

Analysis on Mine Gas Explosion Rescue Procedure and Technology

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Outlines

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1 Introduction

- Nearly half of the coal mines in China are High-gassy mines. Gas explosion accident is the most harmful accident which causes most of the injuries in coal mine accidents and broad influences in society in China.
 - The explosion destroys mine ventilation system, which may cause fire and even further explosion. With inappropriate disposal, it may make the disaster even worse and cause more injuries.
 - During the rescue operation in mine gas explosion, it is very necessary to follow the rescue principals and procedures, and have a good understanding of the technology to use to ensure a safe, quick and efficient operation.
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2 Features and difficulties for mine gas explosion rescue operation

2.1 Features of gas explosion

- **Sudden** : The sudden happening of accidents always put people in shock
 - **Catastrophic** : The accident causes many injuries and/or even threatens people's lives.
 - **Devastating** : The accident destroys roadways and ventilation system, and always with plenty of toxic gases overspread around.
 - **Complicated** : The explosion often inter-converts with fire, the changing of the environment and gas in disaster area is complicated which may cause explosion.
 - **Successive** : If there are ignitions in explosion area, it may cause a further explosion even successive explosions in gas accumulated section.
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2 Features and difficulties for rescue in mine gas explosion

2.2 Difficulties for mine gas explosion rescue operation

- The explosion happens suddenly, so it is difficult to make a right decision in a short time, which may cause the team take a risk to rescue due to fluster or miss the best chance for rescue due to hesitation.
 - Recover and stabilize the ventilation system, adjust and control the ventilation in disaster area.
 - Accurately monitor the gas components and dynamic changes in explosion area, analyze and assess the status and risks of explosion.
 - Sealing off the high-gassy fire area formed by explosion.
 - With potential risk of explosion, whether to take the rescue operation or not and how.
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3 Principals and procedures for mine gas explosion rescue operation

3.1 Basic principals for mine gas explosion rescue

- **Rescue Concept:** People foremost, rescue safely. Endeavor to rescue people in danger with life guarantee of the rescuers.
 - **Action Principals:** Consistent command, perform in order, analyze scientifically, sharp decision, follow the regulations, safely and rapidly.
 - **Rescue Principals:** Alive people first and easy task first. When there are many people in danger, we have to rescue the alive ones first, especially traumatized people, assist the lightly wounded people, and then move the bodies out. Give priority to the ones who are easier to be rescued in complicated circumstances.
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3 Principals and procedures for mine gas explosion rescue operation

3.2 Procedures and regulations

● Procedures:

When explosion happens, the people in disaster area must evacuate immediately, meanwhile report to mine control center—the control center notifies mine director, deputy directors, chief engineers and rescue brigade—mine director launches emergency rescue preparedness plan and establishes rescue headquarters—rescue brigade enters into the disaster area to look into the situation and rescue—the headquarters makes the rescue plan—rescue brigade rescues people, puts out fire, recovers ventilation—takes first aid to the injured, saves equipment losses, recovers the production until the end of rescue.

3 Principals and procedures for rescue in mine gas explosion

3.2 Procedures and regulations

● Rules in “Mine Rescue Regulations”:

- Mine director is nominated as the chief commander, and the other leaders and managers have to be involved in the rescue. The rescue headquarters makes rescue plan and organizes the rescue.
 - The captain of the mine rescue brigade is a member of the commanders, who should be involved in making the rescue plan and responsible for the rescue brigade. When his brigade cooperates with other teams to take rescue, the Captain who serves for the mine coordinates all the brigades.
 - The other members are in charge of the operation of main ventilators and hoisters and statistics of workers underground, analyzing staff distribution in disaster area, as well as preparing rescue materials and organizing hospitals to provide medical support.
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3 Principals and procedures for mine gas explosion rescue operation

3.3 Tasks and Procedures of mine rescue brigade

- **24 hours watch system, when the rescue brigade receives the alarm call, it must take actions within one minute and two branches must be sent to deal with gas explosion accident.**
 - **Establish surface and underground rescue bases, store and provide rescue equipments and devices, set up rescue preparedness team and first-aid people.**
 - **The rescue team should detect the disaster area first, and the team should include at least 6 people with necessary equipments.**
 - **The brigade implements the rescue plan made by the headquarters to rescue people in disaster area, recover ventilation and put out the fire.**
 - **Act to the disaster underground and save equipment, help recovering roadways and devices.**
 - **When finishing the rescue, the brigade has to return to the station with all rescue equipments and re-set the equipments as standby.**
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4 Technical Highlights of Mine Explosion Rescue

