Determination of methane content at Maokhe coal mine from curent mining to -450 level in Vietnam

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Abstract. Methane gas is one of the most serious dangers of underground coal mining as its buildup can lead to methane gas explosion. In QuangNinh province- Vietnam, several coal mines such as TrangKhe II-III coal mine, Khe Cham coal mine, especially MaoKhe mine that have high methane content. At the MaoKhe coal mine,experimental data showed thatthe concentration of methane in coal seams at different depths were not similar.In order to ensure safety, this report has been undertaken to determine a pattern of changing methane contents of coal seams at different exploitation depths in MaoKhe underground coal mine.

1. Introduction to Maokhe underground coal mine

Maokhe underground coal mine is located in DongTrieu town, Quang Ninh province, Vietnam
+ The North, it borders on TrungLuong commune
+ The East, it borders on PhamHongThai commune
+ The South, it borders on 18A road
+ The West, it borders on KimSon commune
Geographical coordinates of Quang Hanh coal mine:
From $106^0 33^{'} 44^{''} \div 106^0 30^{'} 27^{''}$ North latitude
From $21^0 02^{'} 33^{''} \div 21^0 06^{'} 15^{''}$ East longitude
The expected output of MaoKhe underground coal mine in 2019 is 1 600 000 tons/year.

At the moment, Maokhe underground coal mine is mining at level -250 and this mine is digging tunnel vertical tilt from level +56 to level -450.

It is therefore necessary to determine the methane content of the coal seams from level -150 to level -450 of MaoKhe underground coal mine.

2. Coal sampling and methane gas analysis sequense

Take the coal sample from boreholes drilled into the coal seams at a depth of 4.5 m and put into steel containers, with tightly covered lid.

Samples of coal are fed into a vibrating shaker inMine safety center- Vinacomin's laboratory to crush the sample by the impact of steel balls. Then introduced into the

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vacuum gas separation system to separate the gas and determine the volume of gas (Fig 1). The extracted gas composition was analyzed by VARIAN gas chromatography. Analysis results from the VARIAN machine will determine the volume of methane gas from each sample of coal (Analysis results are presented in Section 3).
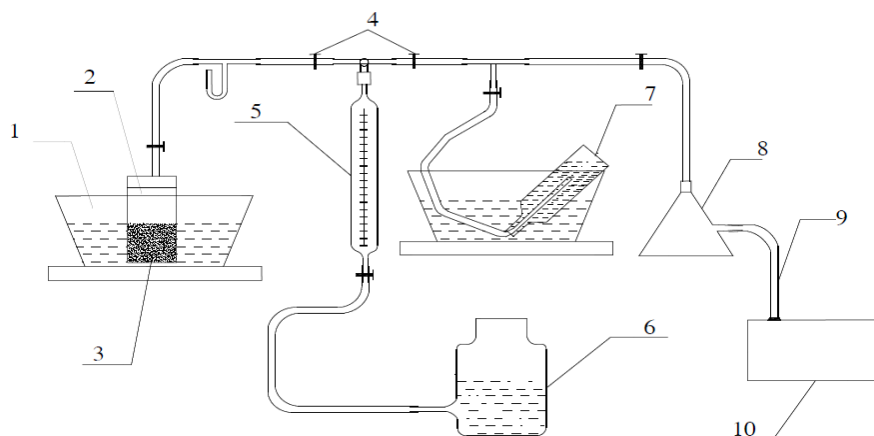

Fig.1. Gas separation diagram by vacuum heat
1.Hot water bottle; 2.Coal sample container; 3.Electric stove; 4.Regulating valve;5.Piet measured the volume; 6.Pressure vessel; 7. Bottle containing specimen separation gas; 8.Intermediate gas cylinders; 9. Tube; 10. Vacuum machine

From the results of the analysis, establish a relationship between the trend of methane density and the depth of the coal seam by using Excel software to construct methane gas prediction graph. Forecast results are presented in Section 4.

3. Results of analysis of methane content in Maokhe underground coal mine

The results of the analysis are shown in table 1 to table 4 with the corresponding coal seams of Maokhe underground coal mine.

