Remote Sealing and Shrink-sealing Fire Extinguishment Methods for High-gas Mines: A Case Study of the Yuwu Coal Mine Fire

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Presentation Outline

1、China’s Coal Safety Progress and Rescue System

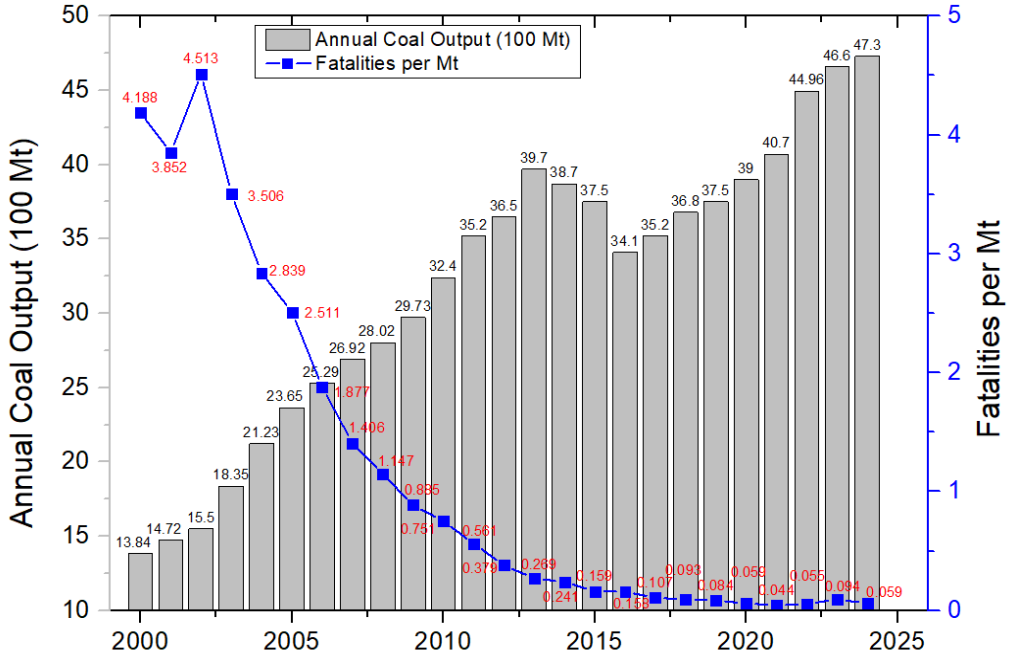
2、Mine Fire and Gas Explosion Hazards in High-Gas Mines

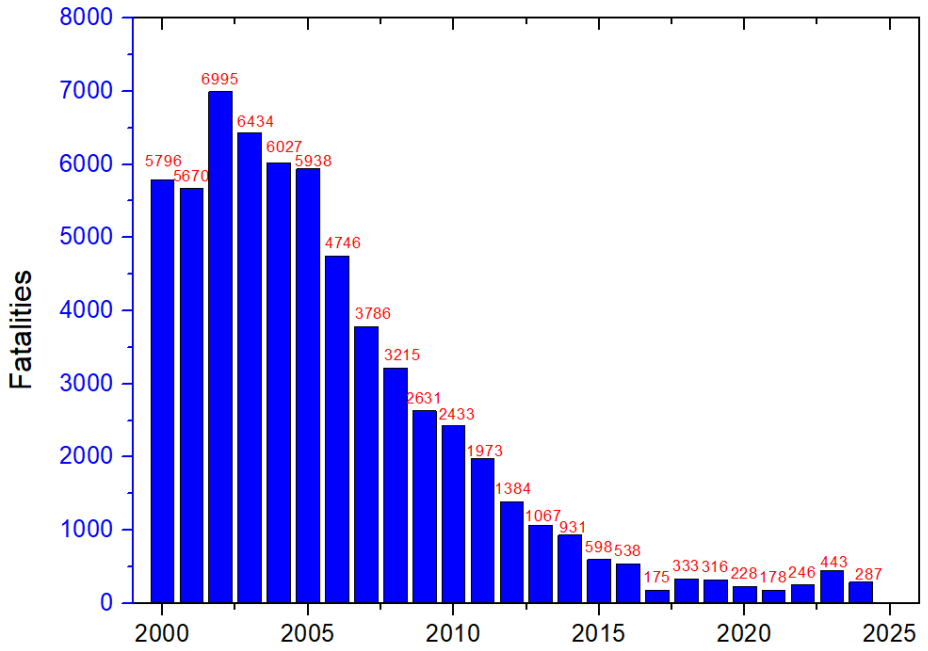
3、Case Study: YuWu Mine Gas Fire – Conditions and Rescue Process

