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Capture and utilization of methane from mines to ensure the safety, consumption and reducing of greenhouse gas emissions

Baimukhametov S.K. - Doctor of Technical Sciences, Professor, Advisor for Development and Modernization of the Coal Division of JSC "ArcelorMittal Temirtau"

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Dear ladies and gentlemen!

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Karaganda coal basin is one of the most gas containing ones world wide. Traditionally Karaganda– is the center of coal production by underground method and supplier of high quality coking coals for metallurgist of Kazakhstan, Russia, Ukraine.

The major limiting factor which unable to increase coal production volumes and development operation rates (drifting operations)– is a gas factor. This is why since 60th of previous century works on degassing of coal seams and mines being carried out constantly.

There are some achievements and improvements, however the problems are still not resolved completely.

It is necessary:

- Reduction of seams' gas containing down to 10 m^3/t. in 2 times
- Ensuring of equal degassing of coal seams along the area
- Reduction of greenhouse gas emissions and utilization of methane as secondary resource for heating and generation of electric power

In developing of these seams at a depth of over 500 meters natural methane content reaches 20-25 m3/t, and the absolute methane content of excavation sites reaches 120-150 m3/min.

Coal division includes eight coal mines that produce annually about 11 million tons of coal.

In the depths of the current development (500-700 meters), coal seams have very low gas permeability (1,5x10-2 mD). Loads on the production faces, on average, do not exceed 3000-4000 tons per day.

The maximum rate of development roadways heading in outburst seams does no increase 25-80 meters per month, due to the need to conduct blowout events.

To reduce the gas content of coal seams in Karaganda basin a complex of degassing measures is applied, such as:

- Advance degassing of coal seams by creating artificial fractures in the seam (DHFS - directed hydrofracturing of seams) 7-8 years before the start of mining operations.

Unfortunately, this method does not completely provide the required reducing of gas content in the coal seams, and proportional reducing of gas content in the mined seam, due to the mismatch of the used equipment to the mining and geological conditions.

Application of the method of advance degasification by drilling of directional wells from the surface, as in other countries, has not yet found a use in the basin. Tests for permeability of coal seams which were conducted in the mines of the Karaganda coal basin showed a very low permeability.

Therefore the problem of advance degasification of coal seams of the Karaganda basin at depths more than 600m remains relevant.

We hope for a positive result of the experiment being carried out by KazTransGas company on determination of possibility of industrial production of methane with involvement of advanced technologies.

Another way to reduce the gas content of coal seams is a preliminary degassing by drilling of wells in coal from underground roadways.

The existing technology of conducting such work, with degassing period longer than one year helps to reduce the gas content of coal seams by only 15-20%, when required by 50%.

As a rule, by degassing of excavation sites different methods are used, but at the same time there are cases when it is not possible to achieve the desired result due to the geological characteristics of excavation sites or lack of effectiveness of methods applied.

All this forces to conduct searches on improving of existing methods and developing of new more effective ways of degassing.

As shown by theoretical studies and by practice of mining operations in the Karaganda coal basin, the greatest effect of reducing of gas content in coal seams is achieved by unloading it from the rock pressure.

Using this effect, in some mines of coal division the method is applied of undermining of the most gas-bearing coal seam K12 with K10. Thus, the gas content of seam K12 is reduced by more than 80% and almost all problems associated with gas are eliminated. However, geological conditions where it is possible to use this technology is limited.

When heading roadways in outburst coal seams to prevent sudden coal and gas blowout, for each meter of development from 17 to 20m unloading wells are drilled and up to 60 m - in the area of geological faults.

Drilling of exploratory and unloading wells with a purpose to survey the areas of geological faults takes from 50 to 70% of the development cycle time that prevents the increase in the rate of development.

In specially high outburst seam D6, the rate of roadway heading in coal ranged from 25 to 40 m/month, and did not provide timely generation of production faces.

