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UPDATE ON THE STATUS AND ACTIVITIES OF THE TASK FORCE ON THE ECONOMIC BENEFITS OF IMPROVING MINE SAFETY THROUGH THE EXTRACTION AND USE OF COAL MINE METHANE

Project for the extraction and use of methane from mines and in the Karaganda coal basin (Kazakhstan)

Papers submitted by the expert from the Russian Federation

1. The Coal Department of Mittal Steel Temirtau has eight active mines in Kazakhstan's Karaganda coal basin. They produce approximately 12 million t of coal a year. Emissions of methane, one of the main greenhouse gases, amount to 15-120 or more m^3 per t of coal won.

2. Various means of seam degassing are employed to ensure high face output and safe working conditions underground. Some 100 million m^3 of methane are extracted every year. The quantity extracted in 2004 was 103.2 million m^3, for a total of 78.8 million of conditioned gas (concentration over 25%), of which 25.3 million m^3 were used in mines' heating plants (table 1). Methane drainage will continue at this level for the next three to five years, but is expected to increase thereafter as mine geology deteriorates and face output rises. Cutting the associated greenhouse gas emissions requires:

(a) Increased, more efficient use of mine methane in heating plants;

(b) Diversification of the ways of using and recycling mine methane.

3. Diversification is needed because mines' heating plants not only cannot cope with the wide range of parameters of the sources of methane emission but also consume widely differing amounts of methane in winter and summer.

4. It is therefore planned to pursue the goal of reducing greenhouse gas emissions in three ways:

(a) Use of methane from the Shakhtinskaya mine in group heating plant at the Tentekskya mine;

(b) In-situ flaring of methane drained from the Coal Department's mines;

(c) Development and introduction of the manufacture of carbon black from methane obtained through pre-mine drainage of a seam at the Kazakhstanskaya mine.

Table 1

Methane obtained by degassing and its use in mines' heating plants, 2004 (millions of cubic metres)

Mine	Degassing methane			Of which concentration >25%			Recycled			Unused, concentration >25%		
	Total	Winter	Summer	Total	Winter	Summer	Total	Winter	Summer	Total	Winter	Summer
Kostenko	7.6	5.1	2.5	6.0	4.2	1.8	5.5	4.0	1.5	0.5	0.2	0.3
Kuzembaev	1.3	0.9	0.4	-	-	-	-	-	-	-	-	-
Saranskaya	8.8	6.0	2.8	6.0	4.2	1.8	4.1	4.1	-	1.9	0.1	1.8
Abaiskaya	27.9	18.6	9.3	24.0	16.0	8.0	4.1	3.7	0.4	19.9	12.3	7.6
Shakhtinskaya	30.3	20.3	10.0	25.0	16.7	8.3	2.5	2.2	0.3	22.5	14.5	8.0
Kazakhstanskaya	4.7	2.9	1.8	1.0	1.4	0.6	-	-	-	2.0	1.4	0.6
Tentekskaya	4.6	3.1	1.5	1.8	1.2	0.6	-	-	-	1.8	1.2	0.6
Lenin	18.0	12.0	6.0	14.0	9.4	4.6	9.1	6.3	2.8	4.9	3.1	1.8
Grand total	103.2	68.9	34.3	78.8	53.1	25.7	25.3	20.3	5.0	53.5	32.8	20.7

Winter, 8 months, October-May Summer.
4 months, June-September.

5. Table 2 below shows the reductions in greenhouse gas emissions that are expected from the actions described in paragraph 4.

Table 2

Expected reductions in greenhouse gas emissions

Use	Place(s) of use	Quantity to be used, thou m^3	Reductions in greenhouse gas emissions, thou t CO_2
Mine heating plant	Shakhtinskaya and Tentekskaya mines	22 500	334*
Flaring	Coal Dept mines	53 500	748**
Carbon black	Kazakhstanskaya mine	2 000	28

* The size of the reduction is attributable to the quantity of methane to be used and the reduction in CO_2 emissions from converting the heating plant from coal- to gas-firing.

** Implementation of the first proposed method will entail a corresponding reduction in the quantity recycled by the second method.

6. The intended schemes cannot be carried out without further work and the procurement of the special equipment needed to extract, prepare and recycle the gas and to monitor the amount of methane used. Rough estimates of the additional costs the schemes will entail are given below.

Conversion of heating plant to methane-firing

7. The environmental benefits of using methane in heating plants stem from the reduction in the discharge of methane to the atmosphere and the reduction in CO_2 emissions. Conversion from coal- to gas-firing cuts CO_2 emissions by a factor of 1.7 for the same heating power (see table 3).

Table 3

The environmental benefits of using methane

Fuel	CO_2 emissions		
	t/tce	kg/kWh of heat energy	kg/kWh of electricity
Brown coal	3.25	0.40	1.18
Hard coal	2.68	0.33	0.97
Oil	2.3	0.29	0.85
Natural gas	1.5	0.19	0.53

8. The project provides for the conversion of two coal-fired boilers in the group heating plant at the Tentekskya mine to use methane from the working of faces 322 D_6-Ts and 323 D_6-Ts at the Shakhtinskaya mine. Coal reserves in these faces amount to 2,900,000 and 2,400,000 t respectively. Face 322 D_6-Ts will be worked until December 2006 and face 323 D_6-Ts until the second quarter of 2008. Methane drainage will be effected via 50 vertical wells to be drilled from the surface. These may have a useful life far longer than the life of the faces. In 2004, 25.0 million m^3 of methane at over 25% concentration was extracted from the Shakhtinskaya mine and methane consumption by the mine's heating plant amounted, in terms of 100% methane, to 2.5 million m^3. The surplus methane could be used in the group heating plant at the Tentekskya mine. That would require:

(a) Installation of a vacuum pump station with a capacity of 100 m^3/min;

(b) Procurement of 325 mm diameter pipes and construction of a 1,200 m long pipeline from the vacuum pump to the Tentekskya mine group heating plant;

(c) Conversion of two boilers from coal- to gas-firing.

