Stimulation of commercial coal seam methane production aimed at improving mining technology

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Abstract. The relevance of the current research is due to the urgent need to revise the existing normative bases and procedures involved in intensive development of coal-methane deposits and commercial production of coal seam methane. The article presents the analysis of data on coal production volume and amount of methane emitted into the atmosphere in Kuzbass. There is a need to develop the exploration techniques that would allow implementing pre-mining gas drainage of coal seams and provide the companies with the guidance on coal seam methane drainage in very gassy coal mines. Commercial production of methane should become an integral part of economy and energy balance of the Russian Federation, which, in its turn, would enhance environmental protection due to reducing methane emissions, the largest source of greenhouse effect.

Introduction

The coal seams play a significant role in methane accumulation within the earth's crust and open up new wide horizons in building up hydrocarbon gas resources. Due to the fact that the Russian Federation (RF) is rich in coal deposits, unconventional sources of hydrocarbons have been neglected. And just recently one can notice a fairly obvious interest towards this sector of petroleum industry and, in particular, to the State balance of methane resources.

The predicted methane accumulation within the basic coal basins of the RF accounts for 83.7 trillion cubic meters, which, in its turn, makes up about one-thirds of Russian natural gas resources. Among coal basins of the RF, a special role belongs to Kuzbass which is proved to be the largest and most studied coal-methane basin of the world. Forecast resources of methane in the basin account for more than 13-20 trillion cubic meters [1].

This estimation of methane resources in coal seams corresponds to the depth of 1800–2000 m and provides a great potential for wide-scale production of methane as an independent mineral resource within Kuznetsk coal basin.

In accordance with the reports of the Kemerovo regional administration, 25 coal pits and open-pit coal mines will be closed down by 2025 [2], with 13 coal mines being closed due to resource depletion, while the rest – due to unprofitability. The coal mines are basically located in Kisilyovsk

and Prokop'evsk. They were constructed in 1920-1940 and characterized by complex rock and geological conditions. Most coal enterprises closed in the 1990s. Those enterprises that still operate just queue to wait for their turn and do not produce anything. In Kuzbass, the total number of coal mines reduced from 86 to 62 between 1996 and 2013. An increase in coal seam gas content was one of the basic causes for closing coal mines.

Today, coal enterprises that operate in Kemerovo Oblast make up 57% of Russia's total coal production. In accordance with the Instruction on Mine Air Content Monitoring, Gas Content Determination and Mine Classification based on Methane and Carbon Dioxide Concentration [3], coal mines are annually classified based on relative gas content. The relative gas content is a volume of gas released during coal mining over a certain period per amount of coal produced over the same period and it is measured in m^3/t [4].

Thus, the coal mines in Kuznetsk coal basin are classified as follows:

- 9 coal mines are referred to I category, with relative gas content being up to 5 m^3/t of average daily production;
- 7 coal mines are referred to II category, 5-10 m^3/t;
- 11 coal mines are referred to III category 10-15 m^3/t;
- 21 very gassy mines, i.e. more than 15 m^3/t or blows;
- 14 mines are classified as dangerous due to methane outburst.

It is worth noting that relative gas content of very gassy mines is sometimes several times higher than that indicated in the classification and it can reach 100 and even more m^3/t.

To ensure safety of coal mining operations, costly and at the same time inefficient technologies to gasify coal seams have to be applied. This makes coal production costs much higher. The violation of dust-gas regulations leads to outbursts in coal mines which, in this case, should undergo complete reconstruction. The emergency response plans of the coal and gas outbursts are commonly rather expensive and time-consuming involving such issues as development and application of gas drainage techniques to control gas emission after complete underground mine reconstruction. Therefore, those mining companies that do not follow the management plans of outbursts in underground coal mines or do not have any opportunities to implement up-to-date gas drainage techniques have to stop mining activity, shut down coal mines or dissolve mining companies. It is due to the fact that production costs do not ensure either loss-free operation of the mining enterprises or safety of mining activity.

Increase in underground coal mining costs caused by high gas content in coal seams inevitably results in reduction of coal production volume. As an illustration, table 1 shows the data on coal production in Kuzbass between 2004 and 2013 based on materials provided by the State Balance of Minerals [5].