To solve this problem, in the development of mine roadways of seam D6 the technology was introduced of preliminary development of roadways in rock at a distance of 8-12m below of the seam; and using the effect of unloading of the seam D6 from the rock pressure to conduct its degassing in the area of developed roadway; it has increased the rate of development up to 100-120 m per month and will ensure the timely preparation of production faces and will completely eliminate the risk of sudden coal and gas outburst. Incremental cost of tunneling of roadways in rock is compensated by the timely start of production faces. It was purchased and is being introduced the drilling rig VL-1000 of Australian company for directional drilling of wells up to 1000 meters from underground roadways. This machine allows to track the trajectory of well drilling. Unfortunately, experience in Kuzembaeva mine showed that drilling can be carried out only in rock, and in soft packs of coal drilling is impossible.

These innovative technologies of mining of coal seams with high gas content and low permeability allowed to increase the rate of roadway development up to 150-200 meters per month and to increase the daily load for longwall up to 5 000 tons per day.

In mines of CD JSC "ArcelorMittal Temirtau" emphasis is made on utilization of methane after degassing of mines. In 4 mines methane is used to generate heat in the winter period.

In 2013 it was launched a pilot plant for electricity generation using of coal mine methane, with capacity of 1.4 MW.

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Operation of the generator at the mine methane showed its stable operation and coverage of up to 20% of one mine's power consumption.

Based on mentioned above corporate office took a decision to involve investors in order to generate power on mine methane up to 20mW. A tender was held and company was selected. But 3 years passed, and contract with investors was not concluded so far.

A pilot project has fully paid back within 3 years and now it is working for a profit. Calculations are showing that for generation of electrical power for 1mW it is necessary to purchase a generator and auxiliary equipment for amount of 1 MIO USD approximately and 7 m^3/min of methane. Assembling and commissioning of the generator requires not more than 3 months. We are discharging more than 100 m^3/min of conditioned methane to atmosphere, and with some efforts from mine we can increase this figure.

Unfortunately due to limitation of investments during a crisis CD has no possibility to purchase generators running on mine methane.

Therefore it is necessary to determine following on the level of corporate: either to involve investors as soon as possible or to allocate specific annual investments in CD for purchase of 2-3 generators and electric transformers for generation of electrical power on mine methane. Second option is more preferable from our point of view.

It will allow to improve both economic performances and to reduce greenhouse gas emissions.

In 2014 Coal Division have carried out the process of verification and got greenhouse gases emission quota for 2015. We do not feel any effects in terms of greenhouse gas regulation, since CD does not experience any significant benefits or losses due to reduction of greenhouse gasses emissions. To increase the volume of methane utilization (reduction of emissions) it is necessary to have mechanisms of economical incentive, since methane utilization is not our core business. All projects on electric and heat power generation on coalmine methane are on the verge of return on investments and they did not have any return.

What is further necessary to undertake

For full utilization of methane's energy resources, which appears in a process of mining operations it is necessary:

I. To develop the economically effective technologies of low concentration methane utilization.

II. Technologies of enrichment of methane with concentration from 4 to 25%.

Gas balance of excavation sites

In mines of CD, JSC AMT, with coal production of about 11 million tons a year it is emitted to 300 million cubic meters of methane. Including:

- Approximately 200 million m3 (i.e. about 70%) is Ventilation Air Methane with concentration of 0.2 to 1%
- About 50 million m3 (15%) - substandard methane recovered through degassing methods, with a concentration of 4 to 25%
- About 50 million m3 (15%) – conditioned CMM with a concentration greater than 25% , which is suitable for utilization by industry.

Today about 20% of conditioned methane is used to generate electricity and heating in mines during winter

