C_{об}$

2. Districts income

Each district income D_n и sum of mine incomes D_Σ

3. Expenses

District expenses $З_n$, sum of district expenses $З_{участ} = \sum_n З_n$, $З_{доп}$ - additional substructure expenses, surface expenses $З_{поверх}$, the whole mine expenses $З_{об}$.

Taking into consideration defined parameters we can conclude that coal production efficiency at whole district of coal field will be estimated under the following formula:

$$Э = \frac{Ц\,(V - V_{пот}) - У + \sum D}{\sum к\overline{C}_y + \square C_{вн} + \Delta C_{об}} \qquad (1)$$

$Ц$ - production price (coal) for a consumer rub/тон

$V, V_{пот}$ - real production and loss of coal correspondently, тон/year

$У$ - cost assessment of environmental damage, by the reason of methane emission rub/year.

The formula (1) reflects relation cost of real extracted coal with regard to ecological damage cost to the coal production cost at whole district of mine field. Coal loss means cost of non-extracted coal in consequence of impossibility to extract by the reason of unreduced large amount of methane at the district of mine field. The production cost of coal at whole district is divided into middle-district production cost, substructure production cost and mine production cost. These production costs include preventive measures expenses – initial degassing – which are considered to relate to mine production cost. The compensative measures are the leading and short-range degassing related to substructure and mine cost. The coordinating measures expenses – measures after an emergency situation happened are related to the district production cost.

Efficient expenses control at the different hierarchical levels corresponding to structural model of coalmine attracts reduction whole mine production cost and as consequence increasing in efficiency of a coal mining district. Economic efficiency will be achieved only at the coordinated work of all systems on safety at the different hierarchical levels and at the

coordination through the hierarchical levels of different actions - the preventive, compensating and coordinating measures.

The coordinated work of all systems on a safety at different hierarchical levels is possible at the account of parameters of the spatial, time and general coordination of precautionary compensating and coordination actions.

Analyzing dynamics of the methane emission and considering division of degassing ways in view of the time factor we shall enter the following parameters of measures coordination: the spatial, time and the general coordination.

The spatial coordination parameter of preventive measures:

$$x_V^i = \frac{V^i}{V}$$

- the time coordination parameter of compensative measures:

$$x_t^i = \frac{t^i}{T}$$

- the general coordination parameter

$$x_o^i = 1 - \frac{1 - x_V^i}{1 - x_t^i}$$

V^i - volume of mined out space at the corresponding hierarchical level, м^3 ;
V - general volume of mined out space м^3
t^i - measures duration, mo;
T - average duration of season increasing of water pollution density, mo;

The general coordination parameters within limits of 0 to 1. Sensibility of its changing will depend on the spatial and time coordination parameters. (fig.3)

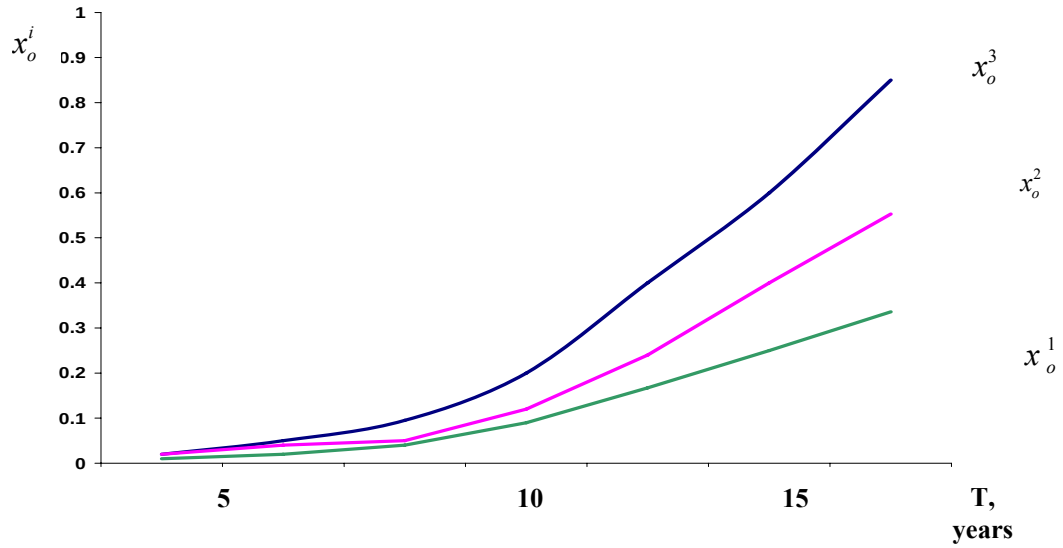

Fig. 3 The general coordination parameters changing.

$$x_V^3 \rangle x_V^2 \rangle x_V^1$$

$$x_t^3 \rangle x_t^2 \rangle x_t^1$$

The methods of gas emission management on a coalmine have precisely traced division on the way and function. As on potentially dangerous object for occurrence of an emergency situation on a coalmine the forecast and designing of methane extraction from coal layers should be made in view of economic efficiency estimation and estimation of spatial, time and general coordination parameters of preventive and compensative measures in time at the different stages of reservoir development.

Results/Conclusion:

1. At consideration of gas emission dynamics (dynamics of methane flow) on a coalmine it is appreciable that without dependence on scale of classification technological object the gradual increase of methane flow with achievement of the maximum point, then the period of stable gas emission and after the end of coal extraction the gradual decrease in a stream are observed.
2. It is necessary to divide the degassing methods according to the approach to mine structure consideration in view of the time factor. Management of a methane flow at the extraction district is provided with the degassing methods directly connected with mining of one production unit. Among them early in-seam, leading and short-range degassing of minor minerals and mined out spaces. According to the types of measures they can be divided into preventive (early degassing) and compensative measures (leading and short-range degassing).
3. It is necessary to approach to the expenses estimation for degassing with consideration of the time factor. So whole mine expenses are expedient for considering as capital expenses for preventive measures. The expenses connected with gas emission control at the district and substructure level should be carried on the production cost of a corresponding coal extraction to consider as the expenses for the compensative measures. The expenses directed on failure consequences liquidation are considered as coordinative measures.
4. The economic efficiency depending on the expenses management will be achieved only at the coordinated control of all systems on safety at the different hierarchical levels and at the coordination through the hierarchical levels of measures: preventive, compensative and coordinative measures.
5. The mismatch of all systems work on maintenance methane safety at all hierarchical levels of the coal mine leads to appearance of potential emergency situations. The account of spatial, time and general coordination parameters of preventive, compensative and coordinative measures will allow coordinating work of all systems.

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