Determination of methane content and methane released when exploiting longwall at different levels at 13.2 seams, Khe Cham coal mine, Vietnam

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Abstract. Khe Cham coal mine is managed by Ha Long Coal Company - TKV. Currently, Khe Cham coal mine is exploited from the ground up to - 350 and is ranked III for methane. In 2008, a methane explosion at -168 level of the 13.2 coal seam of Khe Cham coal mine occurred, injuring 16 people and killing 8. In order to avoid gas explosions at mines like 2008, it is necessary to have appropriate solutions to eliminate methane accumulation in the pit paths. We have studied to determine the relationship between the level of methane emissions with the methane content in the coal seam and the bazaar's mining output because of the methane content in the coal seam and coal mining output. These are the two factors that greatly affect the release of methane from the longwall. The paper used practical measurement, sampling, and analysis methods to determine the level of methane emissions from longwalls at different extraction levels of the 13.2 coal seam and determine the relationship between the methane drainage and the methane content in the coal seam and the exploitation output of the longwall. This relationship is expressed by the equation $y = a.x^2 + b.x + c$ (Fig. 2 and Fig. 3). The results will help with planning for mining and have specific solutions for diluting methane in the mine's pit lines

1 Introduction

Khe cham underground coal mine is located in MongDuong town, CamPha city, Quang Ninh province, Vietnam. The North, it borders on Duong Huy commune; The East, it borders on Quang Loai, Mong Duong commune; + The South, it borders on KheSim, Coc Sau, Deo Nai, Lo Tri; The West, it borders on KheTam coal mine Do not add any page numbers.

Table 1. Geographical coordinates of Khe cham coal mine

N₀	Name of mine	Coordinates		Z: Deep level (m)	Acreage (km²)
		X	Y		
1	**Khe cham**	30 203	425 111		
2		30 575	426 528	+32 level to	5,6

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3		31 000	427 999	-1000 level	
4		30 965	428 928		
5		30 295	429 164		
6		30 116	429 289		
7		29 998	429 244		
8		30 000	429 025		
9		29 703	428 894		
10		29 496	428 669		
11		29 270	428 670		
12		28 710	428 381		
13		28 189	428 657		
14		28 405	428 251		
15		28 516	427 983		
16		28 543	427 598		
17		28 669	427 363		
18		29 041	427 205		
19		29 108	426 928		
20		29 565	426 639		
21		29 825	425 735		
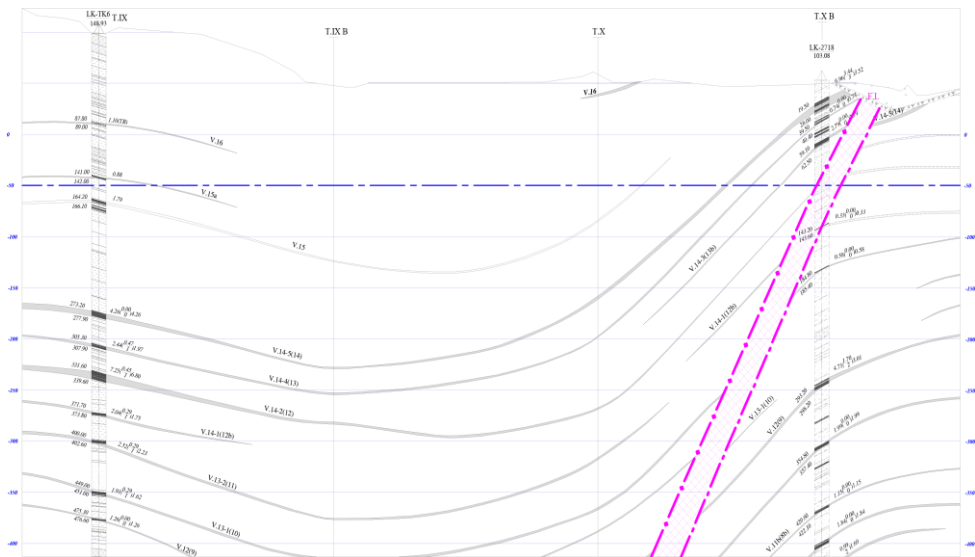
Fig 1. Geological section of Khe Cham coal mine.

