Journal of Mining and Metallurgy, 44 A (1) (2008) 1 - 8

Journal of
Mining and
Metallurgy

IMPORTANCE OF MAINTENANCE OF BARRICADES TOWARDS WORKED OUT AREAS DURING EXTRACTION AND IN CASE OF MINE FIRE

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(Received 24 August 2007; accepted 30 November 2007)

Abstract

RMU Rembas coal mines, with tradition of over 150 years in coal mining, experienced numerous mine fires, sometimes causing closing of entire mines for long period of time. Mine fires occurred very often, due to brown coal strong disposition to oxidation and self – ignition.

Beside usual measures for preventing mine fires, special attention should be paid to barricading of worked out areas and prevention of air flow in caved areas. Quality and maintenance of barricades are essential in prevention of mine fires in worked out areas.

In October 2006, at Strmosten mine, one of the Rembas mines, due to decreased coal extraction, high degree of carbon – monoxide CO appeared at transport drift TH-4 in OP-1 section. CO is a direct indicator of mine fire and later it was followed by smoke.

To avoid further development of mine fire, temporary barricades (named PIP 10 and PIP 11) were placed at No 35 and No 38 drifts. Concentration of gasses was measured on stationary instruments, along with mobile instruments, which were used to measure concentrations behind barricades. Used mobile instruments were "ORSAT" apparatus and "OLDHAM" instrument.

This paper provides air analyses before and after placement of barricades.

Key words: *mine fire, internal mine fire, worked out areas, barricades, concentration of gasses.*

1. Introduction

Mine fires belong to most endangering appearances in mining. They slow down the production, destroy natural and production goods and endanger lives of miners. Mine fires produce strong thermal effects, along with large amounts of noxious gasses, thus affecting mine workings.

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Mine fires appear in cases of influence of external heat source to flammable material, or due to internal chemical processes in coal, producing huge quantity of warmth. Internal mine fires are especially dangerous, because it is difficult to determine point of their origin, strength and area of influence. Internal mine fires are the consequence of coal disposition for self – ignition in presence of oxygen. Most common spots of mine fire origin are worked out areas, fractures in coal seams, fault zones and other places with presence of oxygen [2].

RMU Rembas coal mines, with tradition of over 150 years in coal mining, experienced numerous mine fires, sometimes causing closing of entire mines for long period of time. Mine fires occurred very often, due to brown coal strong disposition to oxidation and self – ignition [1].

2. Measures for preventing mine fires

Beside usual measures, such as ban of open flames, use of safe electric equipment, use of non – flammable support materials, prevention and removal of coal dust and similar, special attention should be paid to barricading of worked out areas and prevention of air flow in caved areas. Quality and maintenance of barricades are essential in prevention of mine fires in worked out areas.

Isolation of worked out areas and prevention of air inflow is performed by barricades. Depending on their importance and purpose, barricades can be permanent or temporary. Temporary barricades are usually made of wooden bars and clay. Permanent barricades are made of timber, clay, concrete, mud, etc [4].

In October 2006, at Strmosten mine, one of the Rembas mines, due to decreased coal extraction, high degree of carbon – monoxide CO appeared at transport drift TH-4 in OP-1 section. CO is a direct indicator of mine fire and later it was followed by smoke.

Strmosten mine is opened by main slope GN-1 and inclined ventilation shaft GVO. It is connected with section OP-1 by main transport slope GTU-1 and main transport drift GTH-4. Development of section OP-1 is performed by transport and ventilation drifts TH-4 and VH-4, followed by TH-5 drift, with ventilation connections between them (Fig. 1).

As the most of Rembas mines, Strmosten mine is using low-scale mining method after failing to introduce longwall mining.

Current mining method is “G pillar method”. This method includes slope drifts at 12 m spacing, driven from transport drift. From slope drifts, production drifts are lined at 6 m spacing to the left. Production drifts are 3 x 2,5 m, with timber support. Second phase is extraction of roof coal. Roof coal is extracted by blasting in retreat. However, production drift does not cave until all of remaining coal is extracted, thus enabling concentration of gasses.

Ventilation of stopes is done by auxiliary fans “DVT” and “SPARTAK”.