Table 1. Data on coal production in Kuznetsk coal basin between 2004 and 2013

Year	Coal production in Kuzbass basin, million tonnes	Proportion of coal production within Kuzbass basin	
		underground mining	surface mining
2004	141	45	55
2005	149	44	56
2006	156	44	56
2007	162	44	56
2008	162	41	59
2009	158	45	55
2010	161	40	60
2011	166	37	63
2012	175	37	63
2013	178	35	65

The data presented in table 1 reveal the increase in coal production over the past 10 years in Kuznetsk coal basin. Due to construction of new mines, the total number of coal mining companies that have to produce coal by underground mining methods because of unprofitable mine liquidation does not significantly decrease.

On the basis of the data presented in table 1, special attention should be paid to the increase in volume of coal extracted by surface mining methods, i.e. up to 65% of total coal production volume in Kuznetsk coal basin. To make it more obvious the data are given as a diagram (figure 1).

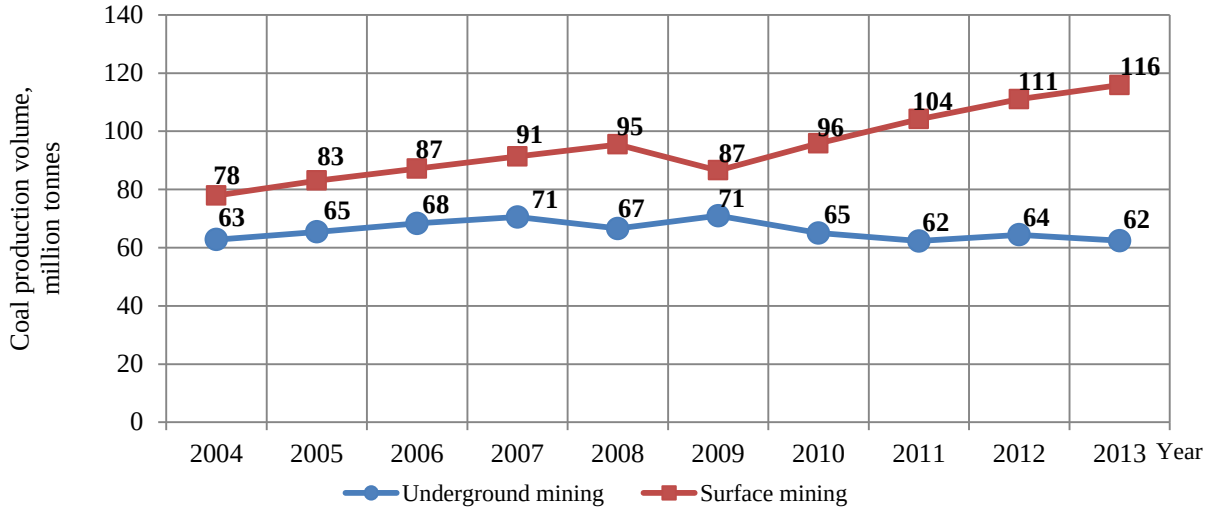

Figure 1. Volume of coal produces by underground and surface mining methods between 2004 and 2013 in Kuznetsk coal basin.

The data illustrated in figure 1 indicate a slight increase in volume of coal extracted by surface mining methods in 2004 in respect to the volume of coal extracted by underground mining methods and steady increase in surface mining over the past 4 years.

For further analysis of coal production volume and methane emission, we collected the data on the amount of methane being emitted into the atmosphere between 2004 and 2014. The data were provided by regional office of the Federal State Statistics Service in Kemerovo Oblast.

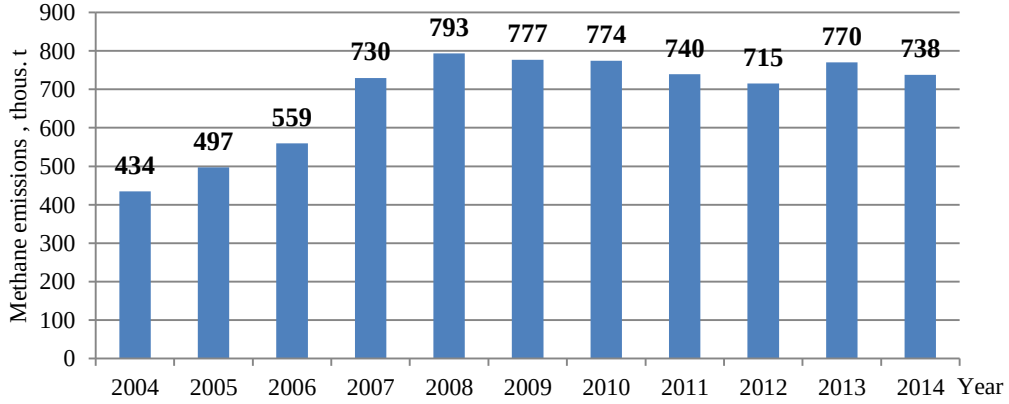

Figure 2 Data on the amount of methane being emitted into the atmosphere between 2004 and 2014 in Kuznetsk coal basin.