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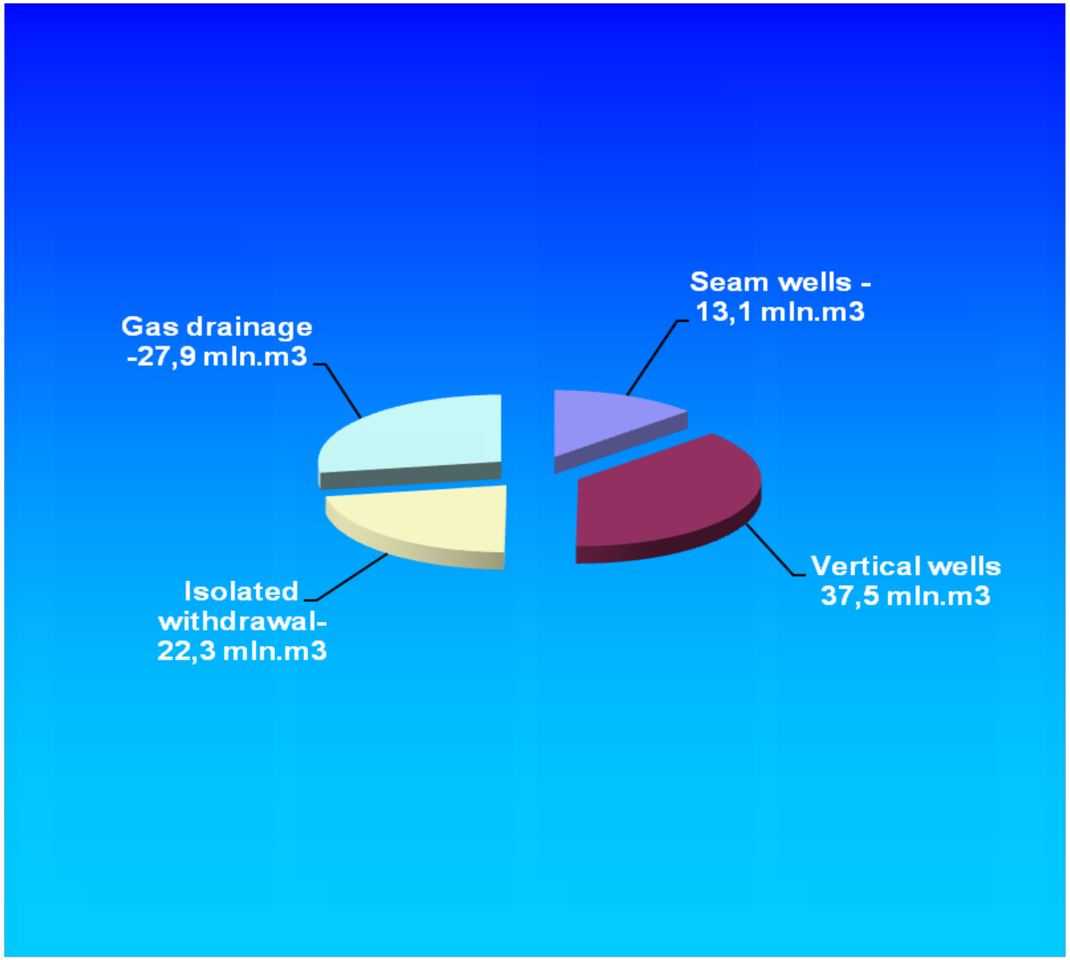
Plant for methane utilization

Currently, boiler rooms of mines of Coal Division: Lenina mine (2 boilers SMTS-10), "Abaiskaya" mine (1 boiler SMTS-10), "Shakhtynskaya" mine (2 boilers UPNV-4) were converted to be run on methane. The total capacity of boiler plants on methane is 38 Gkal/h.