Current coal mining includes three active stopes – developing from VH-4, TH-4 and TH-5a drift. Such situation enabled inflow of fresh air into worked out areas. That is why there is a barricade after each slope drift (Fig.1).

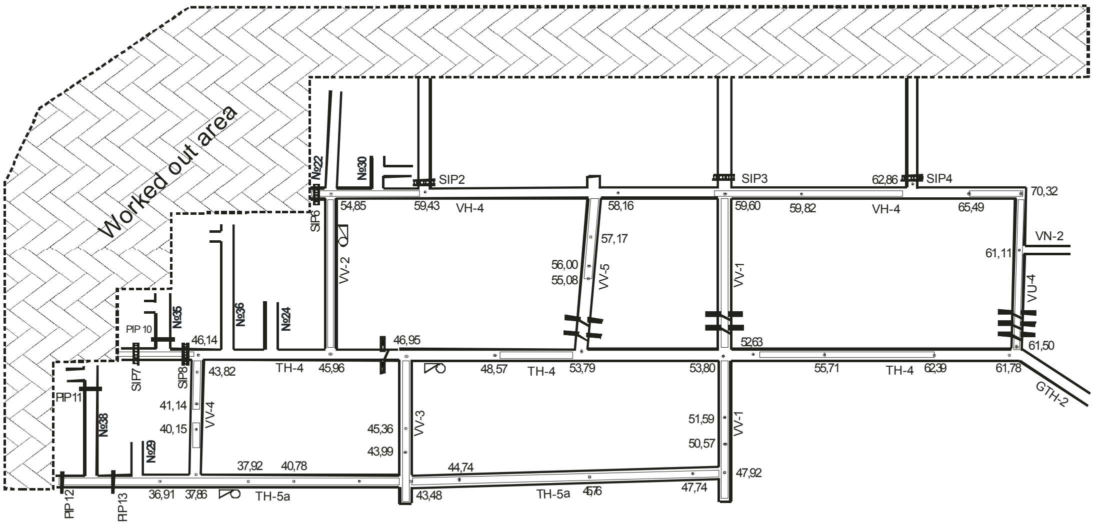

Fig. 1. Scheme of Strmosten underground coal mine area affected by mine fire

Regardless on numerous barricades and other prevention measures, high concentration of CO occurred in drifts No 35, at TH-4 level, and No 38 at TH-5a level, followed by smoke two days later. To avoid further development of mine fire, temporary barricades (named PIP 10 and PIP 11) were placed at No 35 and No 38 drifts. Concentration of gasses was measured on stationary instruments, along with mobile instruments, which were used to measure concentrations behind barricades. Used mobile instruments were "ORSAT" apparatus and "OLDHAM" instrument.

Measuring results are given in following table [3].

Table 1. Concentration of gasses in the air behind barricades

Date and time	Gass	Unit	SIP 6* (VH-4)	SIP 7 (TH-4)	PIP 10 (№ 35)	Date and time	Gass	Unit	SIP 6 (VH-4)	SIP 7 (TH-4)	PIP 10 (№ 35)	PIP 11 (№ 38)
20.10.'06 01^{15}	CO	*ppm*	157	>1200	730	23.10.'06 10^{00}	CO	*ppm*	23	354	115	76
	CO_2	%	>6	>6	>6		CO_2	%	>6	>6	>6	3,2
	CH_4	%	0	0,4	0,1		CH_4	%	0,0	0,0	0,0	0,0
	O_2	%	9,6	9,1	10,7		O_2	%	5,6	3,6	5,2	16,9
20.10.'06 05^{20}	CO	*ppm*		>1200	678	24.10.'06 02^{00}	CO	*ppm*	18	170	53	53
	CO_2	%		>6	>6		CO_2	%	>6	>6	>6	1,8
	CH_4	%		0,4	0,0		CH_4	%	0,0	0,0	0,0	0,0
	O_2	%		9,4	10,2		O_2	%	4,2	3,8	4,9	18
21.10.'06 08^{30}	CO	*ppm*	118	>1200	658	24.10.'06 10^{40}	CO	*ppm*	14	135	52	5,9
	CO_2	%	>6	>6	>6		CO_2	%	>6	>6	>6	2,7
	CH_4	%	0,0	0,4	0,0		CH_4	%	0,0	0,0	0,0	0,0
	O_2	%	9,1	8,5	9,5		O_2	%	2,9	3,7	3,6	17,6
22.10.'06 17^{35}	CO	*ppm*	42	1191	342	25.10.'06 02^{00}	CO	*ppm*	4	114	41	47
	CO_2	%	>6	>6	>6		CO_2	%	8,5	7,8	8,1	1,6
	CH_4	%	0,0	0,2	0,0		CH_4	%	0,0	0,0	0,0	0,0
	O_2	%	8,1	7,7	9,0		O_2	%	3,2	4,2	3,0	18,2
23.10.'06 01^{43}	CO	*ppm*	32	880	256	25.10.'06 11^{00}	CO	*ppm*	10	105	31	53
	CO_2	%	>6	>6	>6		CO_2	%	>6	>6	>6	3,8
	CH_4	%	0,0	0,1	0,0		CH_4	%	0,0	0,0	0,0	0,0
	O_2	%	6,5	6,5	7,9		O_2	%	2,7	3,5	3,4	16,8

