

China's Coal Mine Rescue Service and Breathing Apparatus*

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Introduction

Coal, the primary energy source in China, contributes more than 70% of the total energy consumption. The total raw coal output in 1992 was 1.11 billion tons. It is estimated that the coal production will reach 1.23 billion tons in 1995, and 1.4 billion tons in 2000.

The accidents in China's coal mines are serious. Methane explosions, coal and methane explosions, coal dust explosions, fire and the spontaneous combustion of coal are the main hazards. In 1992, the fatality rate in state-run coal mines was 1.06 persons/million tons, the fatality rate in local state-run coal mines was 5 persons/million tons, which translates to about 1000 victims. The fatality rate in coal mines run by villages and towns was 10 persons/million tons, or about 4000 victims. From January to November, 1993, five accidents occurred in state-run coal mines with more than 10 victims in each accident. On January 18, 1993, a gas explosion took place in the Panyi Coal Mine, Hainan Coal Mine Adminis-

tration, Anhui Province. There were 39 victims. On May 8, 1993, a methane explosion took place in No. 11 Coal Mine, Pindingshan Coal Mine Administration, Henan Province. There were 39 victims. On April 2, 1993, a coal-dust explosion occurred in Linshen Coal Mine, Shenyang Coal Mine Administration, Liaoning Province. There were 23 victims. On March 27, 1993, an outburst of methane with coal occurred in Baijiao Coal Mine, Furong Coal Mine Administration, Sichuan Province. There were 11 victims. On October 27, 1993, a methane explosion occurred in Junhuagong Coal Mine, Datong Coal Mine Administration, Shanxi Province. There were 28 victims.

The control and prevention of great accidents is impossible. The coal mine rescue team is the major and most important rescue force after the accident occurs. At present, the major task is to set up and develop China's coal mine rescue service system.

China's Coal Mine Rescue Service

Main Points of the Coal Mine Rescue Regulations

The Mine Safety Law issued by the state stipulates that mines must set up a professional or voluntary rescue system, outfitted with necessary

equipment and medical supplies. Most rescue team members in the chemical and metallurgical industries are volunteers. For the serious accidents occurring in coal mines, the Coal Mine Safety Regulation issued by the Ministry of Coal Industry stipulates that members of coal mine rescue teams must be professional.

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In China, each mining area sets up a rescue centre station with more than three rescue teams, with not less than nine members per team. The rescue centre station provides rescue service for all coal mines in the mining area. The distance between the rescue centre station and each coal mine is not more than 10 km, or a 15-minute drive. Another rescue station must be set up if the distance is greater. The coal mine rescue station consists of three rescue teams. The first rescue team must start off in one minute after the coal mine rescue station receives notice of the accident. The rescue centre station must be equipped with enough breathing apparatus, compressed-oxygen self-rescuers, foam and nitrogen fire extinguishing equipment, gas test instruments, rescue vehicles and communication equipment, etc. At present, there are 143 rescue centre stations, 1805 rescue teams and 13,538 rescue members in China.

Task of the Coal Mine Rescue Service

The main tasks of the rescue brigade are: personnel rescuing, accident handling, precaution and checking, methane discharging, opening and sealing of fire areas, training of volunteers and underground fire-fighting, etc. The work of the rescue centre station is the management and training of rescue members, and storage of rescue equipment.

The Safety Department of the Ministry of Coal Industry is the management and command centre of the national coal mine rescue stations. Its main tasks are to supervise the implementation of the Coal Mine Safety Regulations, Coal Mine Rescue Regulations, and Military Mine Rescue management measures, and to coordinate rescue centre stations to provide mutual support when needed and to deal with important disasters occurring in coal mines. The main means of communication is radio. Each rescue centre station is equipped with a 100 W radio. The communication centre is located in Beijing.

In 1992, 10,037 accidents were handled by the national coal mine rescue teams, 5636 personnel were rescued, 103,428 precautionary checks were made, 12,240 methane discharges were made, and 1224 fire areas were reopened.

Training and Competition of the Coal Mine Rescue Teams

The training of the rescue members includes the study of fundamental theories, physical training, and the rescue techniques. The most important training concerns the breathing apparatus including study of the breathing circuit theory, structure, replacement of the oxygen cylinder and carbon dioxide absorbent, methods of testing and wearing breathing apparatus in high temperatures and heavy smoke. The high temperature and heavy smoke training for most rescue centre stations is conducted in underground simulated roadways. With the mode of manual ignition, the high temperature and heavy smoke test approaches reality, but the temperature and the smoke density cannot be controlled effectively. It is necessary to set up a high temperature and heavy smoke building in the future.

