

HORIZONTAL DRILLING AT MINE III IN MINERALES MONCLOVA IN THE SABINAS BASIN COAHUILA, MÉXICO

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ABSTRACT

In 2002, Minerales Monclova S.A. de C.V. operated six underground mines, five in the gassy Olmos Coals of the Sabinas Basin, and one in the Saltillo Basin. The total coal production was 4,942 Ktons. (1,122 Ktons from mine III). In June 2003, the mine finished installing surface vacuum pumps as a part of the horizontal drilling desgasification plan. This mine had mined 16 longwall panels previously without desgasification plan, because the coal in the first mine quadrant had a low average gas content of 6.5 m³/ton. The new area's gas content is much higher at 8.0 m³/ton. With this higher methane gas concentration, very high permeability and higher development advance rates (because of more advanced mining equipment) than the first mine area, an effective desgasification plan in advance of mining, a gob desgasification program, became necessary.

The staff at Mine III drilled 1,212 meters (3,975 feet) of horizontal boreholes. The coals are highly permeable at this mine (33 md) so that drilling ahead of mining is sufficient to protect the mine. The greatest drilling length was 390 meters (1,279 feet); 10 holes were drilled to protect working areas of the mine, since the rib produces 60% of the total gas, with the remaining 40% coming from the development face. When the longwall started we connected the seals to the main pipeline to extract the methane gas from the gob, applying vacuum from the surface. The mine plans to use 1,620 meters (5,314 feet) of horizontal boreholes in 2003 to protect the next longwall panels, using the cross-panel system. Also there will be a project to drill vertical wells to desgasify a new area at the same time as drilling exploration, taking care with the drilling plan to use the same holes as gob wells. We also plan on keeping the system-wide methane gas production at 334 liters per second (1,018,673 cubic feet per day), not counting the methane gas that we produce with the vertical well drilling program.

1.0 INTRODUCTION

Over the past 30 years, Minerales Monclova S. A. De C.V. (MIMOSA) has operated six underground coal mines with very high gas contents in the northern Coahuila State in México (Figure 1). Methane emissions from these coal mines have increased significantly because of higher coal productivity. In order to comply with the Mexican

regulation regarding the methane gas concentration below 1.0 % at the work faces, and 1.5 % in the main returns, MIMOSA has implemented a desgasification program in each mine. In addition to improving mine safety and decreasing downtime as a result of methane, we are using the desgasification systems to extract

much of the coal methane from our seams before and during mining. Methane drainage offers advantages of reducing the ventilation cost and development cost, allowing the mines to be more productive.

This paper will focus on Mine III, which implemented a pre-drainage project in advance using in-seam boreholes in 2002. We will have the

opportunity to evaluate the drilling technique, vacuum application, coal mine operation evaluation, a behavior of ventilation, and the most important aspect, the use of coal mine methane to generate energy at the same time., Mine Management is also evaluating the possibilities of obtaining emissions reduction credits by using the methane.

2.0 HORIZONTAL DRILLING PROGRAM

2.1 DRILLING EQUIPMENT

In order to start with the horizontal drilling program in June 2002, MIMOSA Mine III drilled a vertical borehole to collect the methane gas from underground in-seam boreholes. The vertical hole was cased with 8" steel pipe from the surface all the way to underground. At the surface we installed a vacuum pump to extract the methane gas from in-seam boreholes previously designed in order to protect the next long wall panel and give us the opportunity to connect the seals from the longwall in operation (gob) to the main pipe line.

The equipment that our staff used during the drilling process was a TURMAG machine PIV / 8 HP, This machine has a reversible drilling pneumatic motor supplied with an

intermediate reduction gear of 100 r.p.m. at the boring shaft with a pressure supplied by the compressor of 6.0 Kgs/cm² (5.34 psig). This is perfectly suitable for drilling to a projected depth of 180 meters (590.5 ft.). The drill rods used were BQWL with the following specifications O.D. 2^{3/16"} and a length of 3.0 meters (10.0 ft.). The drill bit utilize is the series MP – 200 from Blue Demon. This drill bit was developed for use drilling inside small diameter situations. The MP – 200 series bit was designed for use on lightweight drilling equipment, like our TURMAG, the diameter was 2^{15/16"}. The carbide insert blades are designed for use in medium-hard formations. This bit permitted us to obtain a very good drilling penetration.