Considering the specific features of coal-methane deposits, coal is basically extracted by surface mining methods in gas weathering zones. Therefore, figure 3 presents the comparative analysis of volume of coal extracted by underground mining methods and amount of methane being emitted to the atmosphere.

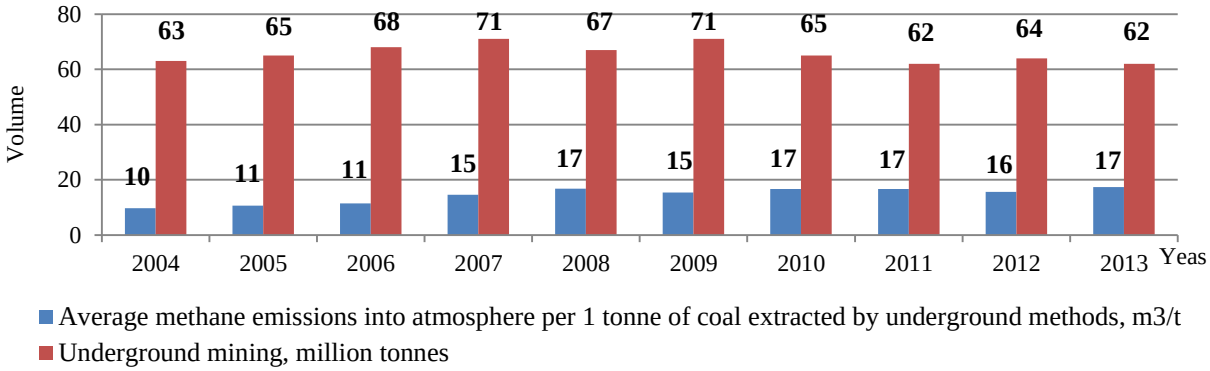

Figure 3 Methane emissions per 1 tonne of coal extracted by underground mining method.

As apparent from the data shown in figure 2, the amount of methane emitted into the atmosphere has increased since 2008. Despite reduction in underground coal production, average number of methane emissions per a tonne of extracted coal is 17 m^3/t. This proves the urgency of the issue concerning increase in coal mine gas.

This situation has been actively discussed at various levels of public authority. In 2014, the government of the RF approved the Coal Industry Development Program up to 2030 [6].

The program is aimed at ensuring high-efficient operation of coal mining industry due to the following steps: complete modernization of Russian coal industry, implementation of up-to-date coal production technologies, development of new coal mining activity centers and complexes intended to convert coal into products with the high share of added value, implementation of the already taken decisions of federal executive authorities on technical, social, and environmental issues related to liquidation of unprofitable underground and open-pits mines and reestablishment of safe living conditions for local civilians.

The program also implies construction of new coal mines. It is worth noting that application of various gas drainage techniques is the only way to provide safe coal mining activity at depth greater than 500 meters, with gas content being 20-30 m^3/t when reported on a dry, ash-free basis. In this context, implementation of pre-mining gas drainage and utilization would ensure the safety of further coal production and reduce methane emissions.

In accordance with the data presented in figure 2, annual emissions of coal mining companies reached 434 thousand tonnes in 2004, while in 2014 – 739 thousand tonnes. Therefore, it is possible to conclude that the amount of methane being emitted into the atmosphere has risen by 70 % over the past 10 years. This proves the urgency of selecting more appropriate coal production method in coal mines characterized by high gas content.

The standard tax rate per tonne of methane within the established standards for permissible emissions is 50 rubles, within the established limits for emissions – 250 rubles [7]. It is noteworthy that the tax on methane emissions into the atmosphere has remained constant for more than 10 years. Due to the growth rate of methane emissions and corresponding increase in coal production costs, the tax reduction is not foreseen. However, the tax rate does not ensure safety of coal mining and guarantee shut-down free operation of high gassy coal mines.