1、China’s Coal Safety Progress and Rescue System

1.1 China’s Coal Production and Safety Progress (2000–2024)

- China produces >50% of the world’s coal (~4.7 Bt in 2024).
- Fatalities dropped from ~6,000 in 2000 to <500 in 2023.
- Fatalities per Mt declined from >4.0 to <0.06.
- Key drivers: people-first policy, stricter supervision, better training, mechanization, disaster prevention tech, strong rescue teams.





1、China’s Coal Safety Progress and Rescue System

1.2 China’s Mine Rescue System and Regulatory Framework

- Leading authority: National Mine Rescue Center, MEM
- 451 enterprise-based full-time rescue teams
  - 49 national-level teams
- Past model: military-style management
- Now: standardized management
- Issued: 2 regulations, 7 standards
  - Personal protective clothing
  - Theoretical training outline
  - Training curriculum
  - Assessment and evaluation norms
- In preparation: 9 new standards

1、China’s Coal Safety Progress and Rescue System

1.3 Government Support for National Mine Rescue Teams

In 2023 and 2024, the Chinese government allocated approximately **7 billion RMB** in dedicated subsidies to support **49 national professional mine rescue teams**. The funding was primarily directed toward strengthening team capacity, with a focus on **equipment purchase subsidies, emergency drill subsidies, and accident rescue subsidies**.

Government Subsidy for National Mine Emergency Rescue Teams in 2023

No.	Type of Subsidy	Funding (100 million RMB)
1	Equipment Purchase Funding	56.31
2	Emergency Drill Funding	3.38
3	Accident Rescue Subsidy	0.16
Total	59.85	

1、China’s Coal Safety Progress and Rescue System

1.4 The 12th National Mine Rescue Competition in China（2023）

- Theoretical Exam
- Comprehensive Skills
- Breathing Apparatus Operation
- Gas Detection (Chromatograph)
- First Aid
- Disaster Simulation
- Rope Rescue
- VR Drill











1、China’s Coal Safety Progress and Rescue System

1.5 One specialty, multiple skills

Forest Fire Rescue

Landslide Rescue

Urban Flood Drainage Rescue

Earthquake Rescue Training

Rope Training

Communication Support Training

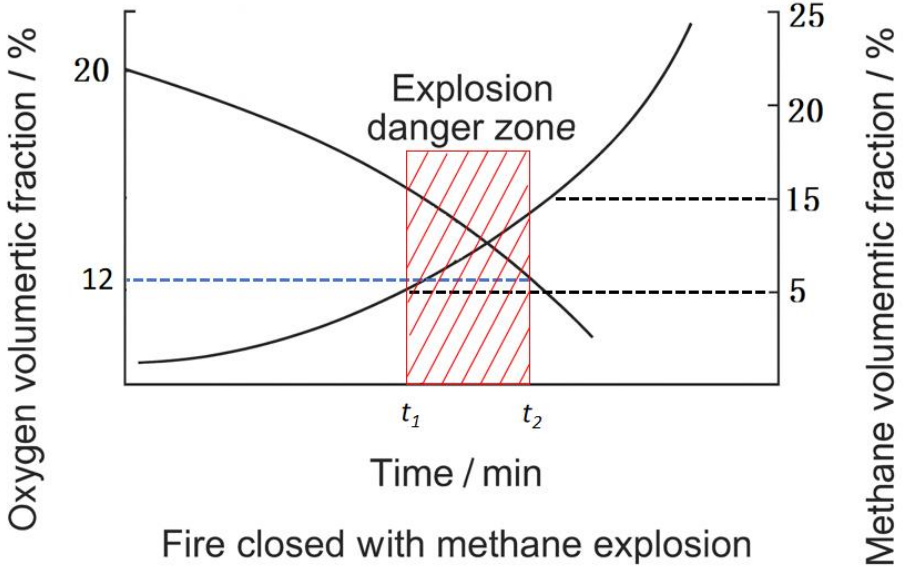
2、Mine Fire and Gas Explosion Hazards in High-Gas Mines

2.1 Mine Fires: The Most Dangerous Disaster in Coal Mines

Fire-induced explosions cause the highest number of fatalities.