2.2 OPERATION

At Mine III our staff has drilled 1,212 meters (3,975 feet) of horizontal boreholes, the first borehole drilled was in the bleeder, draining the eastern half of the mine, and is still producing gas today The average production is

120 lps (366.0 cubic feet per day). When we completed this hole it started producing 209 lps (637.4 cubic feet per day) We hope that after more than one year of methane extraction from this hole the development does not have

any down time for methane gas concentration, especially as this area are very close to mine II, where BHP conducted a gas content test in 1991. They developed a test from underground samples which results ranged from 3-6 m³/ton (105.9 to 211.8 ft³/ton) compared the surface results of 8 to 15 m³/ton (282.4 to 529.5 ft³/ton). This difference is due to the high permeability of the coals at this mine (33 md). This was substantiated with the results that REI founding at the same area at Pasta de Conchos Mine (CNR), so that drilling is sufficient to protect that area of the mine. This hole was the longest at 390 meters (1,279 feet), which should insure the reduction of methane gas concentration. We also learned through the empirical test at the Mine II area, demonstrated by BHP (1), that the roadways that were driven a year ago should reduce the concentration 300 to 400 meters (984 to 1,312 ft.) away.

The rest of the boreholes were drilled at the 5 West entry to protect the next longwall panel. Three boreholes were drilled in the cross cut 20, one at 207 meters (679.1 ft.), one at 84 meters (275.5 ft.), and the third at 45 meters (147.6 ft.). Three additional boreholes were drilled in the cross cut 17, the first at 115 meters (377.2 ft.), the second at 190 meters (623.2 ft.),

and the third at 54 meters (177.1 ft.). Also, two boreholes were drilled in the cross-cut 14, the first at 195 meters (639.7 ft.) and the second at 126 meter (413.3 ft.). Finally, one borehole was drilled at the cross-cut 9 at 120 meters (393.7 ft.). It is important to emphasize that all boreholes were drilled perpendicular to the face cleat (Figure 2), which enabled mining to continue uninterrupted.

The production of gas in the vacuum pump increases to 334 lps (1'018.7 cubic feet per day), while other statistics indicate that the methane concentration in the developments faces and ribs produces 60 % of the total gas with the remaining 40% from the face. This has led to the reduction of methane concentration at the return air of the area from 1.0 % to 0.6 % of CH₄ has kept downtime to a minimum. In comparison, the longwall panels without degasification have had 222.5 hours of downtime due to high methane concentrations. Comparatively, in the second panel with the degasification project boreholes drilled almost 6 months in advance of mining 336 meter (1,102 ft.) experimented only 116 hours of downtime (3). These numbers represent a 48% reduction in operational delays by methane in the development section.

3.0 SURFACE FACILITIES

3.1 EXHAUSTING PUMP

In June 2002 the mine finished installing surface vacuum pumps. They installed a NASH pump serial 3002 as a part of the horizontal drilling degasification plan. The

facilities were installed according to the safety regulations to avoid any problems with the methane gas that might be encountered during the implementation of the project.

Also installed was a gas flow measurement set to determinate methane flow by pressure in the firedamp drainage pipeline, and after the flame-arrestors, to

measurement the gas quality. Readings are taken every 30 minutes, applying the following formula to calculate the methane/air mixtures(4):

$$Q_F = 0.00134 \text{ CZE } d^2 \sqrt{h} \sqrt{\frac{P_x \delta M}{P_{st} \delta F}}$$

Where:

Q_F = Flow of the firedamp (methane/air mixture) in liters/second at standard conditions of 101.325 Pa. 15° C, dry.

CZE = constant, averaged from BS. 1042 : 1943

d = Orifice diameter in mm

h = Differential pressure in Pa.

P_x = Absolute pressure in Pa.

P_{st} = Standard pressure, 101325 Pa.

δM = Specific gravity of pure methane (dry)

δF = Specific gravity of firedamp (dry)

4.0 METHANE GENERATION

4.1 PRODUCTION AT THE NASH PUMP

According with the number that was calculated the average methane production for 2002 was 282 lps (860.1 cubic feet per day). Currently, the average production is 165 lps. (503.2 cubic feet per day) (Table 1), This current decrease in methane production is because the project of this year will start again in September, the main reason is because according with the mine planning design the eastern area of the mine will need pre-drainage boreholes until that date and we projected according the mine plan, those number are 1,620 meters (5,314 feet) using cross-panel system and will drill perpendicular to the natural cleat of the coal. Also, the vertical wells and gob well will depend of the mine situation. The numbers of the

production by the drainage system does not show the results during the 2002 (Figure 3), the only benefit that we can quantify, was when we communicate the long wall panel, the methane gas concentration in the return entry was higher than our regulation allow to operate the equipment to produce coal, so we connected the seal of the gob to the main pipeline, When the vacuum pump on the surface was turned-off due to mechanical problems, the long wall operation could not continue because the methane gas concentration at the return entry increases to levels that force the methane gas detector to shut-off the longwall equipment., so that we depend of the pump to allow us to keep producing coal.