* SIP – permanent barricade; PIP – temporary barricade

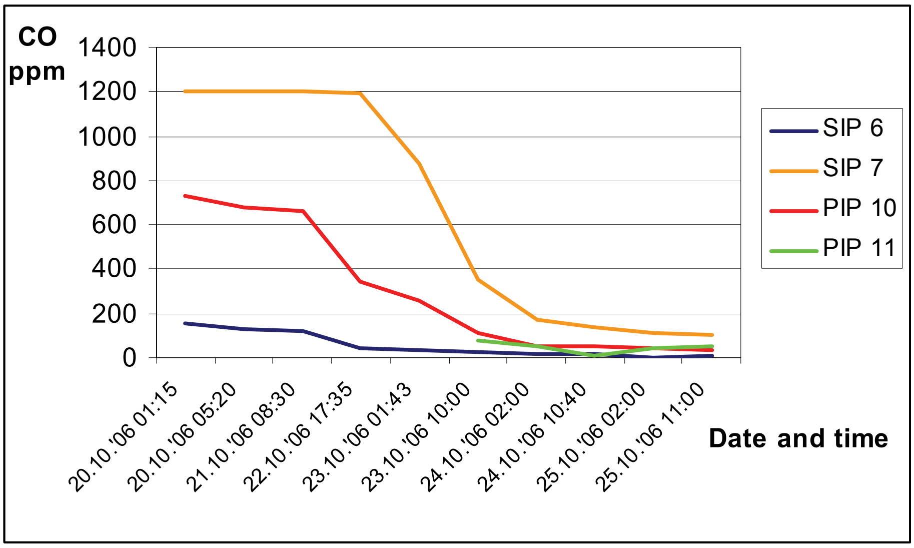

Fig. 2. Concentration of carbon-monoxide (CO) in the air behind barricades

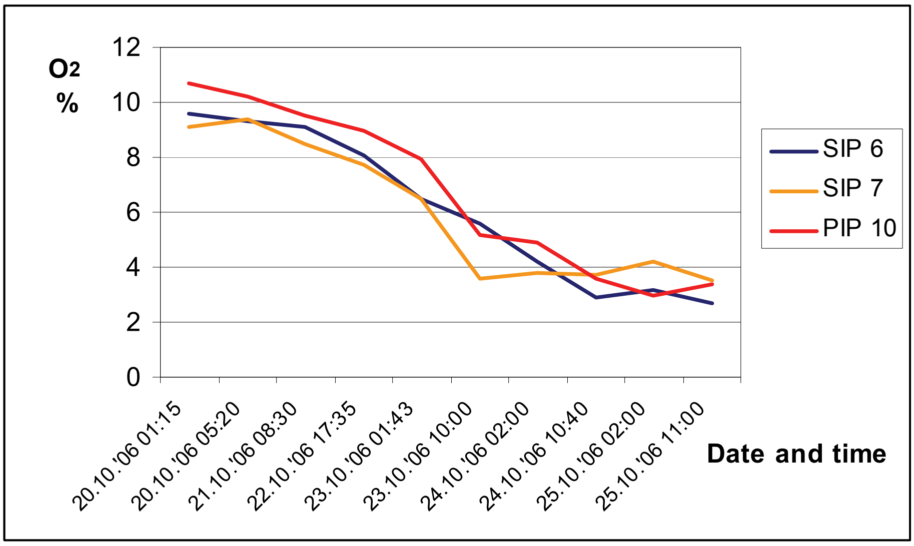

Fig. 3. Concentration of oxygen (O_2) in the air behind barricades

After seven days, barricade PIP 10 was opened and after only couple of hours, concentration of CO at No 35 drift was higher than 500 ppm. PIP 10 was closed again and new PIP 12 barricade was established at TH-5a drift. After closing this section, concentrations of gasses were following [3]:

Table 2. Concentration of gasses in the air behind barricades

Date	Gass	Units	SIP 6 VH-4	SIP 7 TH-4	PIP 10 № 35	PIP 11 № 38	PIP 12 TH-5a
26.10.'06 III shift	CO	*ppm*	67	>1200	758	100	
	CO_2	%	>6	>6	>6	1,4	
	CH_4	%	0,0	0,5	0,1	0,0	
	O_2	%	5,0	4,9	6,1	18,6	
27.10.'06 I shift	CO	*ppm*	35	612	320	202	
	CO_2	%	>6	>6	>6	>6	
	CH_4	%	0,0	0,1	0,0	0,0	
	O_2	%	5,2	7,1	6,8	11,2	
27.10.'06 III shift	CO	*ppm*	18	257	67	51	