Projected volumes of methane capture from mines of Coal Division in 2015



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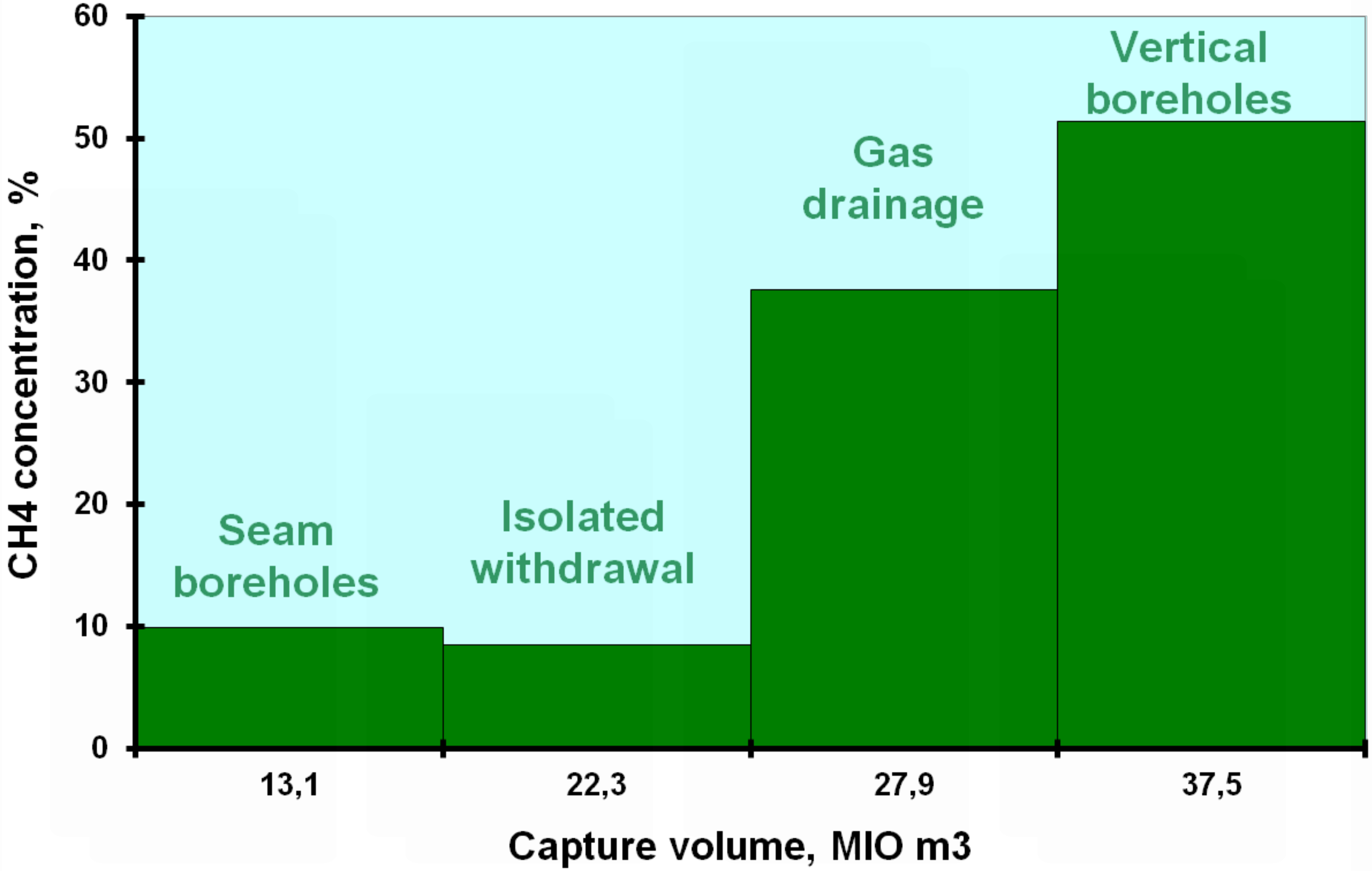
Expected weighted average concentration of methane in mines of CD in 2015 from various sources of methane



Lenina mine

Boiler room was converted to gas – methane in 1997.

Boilers KVTS- 10 – 2 units.

Gas consumption of 1 boiler – 20 m^3/min

For 2015

-It was utilized in boiler room 5,2 mln. m^3 of methane, what is equal to 5,4 thous. t. of coal, Emissions of CO_2 were reduced by 0,07 mln. t., or by 19,4 thous. t. in carbon dioxide equivalent

«Shakhtinskaya» mine

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-Boiler room was converted to gas - methane in 2002
2 boilers UPNV- 4

Gas consumption by 1 boiler – 10 m^3/min

For 2014
was utilized 1,8 mln. m^3 of methane, what is equal to 2,8 thous. t of coal,
Emissions of CO_2 were reduced by 0,03 mln.t., or by
7 thous. t. in carbon dioxide equivalent

«Abaiskaya» mine

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-Boiler room was converted to gas – methane in 2003.

Boiler KVTS- 10

Gas consumption of boiler – 20 m^3/min

For 2014
- in the boiler room was utilized 2,6 mln. m^3 of methane, what is equal to 4,0 thous. t. of coal, emissions of CO_2 were reduced by 0,04 mln.t., or by 10 thous.t. in carbon dioxide equivalent

Gas generation plant, using methane for power generation in Lenina mine

For 2014

-gas generation plant utilized 3,2 mln.m^3 of methane

Thanks for your attention