Production	2002							2003					
	Jun	Jul	Aug	Sep	Oct	Nov	Dic	Jan	Feb	Mar	Apr	May	Jun
	209	258	334	328	297	286	263	179	189	189	138	130	146

Table #1 Average CH⁴ production by month; emissions are in litter per second.

4.2 VENTILATION BEHAVIOR

Mine III had previously mined 16 Longwall panels without adegasification plan in place, primarily because the first mine quadrant had a low average gas content of 6.5 m³/ton. The ventilation requirements were lower too. We used only 85 m³/second (180.0 ft³/minute). Development advance rates and the methane gas concentration in the air volume allowed for the ventilation system to handle all methane liberated to within mine specifications.

However, when we started mining the new gas area, the gas content was much higher at 8.0 m³/ton. With this higher methane gas concentration, as well as very high permeability and higher development advance rates (because of more advanced mining equipment) than the first mine area, the ventilation needs to increase the same way than the gas content to permit keep the gas level in safety rates, our mine design considered to increase the air volume from 85 to 142.6 m³/second (180.0 to 302.0 ft³ / minute) obviously considering a good desgasification plan in advance of mining, if we review the number on the ventilation shaft, we found very good way to evaluate the benefits obtained by the desgasification plan, January 2002 the air volume at the main fan was 142.6 m³/second (302.0 ft³ / minute) an emission of 1,404 lps (2,974 ft³ / minute), we started to drill in June, it is very difficult to evaluate the benefits by the methane delays in the development section also in the

longwall because too many other factor influence, so the most significant number according with the ventilation reports its the following, for ends of the year 2002 the air volume was 148.5 m³/second (314.5 ft³ / minute) an emission of 979 lps (2,074 ft³ / minute) (figure 4), the air volume still almost the same, but the emission reduction was a 30.22 % comparatively with the number beginnings of year.

This year the average of air volume is 150 m³/second (302.0 ft³ / minute), but the gas emission average are lower than the average last year, now is 742 lps (1,572 ft³ / minute), a 36.56 % less. According with the report of the mine dated July 2nd. 2003 the emission at the ventilation shaft is 468 lps (991 ft³ / minute), these numbers are the result with similar condition of production by the longwall, but development is very close to the area that was developed last year. Mine III is draining approximately 18% of the methane currently, but last year this percentage was higher, as we mention before, the desgasification system can collect between 25 to 30 % of the methane and reduce the ventilation requirements. The mine is currently using only 132 m³/second (279.6 ft³ / minute), or 12.3 % less that the average of the previous year. In conclusion, degasification at the mine has increased from 85 to 150 m³/second (180.0 to 317.7 ft³ / minute) and the resultant emissions are now less than year ago without drilling plan.

5.0 GAS CONTENT & COMPOSITION

5.1 IN-SITU GAS CONTENT

Gas content was determined using the Direct Method. The average in-situ gas content of the composite samples was 8.4 m³/t (269 ft³/ton), without dry ash-free basis analysis.

5.2 GAS COMPOSITION

In 1998 MIMOSA implemented a program of coalbed methane exploration involving vertical production wells. Those wells do not be considered due their unsatisfactory results, but any way, during that pilot project the contractor send some gas samples to a laboratory in Alice, Texas, the laboratory certified the results (2). Below are the MIMOSA results.

Component	Mol %	GPM
Nitrogen	0.059	
Carbon Dioxide	0.500	
Methane	97.967	
Ethane	0.699	0.106
Propane	0.349	0.096
I-Butane	0.125	0.041
N-Butane	0.114	0.036
I-Pentane	0.056	0.020
N-Pentane	0.033	0.012
Hexanes Plus	0.098	0.433
Totals	100.000	

Chromatograph analysis

Computed Real Properties (Fesco, 1998):

Specific Gravity..	0.575 (Air =1)
Compressibility	0.9979
Gross Heating Value (14.65 psia & 60° F	
- Dry Basis.	1,026 BTU/CF
- Saturated Basis	1,009 BTU/CF