	CO_2	%	>6	>6	>6	0,7	
	CH_4	%	0,0	0,0	0,0	0,0	
	O_2	%	4,2	5,4	6,6	19,5	
28.10.'06 I shift	CO	*ppm*		243	56	46	57
	CO_2	%		>6	>6	0,8	4,2
	CH_4	%		0,0	0,0	0,0	0,0
	O_2	%		4,8	5,1	19,5	15,4
29.10.'06 III shift	CO	*ppm*		180	39	20	14
	CO_2	%		>6	>6	0,5	>6
	CH_4	%		0,0	0,0	0,0	0,0
	O_2	%		6,7	6,5	19,7	4,3
30.10.'06 I shift	CO	*ppm*	7	239	42	41	
	CO_2	%	>6	>6	>6	0,4	
	CH_4	%	0,0	0,0	0,0	0,0	
	O_2	%	3,4	6,7	7,4	19,9	
30.10.'06 III shift	CO	*ppm*	7	21	61	21	
	CO_2	%	>6	>6	0,8	>6	
	CH_4	%	0,0	0,0	0,0	0,0	
	O_2	%	4,1	10,6	19,2	3,9	
31.10.'06 I shift	CO	*ppm*	10	32	39	18	
	CO_2	%	>6	>6	0,6	>6	
	CH_4	%	0,0	0,0	0,0	0,0	
	O_2	%	3,6	5,0	19,6	5,8	
31.10.'06 II shift	CO	*ppm*	7	29	36	14	
	CO_2	%	>6	>6	0,5	>6	
	CH_4	%	0,0	0,0	0,0	0,0	
	O_2	%	3,4	5,2	19,4	2,8	

After placing of permanent barricade SIP 8 at TH-4 drift and temporary barricade PIP 13 at TH-5a drift, there was a decrease of concentration of CO and O_2 behind barricades, as it is shown in table 3.