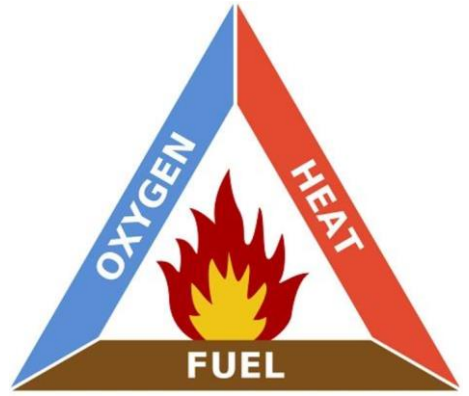
Examples of major disasters:

- 2010 Pike River Mine (New Zealand): 29 deaths
- 2013 Babao Coal Mine (China): 53 deaths
- 2022 Amasra Mine (Turkey): 41 deaths
- 2023 Kostenko Mine (Kazakhstan): 46 deaths
- 2024 Tabas coal mine （Iran）: 51 deaths



Direct firefighting underground is often impossible → sealing is the most effective control measure.

During sealing: methane + oxygen + fire source → explosion risk (t_1–t_2).



2、Mine Fire and Gas Explosion Hazards in High-Gas Mines

2.2 Sealing Operations in High-Gas Mine Fires

- Coal cutting sparks in high-gas mines are inevitable.
- Abnormal gas emission may lead to open flame risk.
- If direct firefighting fails → sealing is most effective.
- Regulations specify: Conditions for sealing; Sealing process; Management of sealed zones; Reopening requirements
- For explosive-risk fire zones, must follow:

1) Prefer ground drilling + grout injection or remote-controlled sealing;

2) Inject inert gas before underground sealing, then construct stoppings at safe positions.