6.0 SUMMARY

This Paper Demonstrates that desgasification system for a coal mine is very important. MIMOSA will continues with the gas drainage system to improve mine safety and productivity, Minerales Monclova are very interesting to contribute to reduce the Green House Gases, and use the Coal Mine Methane and develop a project using Vertical wells and gob well, With the methane we can produce Energy (different systems, Heat Boilers, Power, Etc). The current situations in Mexico regarding gas utilization are changing, Now the Mexican Government do not allow Private companies use the

methane, according with the article 27 and 28 of Mexican Constitution, the government it's the owner of all the natural gas, a new the government law are developing to permit private companies like Minerales Monclova use the methane gas, sell, or produce energy on site, we started with a small pilot project in other mine get, but we received a proposal from very important international companies to increase our situation, the authors hope that our company administration proceed to develop a project as soon as possible.

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4. Ventilation in Coal Mines "A Handbook For Colliery Ventilation Officer" National Coal Board - Mining Department.
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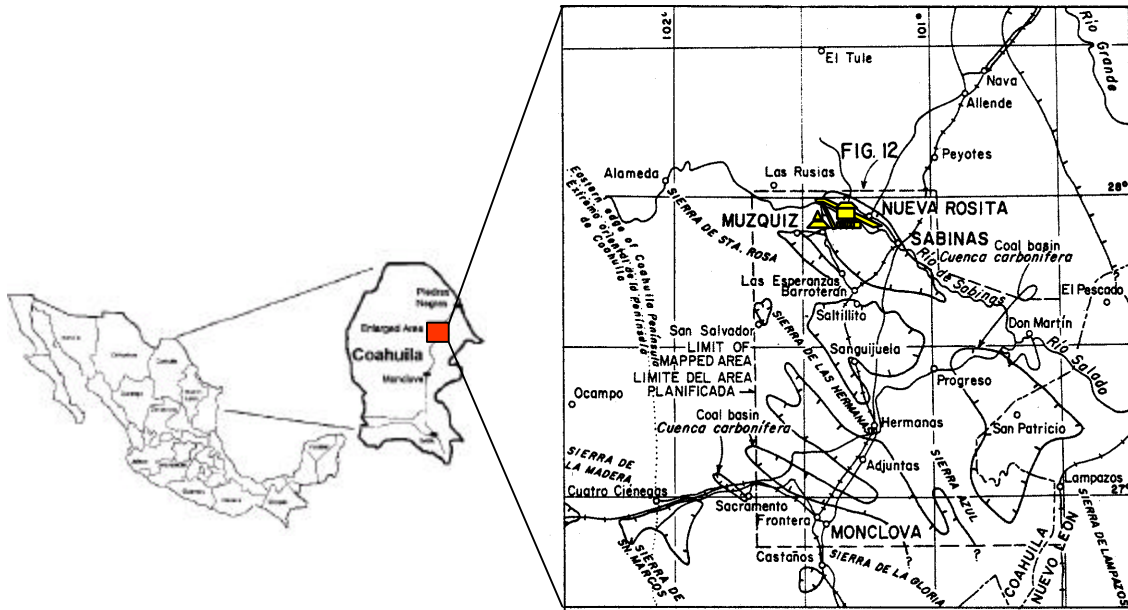


Figure #1.- Map of Coal Bearing Area of Coahuila, México

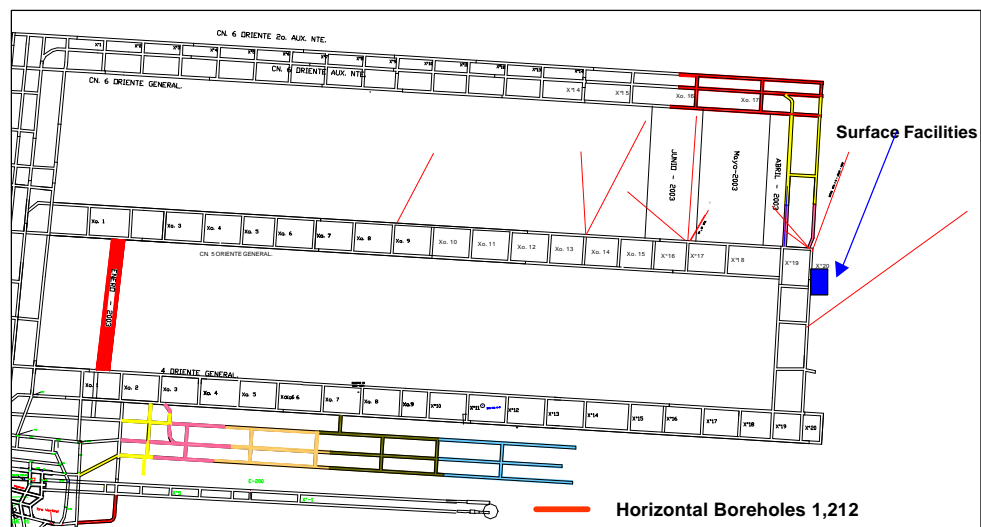


Figure #2.- In-seam pre-drainage boreholes at mine III.