Table 3. Concentration of gasses in the air behind barricades

		VH-4 **SIP-6**	TH-4 **SIP-8**	TH-5a **PIP 13**	VH-4 **SIP 2**			VH-4 **SIP-6**	TH-4 **SIP-8**	TH-5a **PIP13**	VH-4 **SIP-3**
08.11.06 Ishift	CO	5	7	38	24	14.11.06 I shift	CO	7	17	65	
	CO2	>6	1.9	3.5	>6		CO2	>6	>6	>6	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	3.4	18	17.2	4.4		O2	2.7	11.2	13.7	
III shift	CO	1	7	42	0	II shift	CO	11	6	61	
	CO2	>6	1.9	4.7	>6		CO2	>6	>6	>6	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	2.1	17.9	16.1	4.8		O2	16	13.5	14.2	
09.11.06 I shift	CO	4	10	59		III shift	CO	11	7	68	0
	CO2	>6	5.7	>6			CO2	>6	>6	>6	>6
	CH4	0.0	0.0	0.0			CH4	0.0	0.0	0.0	0.0
	O2	4.2	14.7	8.6			O2	17.1	12.7	14.4	3.3
II shift	CO	4	7	39		15.11.06 I shift	CO	15	11	39	
	CO2	>6	5.7	>6			CO2	>6	>6	3.4	
	CH4	0.0	0.0	0.0			CH4	0.0	0.0	0.0	
	O2	2.2	14.8	9			O2	7.3	12.2	17	
III shift	CO	7	4	43	4	II shift	CO	11	4	36	
	CO2	>6	4.6	4.9	>6		CO2	>6	>6	3.7	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	5.9	15.7	16.1	9.1		O2	9.8	10	17	
10.11.06 I shift	CO	10	7	68	14	III shift	CO	4	4	52	0.0
	CO2	>6	2.2	>6	>6		CO2	10.1	6.5	3.7	10.2
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	0.0
	O2	8.5	17.7	13.9	12.1		O2	0.0	7.6	14.8	0.1
II shift	CO	11	7	53	4	16.11.06 I shift	CO	4	7	52	
	CO2	>6	2.2	3.6	>6		CO2	>6	>6	>6	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	12.1	17.7	17.1	13		O2	1.9	6.0	14.7	
III shift	CO	26	11	50	371	II shift	CO	11	11	46	
	CO2	>6	3.6	3.4	>6		CO2	>6	>6	>6	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	9.6	16.1	16.8	15.1		O2	2.9	6.9	12.7	
11.11.06 I shift	CO	4	14	66	42	III shift	CO	0	4		0
	CO2	>6	>6	>6	>6		CO2	10.2	9		9.8
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0		0.0
	O2	1.5	10.3	10.6	12.2		O2	0.3	1.4		0.7
II shift	CO	8	11	18	42	17.11.06 I shift	CO	7	7		
	CO2	>6	>6	>6	>6		CO2	>6	>6		
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0		
	O2	2.0	6.7	3.1	8.3		O2	1.6	1.8		
III shift	CO	4	4	7	4	II shift	CO	4	11	21	
	CO2	>6	>6	>6	>6		CO2	>6	>6	2.1	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	1.9	2.9	1.9	4.3		O2	2.3	2.3	18	
12.11.06 II shift	CO	4	4	18	0	III shift	CO	4		35	
	CO2	>6	>6	>6	>6		CO2	>6		3.8	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0		0.0	
	O2	15.4	8.6	11	8.1		O2	2.0		16.8	
III shift	CO	4	7	11	7	18.11.06 I shift	CO	5	4	28	
	CO2	>6	>6	>6	>6		CO2	>6	>6	2.8	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	4.8	7.8	5.4	13.9		O2	2.8	5.6	17.6	
13.11.06 Ishift	CO	8	14	34	14	III shift	CO	4	4	32	
	CO2	>6	>6	>6	>6		CO2	>6	>6	2.7	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	2.7	12.1	15.6	14.5		O2	1.9	3.7	17.5	
III shift	CO	4	6	42	4	19.11.06 I shift	CO	5	7	21	
	CO2	>6	>6	>6	>6		CO2	>6	>6	3.6	
	CH4	0.0	0.0	0.0	0.0		CH4	0.0	0.0	0.0	
	O2	2.7	10.1	8.9	14.3		O2	2.1	2.0	17.3	