Based on the results of determining the% content of gases, the natural gas content of coal seams in Khe Cham mines, regulations on gas zoning according to the "Guidance on the method of document collection in the search - exploration, and mining, in 2002 of Vietnam Coal Industry Group - Minerals, Khe Cham 1 mines exist three gas zones, as follows:

The Nitrogen-Methane Zone: mainly distributed from the surface up to + 40m; The methane-nitrogen zone: mainly distributed from + 40m to -150m.

The Methane zone: mainly distributed from -150 and below. In some places like Cao Son, the surface of the floating methane zone is up to + 50m, in the South of Da mai subdivision at -50m and gradually raised to + 50m in the southwestern part of the mine. In the part of Khe Cham, the methane zone is at -100m and sinks up to the Northwest.

2 Characteristics of the methane content of Khe Cham coal mine

Survey measurement data on the gas content of coal seams at different levels, the monthly coal mining output, and the ventilation of the longwall at coal seam 13.2 of Khe Cham coal mine 1 are presented at The following tables: 13.2-2 longwall (-25/-55 level), 13.2-5 longwall (-55/-100 level), 13.2-4 longwall (-100/-125 level), 13.2-6 longwall (-120/-140 level), 13.2-5 longwall (-140/-168 level), 13.2-6 longwall (-70/-198 level), 13.2-7 longwall (-195/-210 level) [1]

At the coal seam 13.2, there are 7 longwalls with different levels from -25 to -210 during 10 years. We have synthesized the measurement data of methane release at the times of each longwall when the extraction took place.

The methane concentrations in coal seams were sampled at seam 13.2 and brought back to the lab for VARIAN gas chromatography analysis. The methane content results at different levels of coal seams 13.2 are presented in tables 2, 4, 6, 8, and 10.

The wind flow in the tunnels of mine (Q) and methane concentrations in the airflow (C) were measured directly at the mine's tunnels.

The absolute methane release (I) is determined by the following formula: [2]

$$I = \frac{Q.C}{100}, \ \text{m}^3/\text{min} \qquad (1)$$

The relative methane release (I) is determined by the following formula: [3]

$$q = \frac{I.N.24.60}{A}, \ \text{m}^3/24\text{h} \qquad (2)$$

Measurement and calculation results are shown in tables 3,5,7,9 and 11

Table 2. Methane content in coal seams at 13.2-2 longwall (-25/-55 level)

N_0	Sample survey location	The depth of the longwall, m	Methane content (m^3/Tkc)
1	13.2-2 longwall (-25/-55 level)	-55	1.3
2	13.2-2 longwall (-25/-55 level)	-30	1.15
3	13.2-2 longwall (-25/-55 level)	-27	0.9
4	Average methane content		1.1

Table 3. Results of the calculation of the methane release of 13.2-2 longwall (-25/-55 level),2014

N_0	Parameter	Jun	July	Aug	Sep	Oct	Nov	Average
1	Quantity, A (tons/month)	13000	12500	14300	12300	14500	14000	13433
2	Number of working days per month, N (24h)	24	27	28	27	28	26	26.67
3	Flow Q (m^3/min)	549	742	830	710	828	830	748.17
4	Methane content in airflow CH_4 C (%)	0.082	0.05	0.056	0.049	0.064	0.058	0.05
5	Absolute methane releases I (m^3/min)	0.4502	0.371	0.465	0.348	0.5299	0.481	0.44
6	Relative methane release, q (m^3/24h)	1.20	1.15	1.31	1.10	1.47	1.29	1.25

Table 4. Methane content in coal seams at 13.2-5 longwall (-55/-100 level)

N_0	Sample survey location	The depth of the longwall, m	Methane content (m^3/Tkc)
1	13.2-5 longwall (-55/-100 level)	-95	2.35
2	13.2-5 longwall (-55/-100 level)	-75	2.15

3	13.2-5 longwall (-55/-100 level)	-73	1.6
4	13.2-5 longwall (-55/-100 level)	-58	1.32
5	Average methane content		1.82

Table 5. Results of the calculation of the methane release of 13.2-5 longwall (-55/-100 level),2015