Methane Emission, Airflow Requirements, Advance Rate 5 & 6 East Developments, Mine III

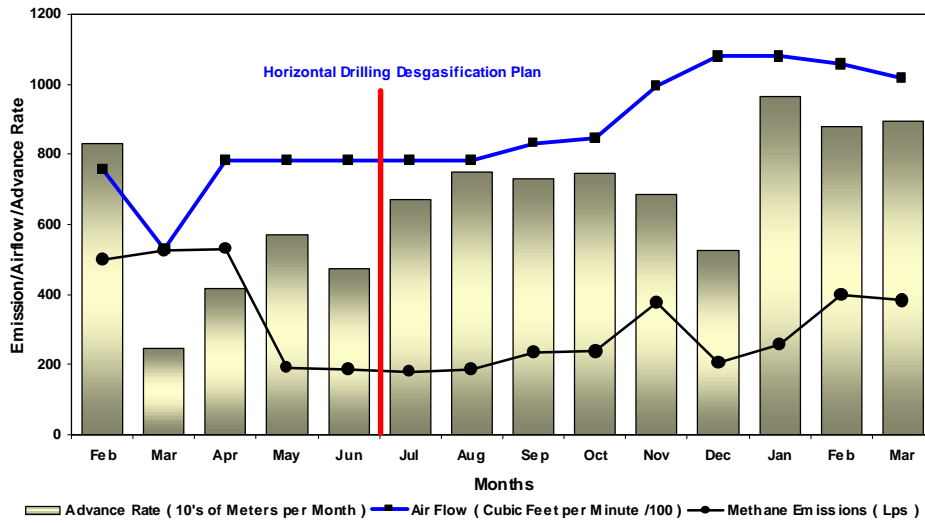


Figure #3.- Analysis of the Horizontal Desgasification plan, Mine III

Airflow Requirements, Methane Drained, Methane Vented, And Production Rate

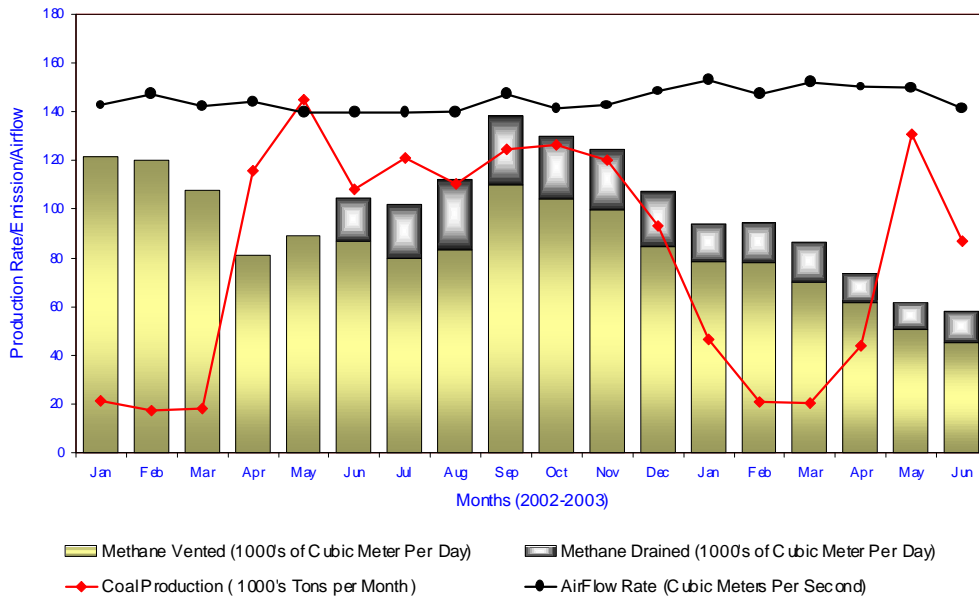


Figure #4.- Impact of Methane Drainage on Mine Ventilation