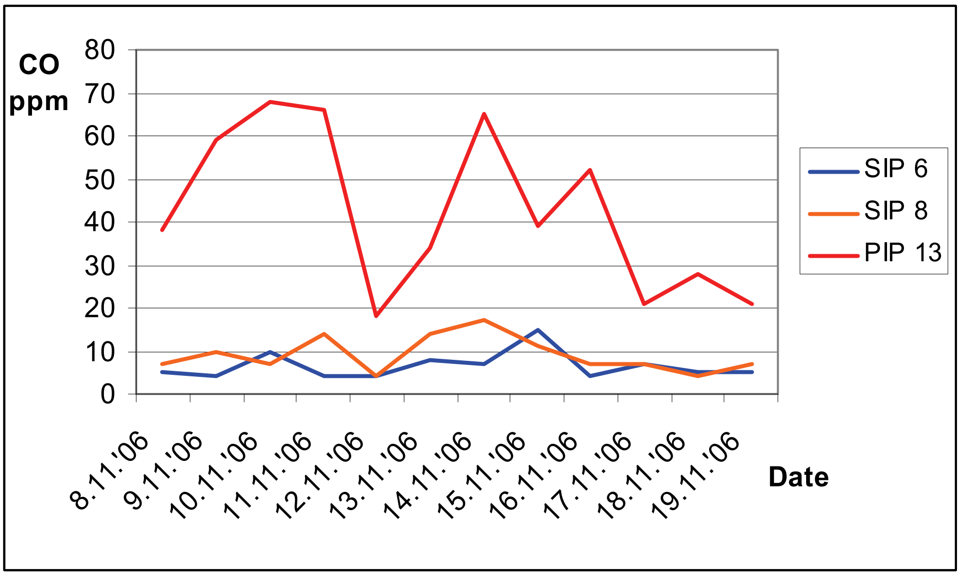

Fig. 4. Concentration of carbon-monoxide (CO) in the air behind barricades

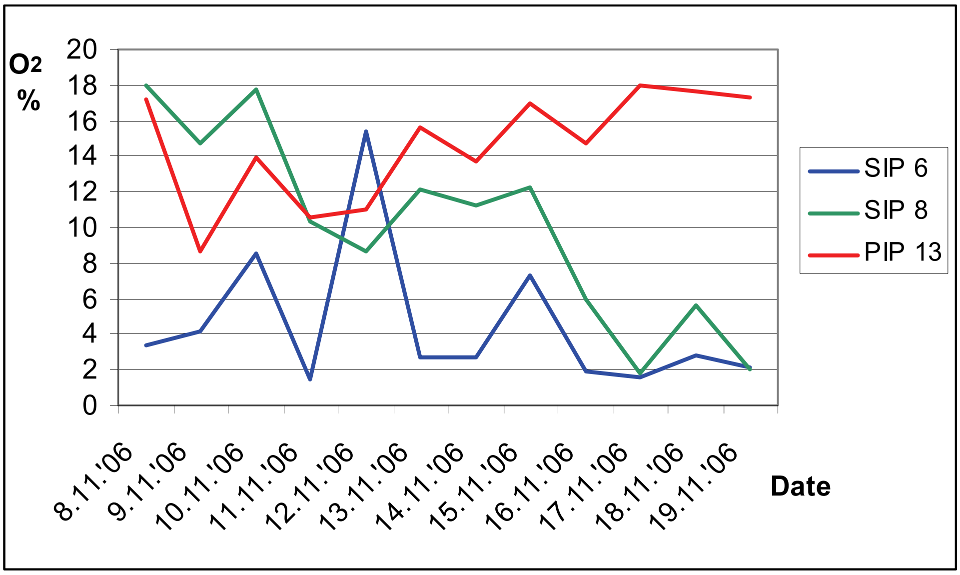

Fig. 5. Concentration of oxygen (O_2) in the air behind barricades

3. Conclusion

Mine fires belong to most endangering occurrences in the mines. They affect work and lives of miners, equipment, production, and sometimes cause temporary closing of mine sections, or even entire mine. At the beginning, they are usually unnoticeable, and at the moment they are exposed, it could be too late to take action. It is important to react quickly. Barricading is the most common and usually successful method. Quality of barricades is crucial, but their maintenance is important, too.

According to data in tables, concentrations of CO and O_2 decreased to a certain level after barricading, and then they stagnated. However, increase of O_2 in second or third shift lead us to conclusion that barricades were not maintained properly at that time. That is why it is important to carefully choose the workers for such responsible jobs, and also to provide their constant control.

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