Table1.Analysis results CH_4 at N^01CB and N^05 coal seam

N^01CB coal seam			N^05 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	50	0.01787	1	-15	0.253
2	-25	0.311	2	-59	0.467
3	-70	0.32033	3	-80	0.78
4	-120	0.462	4	-100	0.825
5	-150	0.634	5	-150	1.05

Table2.Analysis results CH_4 at N^06 and N^07 coal seam

N^06 coal seam			N^07 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}

1	30	0.299	1	-25	0.366
2	-25	0.399	2	-50	0.938
3	-60	0.422	3	-80	1.01266
4	-80	0.456	4	-120	1.342
5	-100	0.672	5	-150	1.5785
6	-150	0.9582			

Table3.Analysis results CH_4 at N^08 and N^09 coal seam

N^08 coal seam			N^09 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-25	0.367	1	30	0.356
2	-50	0.52639	2	-25	0.698
3	-80	1.418	3	-57	1.389
4	-135	1.83364	4	-80	2.26722
5	-150	1.988	5	-120	3.59497
			6	-150	4.217

Table4.Analysis results CH_4 at N^09b and N^010 coal seam

N^09b coal seam			N^010 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-25	0.1479	1	70	0.21066
2	-58	0.4141	2	32	0.289
3	-68	0.8571	3	-25	0.375
4	-80	1.423	4	-38	0.661
5	-105	1.635	5	-80	0.936
6	-150	3.477	6	-95	1.029
			7	-150	1.217

4. Results of gas density forecast methane as mine continue to exploit deeper

From the methane content figures in tables 1 to tables 4, We use Excel software to graph the gas variability at different levels of coal seams.

The results of the analysis are shown in table 5 to table 8, and Fig 2 to Figure 9 with the corresponding coal seams
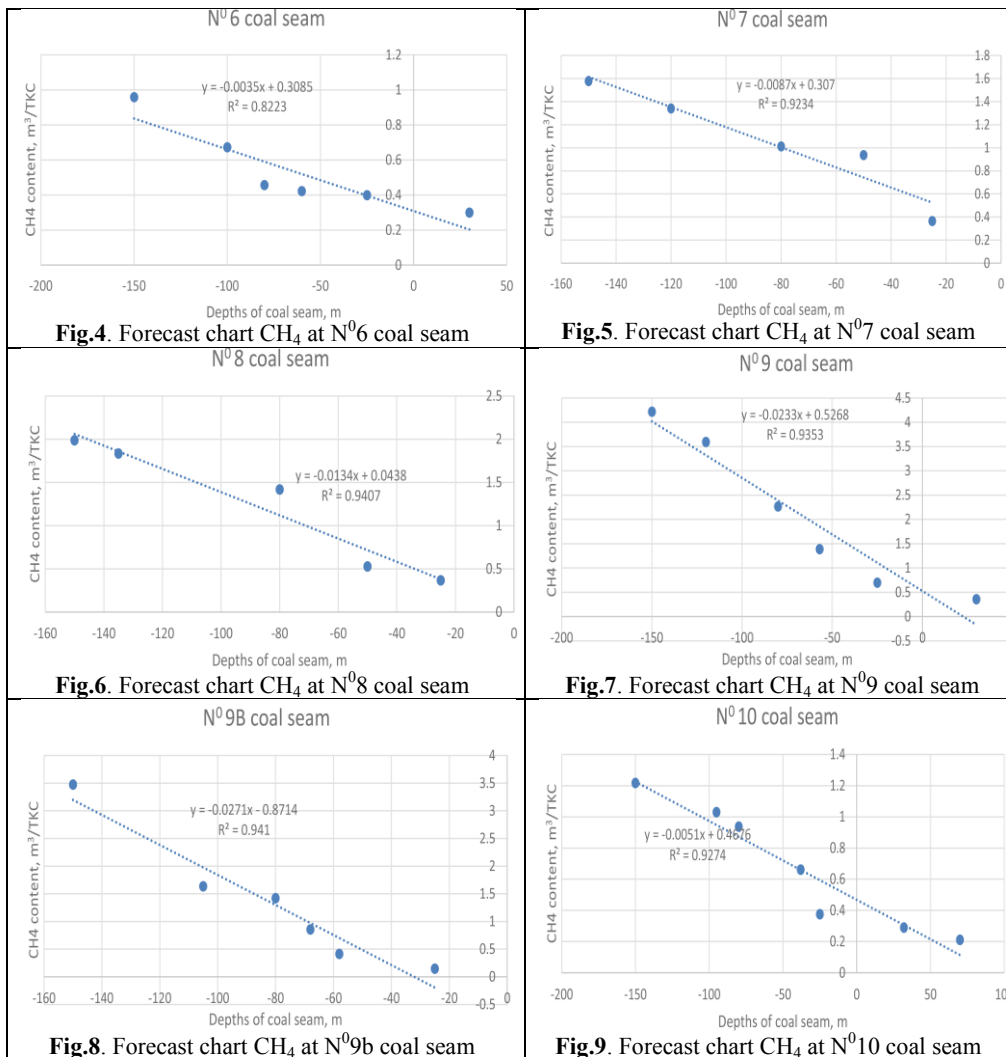