3、Case Study: YuWu Mine Gas Fire – Conditions and Rescue Process

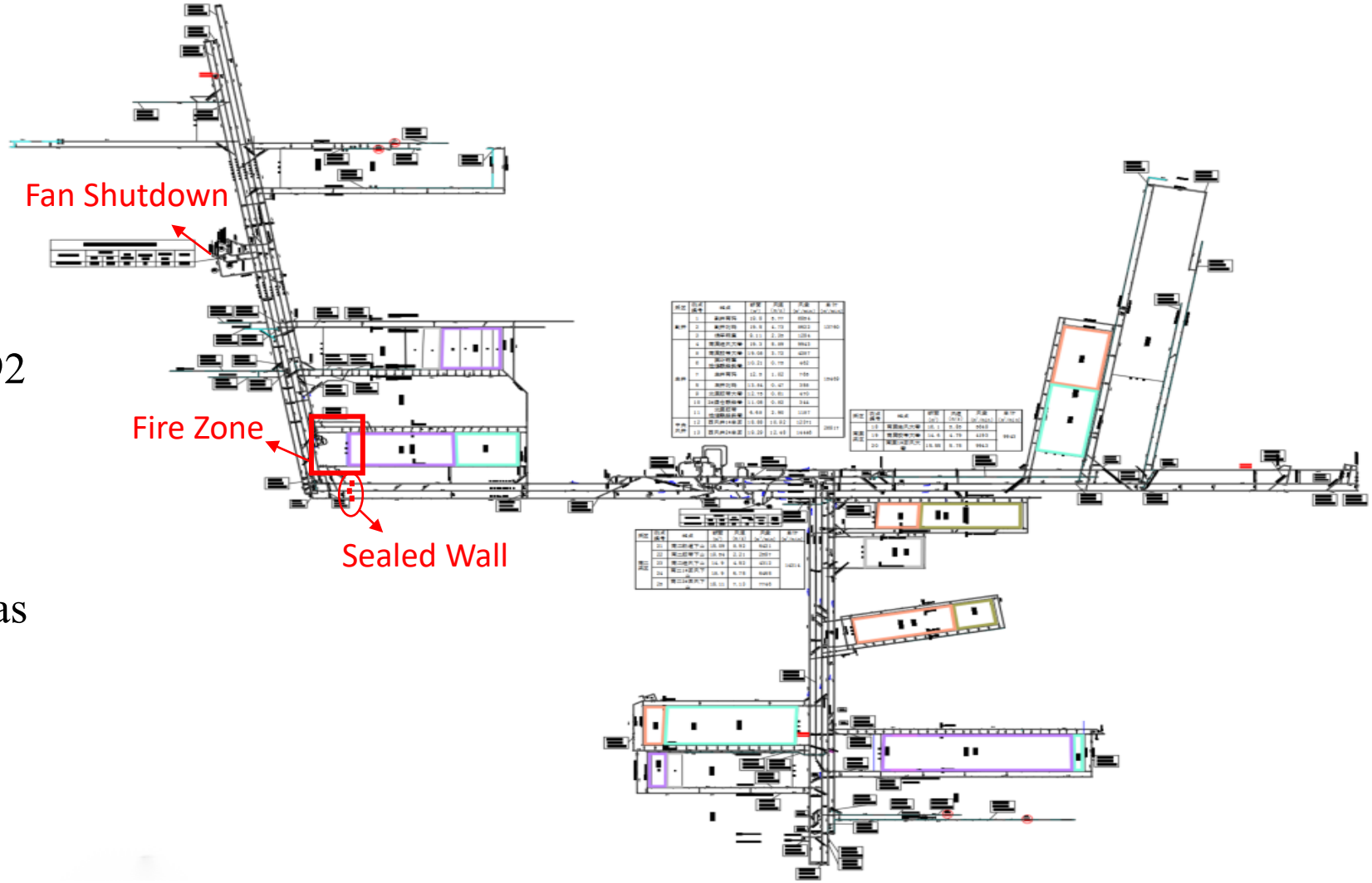
Geological: 1,024 m long, 6.6 m seam thickness, depth 510–534 m.

Reserves: 80 m remained by June 2011.

Ventilation: dual-U system, airflow 5,592 m^3/min.

Gas: methane emission 52.9 m^3/min.

Accident: June 22, 2011 – roof fall → gas accumulation → sparks ignited methane.