N_0	Parameter	Jun	July	Aug	Sep	Oct	Nov	Average
1	Quantity, A (tons/month)	14534	15568	13424	16394	14562	12689	14528
2	Number of working days per month, N (24h)	24	28	26	28	27	28	26.83
3	Flow Q (m^3/min)	420	476	425	530	470	410	455.17
4	Methane content in airflow CH_4 C (%)	0.35	0.33	0.28	0.32	0.28	0.23	0.31
5	Absolute methane releases I (m^3/min)	1.47	1.5708	1.19	1.696	1.316	0.943	1.36
6	Relative methane release, q (m^3/24h)	3.50	4.07	3.32	4.17	3.51	3.00	3.59

Table 6. Methane content in coal seams at 13.2-4 longwall (-100/-125 level)

N_0	Sample survey location	The depth of the longwall, m	Methane content (m^3/Tkc)
1	13.2-4 longwall (-100/-125 level)	-125	2.6
2	13.2-4 longwall (-100/-125 level)	-110	2.5
3	13.2-4 longwall (-100/-125 level)	-120	2.33
4	13.2-4 longwall (-100/-125 level)	-100	2.212
5	Average methane content		2.41

Table 7. Results of the calculation of the methane release of 13.2-4 longwall (-100/-125 level),2016

N_0	Parameter	Jun	July	Aug	Sep	Oct	Nov	Average
1	Quantity, A (tons/month)	13475	13542	16479	15820	12000	17489	14800
2	Number of working days per month, N (24h)	27	25	28	28	22	28	26.33
3	Flow Q (m^3/min)	648	654	710	788	625	780	700.8
4	Methane content in airflow CH_4 C (%)	0.25	0.27	0.32	0.24	0.26	0.32	0.25
5	Absolute methane releases I (m^3/min)	1.62	1.77	2.27	1.89	1.63	2.50	1.95
6	Relative methane release, q (m^3/24h)	4.67	4.69	5.56	4.82	4.29	5.75	4.97

Table 8. Methane content in coal seams at 13.2-6 longwall (-125/-168 level)

N_0	Sample survey location	The depth of the longwall, m	Methane content (m^3/Tkc)
1	13.2-6 longwall (-125/-168 level)	-168	3.101
2	13.2-6 longwall (-125/-168 level)	-162	2.91
3	13.2-6 longwall (-125/-168 level)	-155	2.72

| 4 | 13.2-6 longwall (-125/-168 level) | -130 | 2.6 |
| 5 | Average methane content | | 2.88 |

Table 9. Results of the calculation of the methane release of 13.2-6 longwall (-125/-168 level),2017

N_0	Parameter	Jun	July	Aug	Sep	Oct	Nov	Average
1	Quantity, A (tons/month)	14733	15241	15365	14986	16892	14628	15307
2	Number of working days per month, N (24h)	27	26	27	26	28	26	26.67
3	Flow Q (m^3/min)	821	798	808	812	784	780	800.5
4	Methane content in airflow CH_4 C (%)	0.24	0.27	0.26	0.24	0.32	0.26	0.28
5	Absolute methane releases I (m^3/min)	1.970	2.154	2.101	1.948	2.508	2.028	2.12
6	Relative methane release, q (m^3/24h)	5.20	5.29	5.32	4.87	5.99	5.19	5.31

**Table 10.** Methane content in coal seams at 13.2-6.1 longwall (-170/-198 level)

N_0	Sample survey location	The depth of the longwall, m	Methane content (m^3/Tkc)
1	13.2-6.1 longwall (-170/-198 level)	-195	4.148
2	13.2-6.1 longwall (-170/-198 level)	-180	3.807
3	13.2-6.1 longwall (-170/-198 level)	-175	3.607
4	13.2-6.1 longwall (-170/-198 level)	-170	3.421
5	Average methane content		3.78

**Table 11.** Results of the calculation of the methane release of longwall (-170/-198 level), 2018

N_0	Parameter	Jun	July	Aug	Sep	Oct	Nov	Average
1	Quantity, A (tons/month)	17322	18638	18275	18841	18436	17441	18158
2	Number of working days per month, N (24h)	27	28	27	28	28	26	27.33
3	Flow Q (m^3/min)	842	1044	986	1021	1112	876	980.1
4	Methane content in airflow CH_4 C (%)	0.24	0.28	0.29	0.32	0.27	0.26	0.25
5	Absolute methane releases I (m^3/min)	2.021	2.923	2.859	3.267	3.0024	2.277	2.73
6	Relative methane release, q (m^3/24h)	4.54	6.32	6.08	6.99	6.57	4.89	5.90