Today, within the program of integrated development of Kuzbass coal deposits, gas drainage is carried out in the following coal mines: “Taldinskaya-Zapandnaya-1,2”, “Kotinskaya”, “7th November”, “Kirova”, “Komsomolets”, “Polysaevskaya”, “Mine named after Lenin”, “Chertinskaya-Koksovaya”, “Mine № 7”. Most of the enumerated coal mines are operated by OJSC SUEK (OJSC Siberian Coal Energy Company)-Kuzbass [8]. In the above-mentioned coal mines, methane is basically extracted and utilized in development and production headings, i.e. directly during coal production. Therefore, the applied technologies have nothing in common with pre-mining gas drainage.

Geographically, coal-rich regions are located a significant distance from natural gas deposits. The designated purpose of wide-scale coal-seam methane production is to supply coal-mining regions of the RF with their own local gas. Being an alternative to natural gas, methane is more available, much cheaper, and more environmentally friendly among most known gases. The coal production costs

would reduce up to 30 % if coal mining companies are provided with heat and power generated from coal seam methane.

To provide commercial methane production in Kuzbass, in 2001 the RF developed and approved the program "Hydrocarbon Production in Kemerovo Oblast".

Gazprom Dobycha Kuznetsk is the license owner entitled to operate a test site in Taldinskoye and Haryksko-Ostashkinskoye areas. The company has already produced almost 40 million m^3 of coal seam methane, in 2014 – 12 million m^3. Today, the production rate is 1.2 million cubic meters per month.

In Russia, coal seam methane reserves were first proved in May, 2011(protocol № 2420–dsp of the State Committee for Mineral Reserves in south-east area of Taldinskoye coal-methane deposit [9].

Based on the results of Taldinskoye and Haryksko-Ostashkinskoye site development, it is planned to elaborate legal and regulatory basis to carry out geological study of gas content in coal seams during the exploration stage, to develop methodology to assess geological and recoverable methane reserves and resources and provide the guidance on pre-mining methane drainage and integrated coal-methane deposit development in order to ensure rational use and preservation of mineral resources.

Experience of such countries as USA, Australia, and China shows that wide-scale production of coal seam methane was launched, especially after the Government of these countries began to support the projects by providing the companies engaged in coal seam methane production with significant tax breaks [10].

Implementation of the above recommendations obviously requires significant state support. In Russia, in order to stimulate coal seam methane production, a number of tax breaks have been adopted.

In Kemerovo Oblast, the Congress of People's Deputies adopted tax relief Act N 5-OZ dated 28 January, 2010 "Tax Relief for the Residents of Industrial Clusters and Entities Involved in Investment Activities Engaged in Coal Seam Methane Production in Coal Deposits of Kemerovo Oblast" [11].

Precisely, under article 3 of the above Act, the residents of the industrial clusters and entities involved in investment activities are granted with the following tax concessions:

- the corporate income tax rate to be paid to the regional budget has been reduced from 18 % up to 13.5 %;
- the property tax rate has been reduced from 2.2 % up to 0 %.

In order to ensure coal mine safety, the Government of the RF has granted the companies with tax relief and abolished mineral extraction tax introducing zero import customs duties rates in respect of unique individual types of components parts and parts needed for gas drainage and methane production [12].

Federal Act No. 425-FZ of 28 December, 2010 amended the Russian Tax Code [13]. Under article 325.1, taxpayers are provided with a tax deduction in terms of mineral extraction tax reduction by cost value that is related to provision of coal mining safety, especially in the sites characterized by high gas content and coal seams prone to spontaneous ignition.

Taxpayers may spend the savings from tax deduction as they determine or consider the corresponding costs in calculating the taxation base for the income tax. These amendments have been in force since 1 April, 2011. Besides, article 343.1 amends the procedure of reducing coal severance tax due to the costs related to providing safe working environment.

Pursuant to Federal Act N 278-FZ of 29 December, 2012 on Amendments to Articles 336 and 337, coal seam methane is regarded as independent mineral resource. Moreover, in accordance with Article 336, paragraph 2, coal seam methane is not recognized as an item of taxation. The amendments significantly stipulate coal seam methane production on an industrial scale and provide the basis for coal mine safety due to implementation of various gas drainage techniques [14].

Conclusion

Taking all those considerations into account, therefore, it could be said that there is an urgent need to revise the procedure of underground coal mining in terms of coal seam production. With favorable conditions provided by the RF Government, there is an impetus to the development coal seam methane production on an industrial scale in order to provide coal mine safety. At the same time, the current legislation system does not provide coal-mining companies with exemption from paying for methane emissions, which, in its turn, encourages companies to reflect on their own attitudes towards methane.

Research-and-development organizations and subsurface users are currently implementing the plans for integrated development of coal-methane deposits.

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