In order to test the training level of every rescue centre station, the provincial rescue competition is conducted by the provincial coal mine administration every year, and the national rescue competition is conducted by the ministry of Coal Industry every three years. Theoretical knowledge, physical quality, fire fighting techniques, and breathing apparatus operation technique are the main content of the test. Ten excellent rescue teams are rewarded by the Ministry of Coal Industry. The third national rescue competition will be held in 1994.

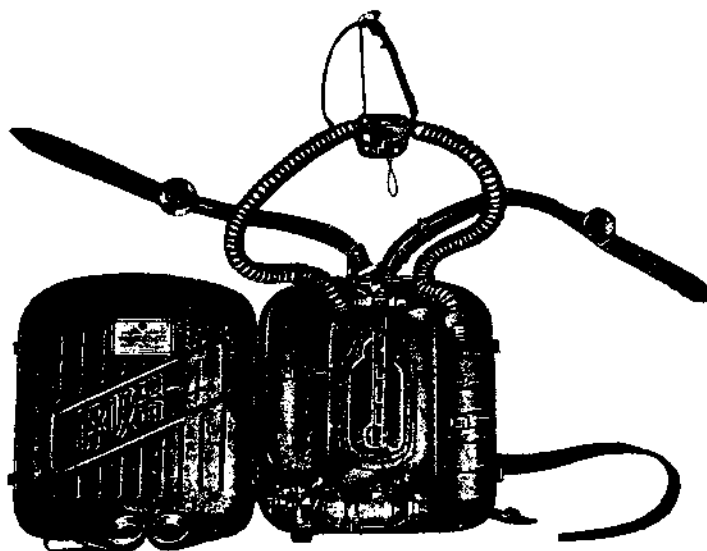
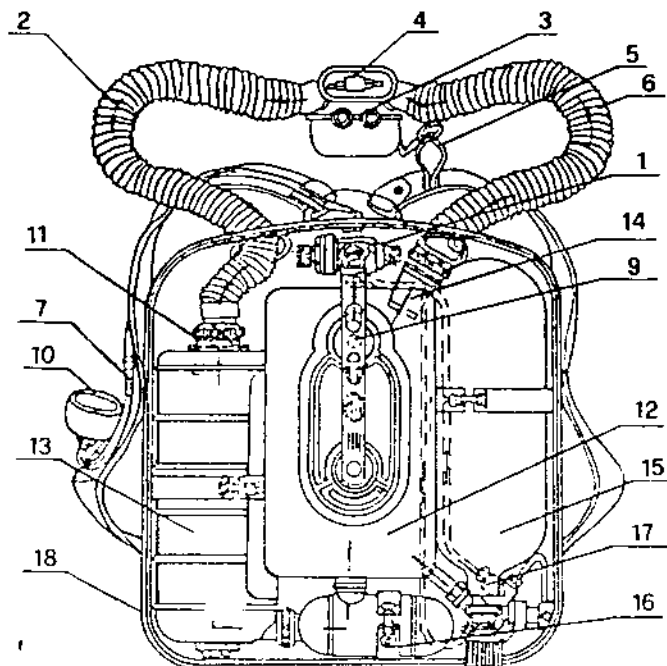
Development of the Compressed Oxygen Breathing Apparatus in China

The introduction of the breathing apparatus AHG-4 in China dates back to the 1950s. The technical data are given in Table 1, and a sketch of

the equipment is shown in Figure 1. After using this type of breathing apparatus over a 40-year period, the following problems have been observed:

Items \ Type	AHG-4	AHY-6
Duration of use	4 hours	4 hours
Capacity of oxygen cylinder	2 litres	2 litres
Charging pressure	200 bar	200 bar
Oxygen supply	400 litres	400 litres
Weight of sodalime	1.8 kg	2 kg
Constant dosage	1.1~1.3 l/min	1.3~1.5 l/min
The opening pressure of the relief valve	2~3 mbar	1~3 mbar
The opening pressure of the lung demand regulator	—1.5—2.5 mbar	—1~—3 mbar
The oxygen supply of the lung demand regulator	>100 l/min	≥60 l/min
The oxygen supply of the manual booster valve	>90 l/min	>150 l/min
Breathing bag capacity	4.0 l	4.5 l
Dimensions	415X385X195mm	450X375X165mm