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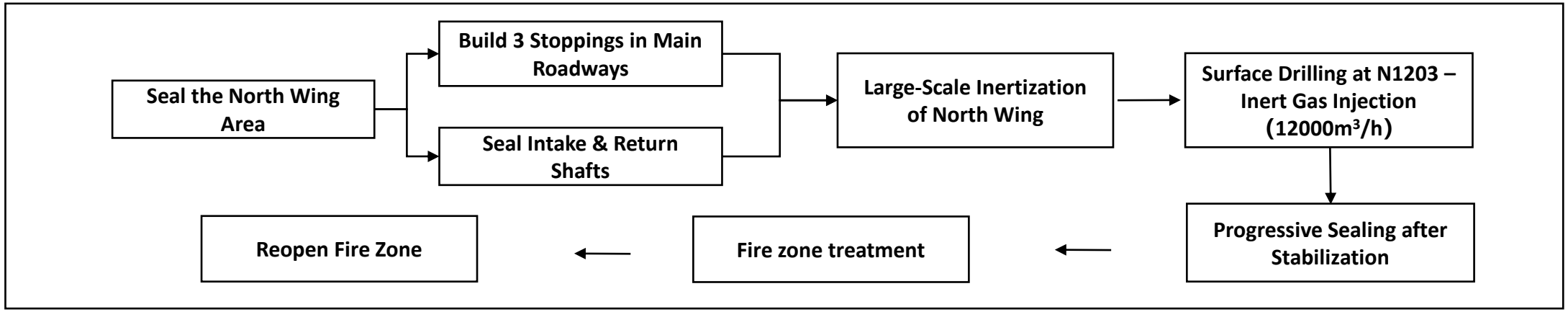
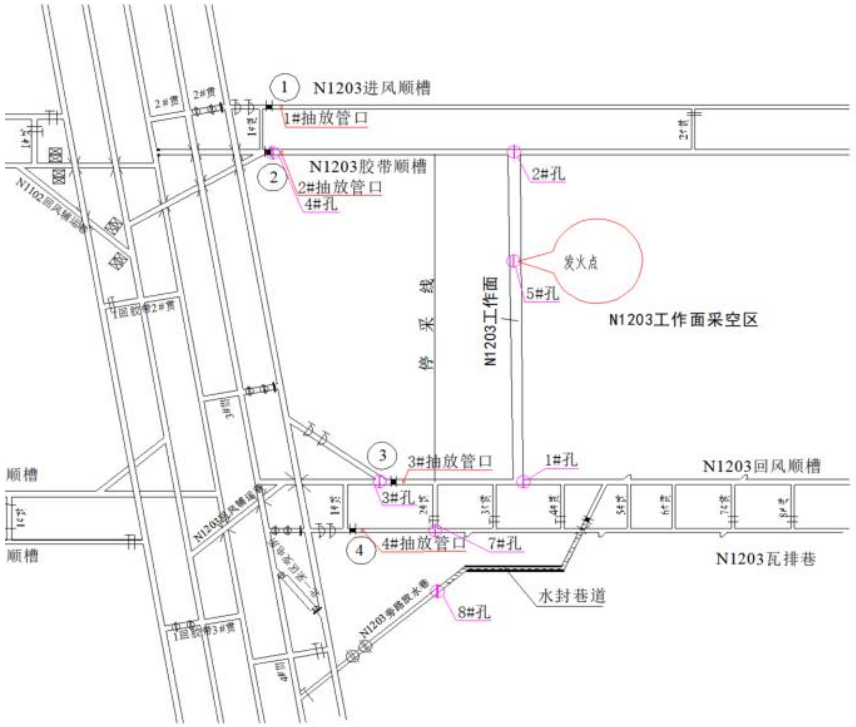
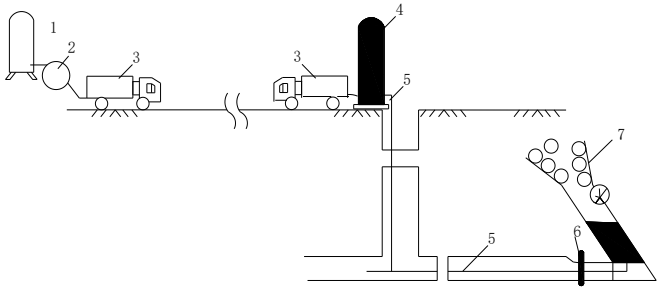