Fig.2. Forecast chart CH_4 at N^01CB coal seam	**Fig.3**. Forecast chart CH_4 at N^05 coal seam

Fig.4. Forecast chart CH_4 at N^06 coal seam

Fig.5. Forecast chart CH_4 at N^07 coal seam

Fig.6. Forecast chart CH_4 at N^08 coal seam

Fig.7. Forecast chart CH_4 at N^09 coal seam

Fig.8. Forecast chart CH_4 at N^09b coal seam

Fig.9. Forecast chart CH_4 at N^010 coal seam
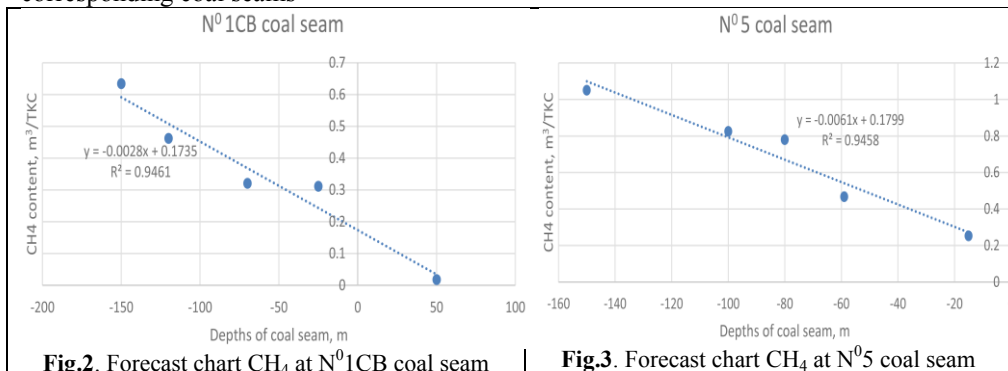
Table 5. Forecast results CH_4 at N^01CB and N^05 coal seam

N^01CB coal seam			N^05 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-200	0.773	1	-200	1.379
2	-250	0.923	2	-250	1.679
3	-300	1.073	3	-300	1.979
4	-350	1.223	4	-350	2.279
5	-400	1.373	5	-400	2.579
6	-450	1.523	6	-450	2.879

Table 6. Forecast results CH_4 at N^06 and N^07 coal seam

N^06 coal seam			N^07 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-200	1.008	1	-200	1.907

2	-250	1.183	2	-250	2.307
3	-300	1.358	3	-300	2.707
4	-350	1.533	4	-350	3.107
5	-400	1.708	5	-400	3.507
6	-450	1.883	6	-450	3.907

Table 7. Forecast results CH_4 at N^08 and N^09 coal seam

N^08 coal seam			N^09 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-200	2.643	1	-200	5.126
2	-250	3.293	2	-250	6.276
3	-300	3.943	3	-300	7.426
4	-350	4.593	4	-350	8.576
5	-400	5.243	5	-400	9.726
6	-450	5.893	6	-450	10.876

Table 8. Forecast results CH_4 at N^09b and N^010 coal seam

N^09b coal seam			N^010 coal seam		
TT	Depths	CH_4 density, m^3/T_{KC}	TT	Depths	CH_4 density, m^3/T_{KC}
1	-200	4.477	1	-200	1.467
2	-250	5.477	2	-250	1.717
3	-300	6.477	3	-300	1.967
4	-350	7.477	4	-350	2.217
5	-400	8.477	5	-400	2.467
6	-450	9.477	6	-450	2.717

4 Conclusion

From the results of the analysis and forecast results from table 1 to tables 8 and figures 2 to figures 9 show the degree of methane storage in the coal seams of the mines with great variation. And the greater the depth, the higher the gas density. Specific for each seam as follows:

- For N^01CB coal seam: From depths level +50 to depths level -450 the density of methane contained in the coal seam is determined and predicted from 0.01787 m^3/T_{KC} to 1.523m^3/T_{KC} (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam) [4] .