To determine the relationship between the emitted methane concentration and the methane content in the coal seam and the mining output of the 13.2 coal seam at Khe Cham 1 coal mine, we used Microsoft Excel software to build the chart variation in production and methane emissions according to each mining month of each long wall. [4]
From there, determine the regression function showing the variation in yield and methane release, and at the same time build a chart showing the relationship between methane content and methane emissions [5]
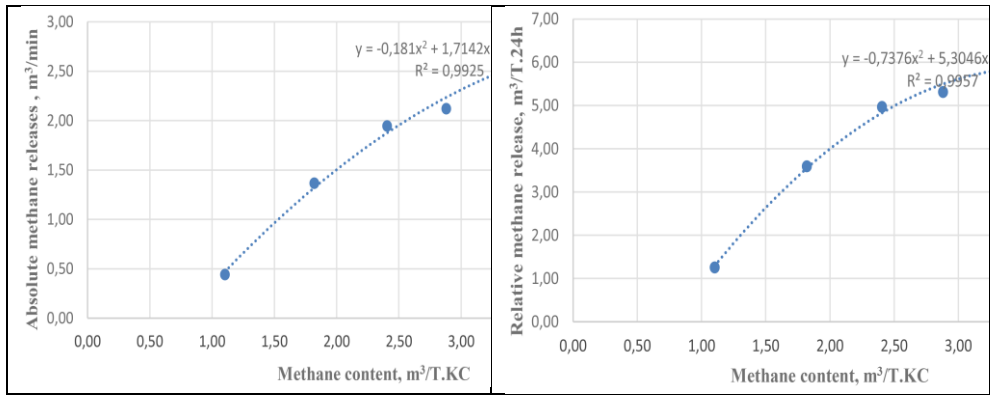
Fig 2. the relationship between the methane content and the methane release of longwalls in the 13.2 coal seam
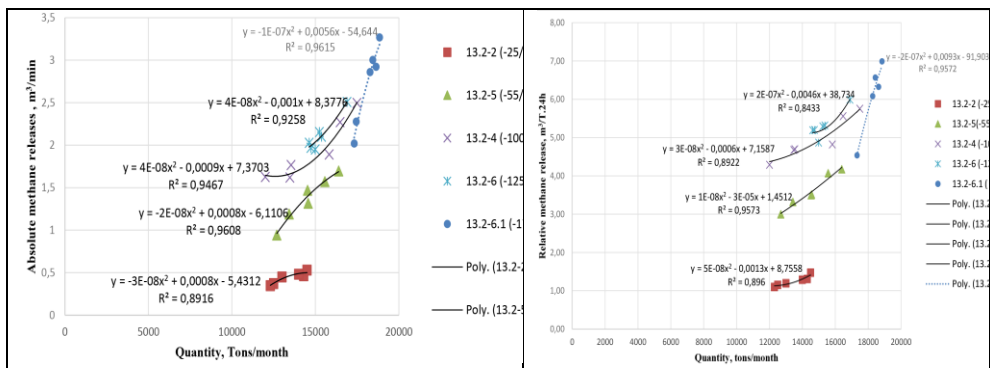
Fig 3. the relationship between the quantity and the methane release in the longwalls of the 13.2 coal seam

3 Conclusion

Analyzing the effect of the methane content of coal seams on the absolute and relative methane gas release, we can confirm that:

1. The absolute methane clearance increases and decreases in accordance with the tendency of the increase and decrease of the storage capacity methane gas in coal seams.
2. Relative methane emissions also increased or decreased proportionally with an increase or decrease in coal seams' methane concentrations.

In the same long wall, when production increases, absolute methane release increases, and when production decreases, absolute methane release decreases. Thus, the absolute methane emissions increase and decrease in the same direction as the longwalls' output.

In the same long wall, when the output of a longwall is increased, the relative methane release decreases, and when the output of the longwall is reduced, the relative methane release increases. Thus, the relative increase in methane emissions in the opposite direction of the increase and decrease of longwalls output.

Acknowledgments

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