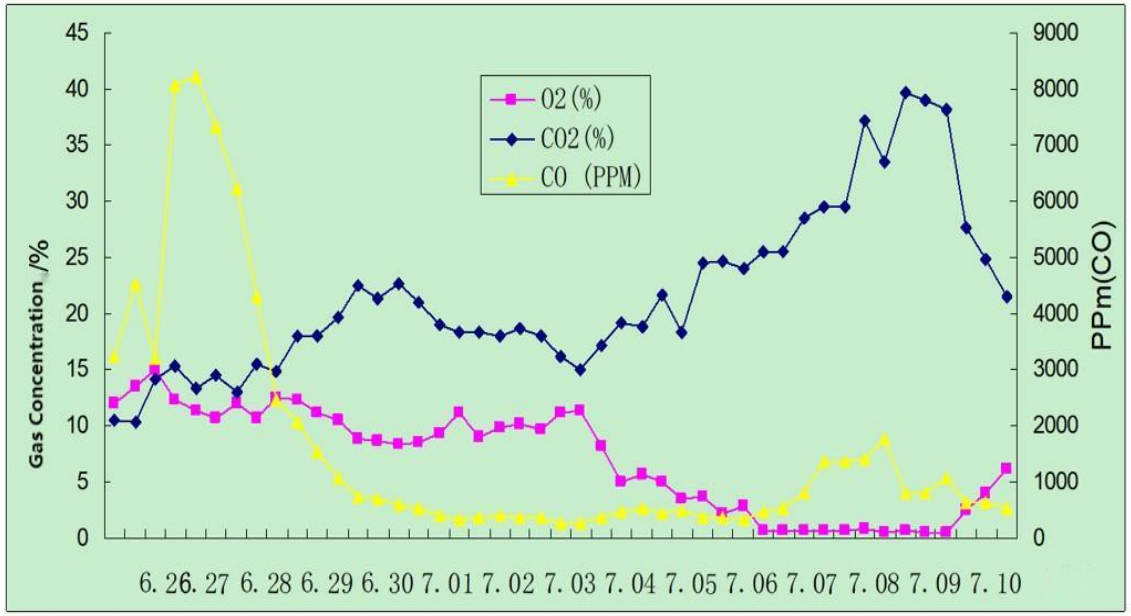


Ground Drilling



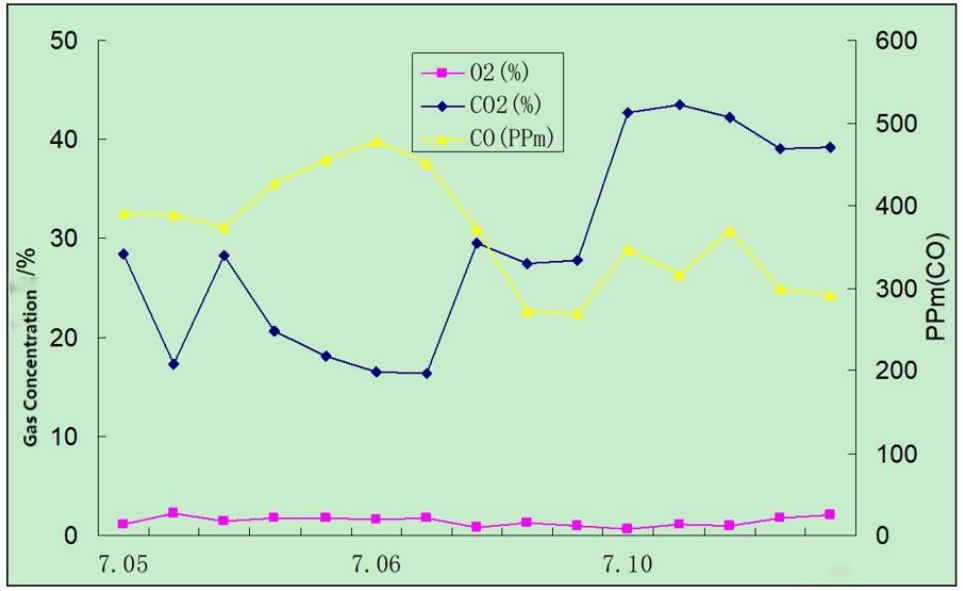
CO_2 Injection System

3、Case Study: YuWu Mine Gas Fire – Conditions and Rescue Process



Concentration Curves of gas inside the Explosion-Proof Cover of the North Airshaft

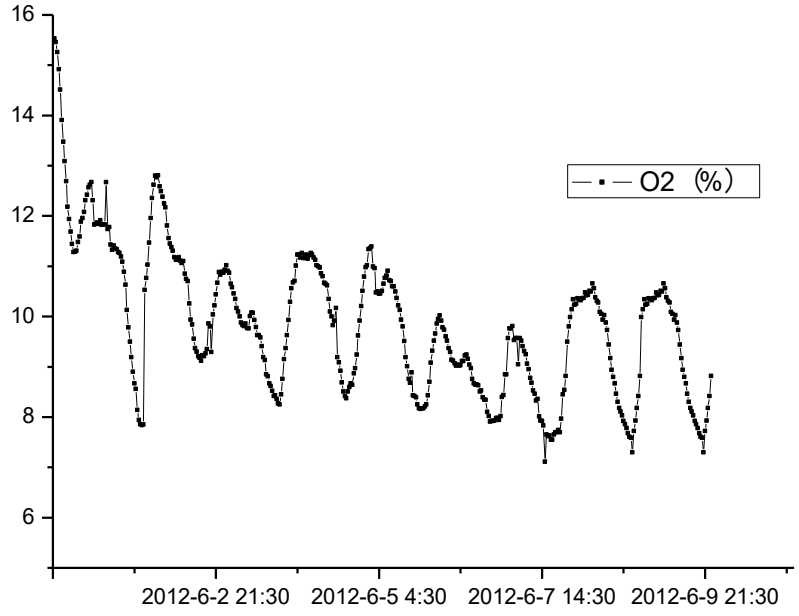
Injection Locations	Inert Gas Types	Injection Volume
Underground rail roadway, north of the stopping wall	CO_2（Gas）	1589660m^3
North wing intake shaft entrance	CO_2（Gas）	740t
Surface Borehole No. 1	CO_2（(Liquid）	233t
Surface Borehole No. 5	CO_2（(Liquid）	543t