- For N^05 coal seam: From depths level -15 to depths level -350 the density of methane contained in the coal seam is determined and forecasted from 0.0731m^3/T_{KC} to 2.279m^3/T_{KC} (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam). At depths below level -390 to level -450 the methane content forecasted from 2.5 m^3/T_{KC} to 2.879m^3/T_{KC} (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam) [4]

- For N^06 coal seam: From depths level 30 to depths level -450 the density of methane contained in the coal seam is determined and forecasted from 0.299m^3/T_{KC} to 1.883m^3/T_{KC} (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam) [4]

- For N^07 coal seam: From depths level -25 to depths level -250 the density of methane contained in the coal seam is determined and forecasted from 0.366m^3/T_{KC} to 2.307m^3/T_{KC} (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam). At depths below level -280 to level -450 the methane content forecasted from 2.5 m^3/T_{KC} to

3.907m^3/T$_{KC}$ (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam) [4]

- For N^{0}8 coal seam: From depths level -25 to depths level -180 the density of methane contained in the coal seam is determined and forecasted from 0.367m^3/T$_{KC}$ to 2.5m^3/T$_{KC}$ (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam). From depths level -200 to depths -450, the density of methane contained in the coal seam is forecasted from 2.643m^3/T$_{KC}$ to 5.893m^3/T$_{KC}$ (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam) [4].

- For N^{0}9 coal seam: From depths level +30 to depths level -80 the density of methane contained in the coal seam is determined and forecasted from 0.356m^3/T$_{KC}$ to 2.26722m^3/T$_{KC}$ (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam). From depths level -95 to depths -140, the density of methane contained in the coal seam is forecasted from 2.5m^3/T$_{KC}$ to 4m^3/T$_{KC}$ (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam), from depths level -150 to depths -320, the density of methane contained in the coal seam is forecasted from 4.217m^3/T$_{KC}$ to 8.0m^3/T$_{KC}$ (This coal seam is ranked III according to QCVN / 03-BCT / 2011, Vietnam) and from depths level -350 to depths -450, the density of methane contained in the coal seam is forecasted from 8.576m^3/T$_{KC}$ to 10.876m^3/T$_{KC}$ (This coal seam is ranked IV according to QCVN / 03-BCT / 2011, Vietnam) [4].

- For N^{0}9b coal seam: From depths level -25 to depths level -125 the density of methane contained in the coal seam is determined and forecasted from 0.1479m^3/T$_{KC}$ to 2.5m^3/T$_{KC}$ (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam), From depths level -125 to depths -190, the density of methane contained in the coal seam is forecasted from 2.5m^3/T$_{KC}$ to 4m^3/T$_{KC}$ (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam), from depths level -200 to depths -380, the density of methane contained in the coal seam is forecasted from 4.477m^3/T$_{KC}$ to 8.0m^3/T$_{KC}$ (This coal seam is ranked III according to QCVN / 03-BCT / 2011, Vietnam) and from depths level -380 to depths -450, the density of methane contained in the coal seam is forecasted from 8.0m^3/T$_{KC}$ to 9.477m^3/T$_{KC}$ (This coal seam is ranked IV according to QCVN / 03-BCT / 2011, Vietnam) [4].

- For N^{0}10 coal seam: From depths level +70 to depths level -410 the density of methane contained in the coal seam is determined and forecasted from 0.21066m^3/T$_{KC}$ to 2.5m^3/T$_{KC}$ (This coal seam is ranked I according to QCVN / 03-BCT / 2011, Vietnam, From depths level -410 to depths level -450 the density of methane contained in the coal seam is determined and forecasted from 2.5m^3/T$_{KC}$ to 2.717m^3/T$_{KC}$ (This coal seam is ranked II according to QCVN / 03-BCT / 2011, Vietnam [4]).

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