4.1 Recover and control the ventilation system

- In case of the whole ventilation system was destroyed, the ventilation should be recovered as soon as possible and kept stable.
 - The ventilation in disaster area should be recovered and adjusted based on the situation to avoid further explosion.
 - When there is no ignition: recovering the ventilation at once and rescuing people;
 - When there are ignitions: **a.** When the gas concentration is below the minimum of explosion, we should recover and control the ventilation to avoid gas accumulation and prevent the toxic gas from outburst; **b.** When the gas concentration is above the maximum of explosion, we should not supply air to the area to avoid the air flow diluting the high concentrated gas and provide oxygen which leads further explosion.
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4 Technical Highlights of Mine Explosion Rescue

4.2 The monitoring and analysis of gas components in explosion area

- Traditional analysis: Choosing gas sample at fixed time and places, and using gas chromatograph to analyze. It is dangerous for the rescuers enter into the explosion area for several times, and it may bring artificial errors by manual work.
 - The portable instruments based on optics, thermal catalyst or electrochemistry are affected by air pressure, temperature, humidity, serious short of oxygen and other high concentration gas, hence the data may not be accurate.
 - Mobile gas analyzing station and tube bundle monitoring system analysis: it could be installed once and for all, which decreases the labor intensity and the risk by entering into the disaster area for many times. The gas chromatograph could analyze and monitor various gas components in real time dynamically, and the data analysis is rapid, accurate and consistent and it could provide graphics to figure out potential explosion risks at any time.
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Mobile gas analyzing station and tube bundle monitoring system



In vehicle analyzing



**In vehicle part of the
tube bundle system**

4 Technical Highlights of Mine Explosion Rescue

4.3 Sealing off explosion area

- If there is an ignition in explosion area, when it is hard to put out fire directly or the gas concentration reaches 2% and even higher, the area should be sealed off after clear of people or in condition of all people died.
 - When sealing off the fire area, ensure the safety of rescuers, it should enlarge the sealing off area, and take long distance and wide sealing.
 - The inert gases should be injected into the area when sealing. The main inert gases we use in sealing are: CO₂ gas, liquefied CO₂, mixed inert gases through burning fuel to remove oxygen.
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CO₂ Gas Generator



Liquefied CO₂ Tank



**Fuel Inert Gases
Generator**



**Fuel Inert Gases
Generator**

4 Technical Highlights of Mine Explosion Rescue

4.4 The rescue in condition of ignitions or other potential risks

- It is essential to check gas and ignitions in roadway. When there is ignition and the gas concentration reaches over 2% and keeps going up, it is not allowed to enter into the area. The rescue could only be taken after eliminating the explosion risks.
 - When there are risks of high temperature and collapse, the commander could decide to send the rescue team into the explosion area only if it is very urgent to rescue people, but they have to take effective and safe measure to ensure the safety of rescuers.
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4 Technical highlights of Mine Explosion Rescue

4.4 The rescue in condition of ignitions or other potential risks

- When the roadway is long, the toxic gas concentration is high and the support is seriously damaged, with the confirmation of no ignition or alive people, the team should recover the ventilation and support first and then move the bodies.
 - When successive explosions happen and there is nobody alive in explosion area, the rescue brigade could not take the risk to enter into the area. In need of rescue alive people, the team could enter into the area only by knowing the interval of explosions and ensuring safety of team members. Once discovering the gas concentration is going up and even close to the range of explosion, the rescue team has to retreat immediately.
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4 Technical Highlights of Mine Explosion Rescue

4.5 It is essential to operate appropriately and avoid the following activities

- Incorrect number of rescuers entering into the explosion area or personal action;
 - Not wearing or taking off the breathing apparatus, or taking off face mask;
 - Unskilled operation or malfunction of breathing apparatus;
 - Incompletion of detecting and rescue or malfunction of equipment;
 - Without safe protection to operate in explosion area ;
 - Fatigued or exhausted;
 - Psychologically incompetent such as Fear or fluster.
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5 Conclusion and prospect

- It puts the rescue in risk because of complicated situation, potential explosion and technical limitation, we must make decisions and take actions based on the principals and regulations.
 - We should work together to research on the procedure and technology for rescue in gas explosion, and apply them reasonably in different situations.
 - We should research on some new technology and equipment such as robot technology which could rapidly enter into the explosion area to detect and search, computer technology, simulation on disaster environment and explosion possibility estimation, and mine rescue expert system, to realize the change from qualitative to quantitative analysis and decision, so as to improve rescue capability and safety.
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Thank you !