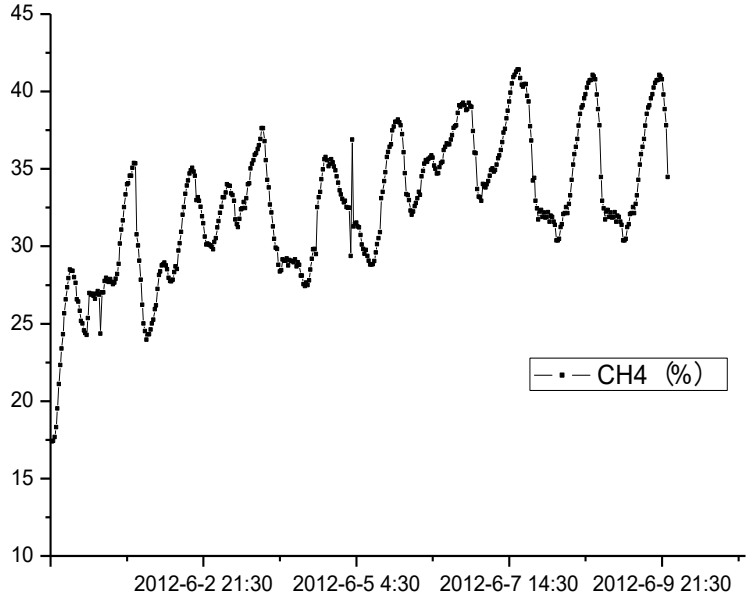


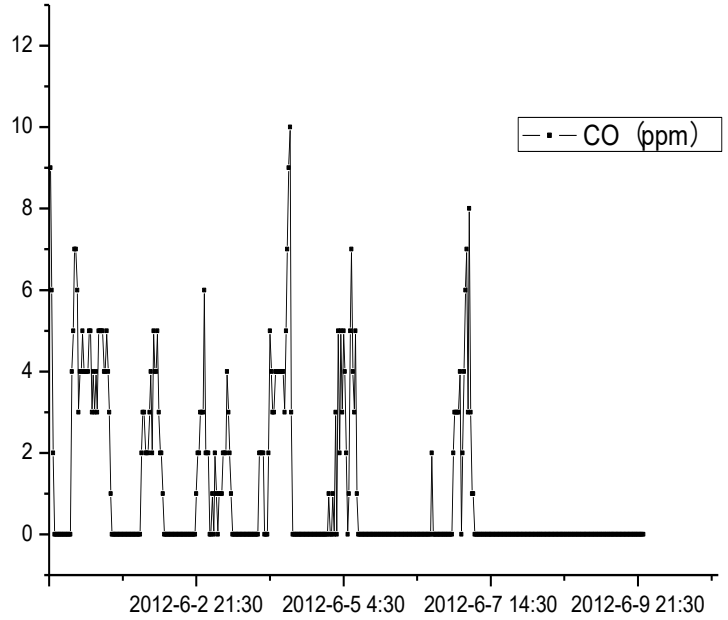
Variation of gas Concentrations at Surface Borehole No. 2

3、Case Study: YuWu Mine Gas Fire – Conditions and Rescue Process

- Fire zone sealed for one year, reopened on June 22, 2022
- Reopening results: only 3 hydraulic supports damaged
- Gas monitoring through surface boreholes before reopening
- Clear 'breathing phenomenon' in gas concentration observed
- Continuous monitoring prevents false judgment and ensures safety







Thank You!