9. Table 4 below contains a consolidated list of the additional spending that this part of the project would entail.

Table 4

Consolidated list of additional costs

	Units	Number	Cost (thou tenge)
Boiler conversion	Boiler	2	15 000
325 mm dia pipeline	m	1 200	6 750
Drilling of surface wells	Well	50	120 000
Vacuum pump station (6 pumps)	Station	1	40 000
Total			181 750*

* Equivalent, at an exchange rate of $1=135 tenge, to $1,346,000.

Flaring of degassing methane

10. At present, there are 28 vacuum pump stations at Coal Department mines. Of these, 24 (13 of them mobile stations) are in operation. The methane nominally available for recycling at the mines totals 53.5 m^3 (table 1). However, because of the need to maintain a concentration of over 25%, the quantity actually usable is 48-49 m^3/yr (Abaiskaya, Shakhtinskaya, Saranskaya and Lenin mines). Disregarding the Shakhtinskaya mine, it is 26-27 million m^3/yr, or sufficient to run four vacuum pump stations (two at the Abaiskaya mine and one each at the Saranskaya and Lenin mines). The flow from a station varies from 7 to 28 m^3/min, so it is possible to use flares with a capacity of up to 5 MW.

11. Recycling this amount of methane requires three type IF 1000 and one type IF 0500 flares. The approximate cost of a single IF 1000 being $155,000, the total cost of the four flares would be roughly $620,000.

Manufacture of carbon black from methane obtained through pre-mine drainage of coal seams

12. Pre-mine drainage of the explosion-prone D_6 seam is in progress at the Kazakhstanskaya mine following a series of special operations (hydrofracturing, etc.). The seam has not yet been affected by mining activities and the gas being extracted from it via surface wells is in virtually its native state. Some 2 million m^3 are being extracted every year and the concentration is stable, at 95-98%. Given the mining plan, the wells will be in operation for at least five to six years. As the flow is low (around 4 m^3/min) and potential customers are a long way off, the gas is not being used, even though it is of high-quality. A pilot plant for breaking the gas down into carbon black and hydrogen has therefore been built and tested. Using methane in this way significantly reduces CO_2 emissions. In fact, the proposed technology is particularly environmentally beneficial because it can cut CO_2 emissions by 40-60%: the heat energy of the by-product hydrogen is utilized by burning the hydrogen, which oxidizes it to water vapour, and water vapour enrichment of the products of combustion substantially increases the efficiency of extraction of their residual heat.

13. At a 1:1 ratio of methane flows for combustion and decomposition, CO_2 emissions per unit of heat released are cut by 35%. In theory, altering the proportion of methane in the flows for combustion and decomposition could cut CO_2 emissions by 35-50% and reduce hydrogen consumption per unit of useful energy released by 20-25%. No known hydrocarbon-based industrial power technology can match these results.

14. The environmental benefits of the proposed technology are twofold: reduction of methane emissions to the atmosphere and reduction of CO_2 emissions (table 5).

Table 5

Environmental benefits

	Units of measurement	
Recycling of methane	m^3/yr	2 000
Output of carbon black	t/yr	400
Reduction of greenhouse gas emissions (CO_2 equivalent), of which:	t/yr	27 750
Methane emissions		27 000
CO_2 emissions from carbon-black production		750

15. Scaling up the technology would require the linking of five pre-mine drainage wells by means of a l00 mm dia pipeline 3,000 m long and the building of a carbon-black manufacturing plant. Table 6 shows the consolidated costs of doing this.

Table 6

Consolidated costs

	Units of measurement		Cost (thou tenge)
100 mm dia pipes (inc. installation)	m	3 000	10 400
Manufacturing plant	Number	1	4 500
Control and measuring instruments	Set	1	3 700
Total			18 600*

* Equivalent, at an exchange rate of $1=135 tenge, to $1,338,000.

Overall assessment of the project

16. The overall indicators for the project are shown in table 7.

Table 7

Overall indicators

	Methane consumption, thou m^3	Reduction of greenhouse gas emissions, t CO_2 equivalent	Installation costs, thou $	Cost per thou t CO_2
Mine heating	22 500	334 000	1 346	4.03
Flaring	26 500	360 000	620	1.72
Carbon-black production	2 000	27 750	138	4.9
Total	51 000	721 750	2 104	

17. It should be noted that no account has been taken of the outputs from the first and third of the proposed activities.

18. The main problem holding back implementation of the project is a shortage of private-sector investment. To make it more attractive to large investors, the project needs a sound business plan, which could perhaps be developed by foreign specialists through the Methane to Markets Partnership.

19. The above information was prepared with the help of the Moscow State Mining University. The Coal Department of Mittal Steel Temirtau submitted the original version to Geneva in July 2005.