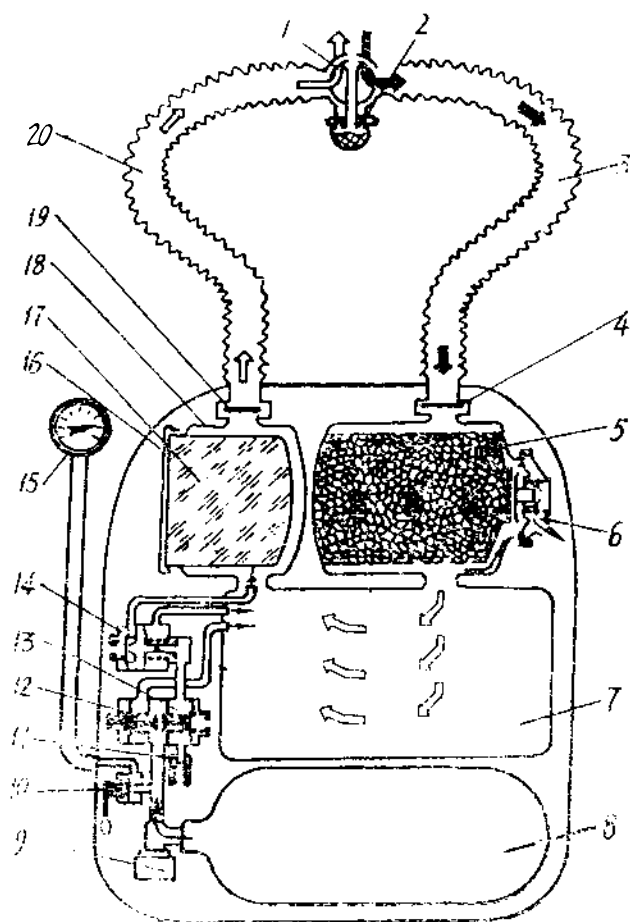
Table 1. Oxygen breathing apparatus technical data.



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|---------------------|----------------------------|------------------------|
| 1. Pressure reducer | 7. Manual signal | 14. Inhalation valve |
| 2. Exhalation hose | 9. Pressure relief valve | 15. Oxygen cylinder |
| 3. Saliva trap | 10. Pressure gauge | 16. Water trap |
| 4. Mouthpiece | 11. Exhalation valve | 17. Oxygen distributor |
| 5. Noseclip | 12. Breathing bag | 18. Light metal frame |
| 6. Inhalation hose | 13. Regenerating cartridge | |

Figure 1. Diagram of the breathing apparatus AGH-4.

- The mouthpiece and the noseclip connects the breathing apparatus to the face and mouth. When the wearer sweats, it is easier to dislodge the noseclip and mouthpiece.
 - Manual signaling cannot satisfy the needs of communication for the rescue members. In an emergency, speaking through the mouthpiece can result in carbon monoxide poisoning.
 - The supply of extra oxygen and pressure relief of the breathing bag depends on the relative movement of the breathing bag and the valve lever. The high-pressure air pipe is too long, has too many links and too many breakdowns.
 - The sodalime, used as the carbon dioxide absorbent, does not have a cooling system. This results in the inhalation air temperature reaching 50°C.
 - Small-diameter breathing hose coupled with the regenerating cartridge shape results in a high breathing resistance.
 - The oxygen cylinder is located on one side of the breathing apparatus and results in an unbalanced load when the wearer dons the breathing apparatus.
- In 1987, the breathing apparatus AHY-6 was developed. Its technical data are given in Table 1 and a drawing shown in Figure 2. Its main features are as follows:



- | | | |
|---------------------------|-----------------------------------|----------------------|
| 1. Apparatus connector | 8. Oxygen cylinder | 15. Pressure gauge |
| 2. Saliva trap | 9. Cylinder valve | 16. Cover of ice box |
| 3. Exhalation hose | 10. Pressure gauge shut-off valve | 17. Ice |
| 4. Exhalation valve | 11. Warning signal | 18. Ice box |
| 5. Regenerating cartridge | 12. Manual booster valve | 19. Inhalation valve |
| 6. Pressure relief valve | 13. Pressure reducer | 20. Inhalation hose |
| 7. Breathing bag | 14. Lung demand regulator | |

Figure 2. Diagram of the breathing apparatus AHY-6.

- The lever controlling the demand for extra oxygen and pressure relief for the breathing bag has been replaced with a pressure regulator, the high pressure pipeline has been shortened, and the safety reliability of the breathing apparatus is improved.
- The mouthpiece and nose clip have been replaced with a full-face mask.
- The full-face mask is equipped with a radio for communication.
- The system is equipped with an ice powered cooling system to reduce the breathing air inhalation temperature to below 38°C.
- The cross-section area of the breathing hoses and the regeneration cartridge has been increased, which results in reducing breathing resistance.
- The oxygen cylinder is now located at the bottom of the breathing apparatus. The breathing apparatus is now balanced on the back of the wearer.

- The weight of the breathing apparatus has been reduced.

At present, the breathing apparatus AHG-4 is replaced by the breathing apparatus AHY-6 in

China. Foreign companies are welcome to invest or to produce positive-pressure breathing apparatus in China. We hope to cooperate with foreign producers and develop the breathing apparatus market of China.

The Use of Self-Rescuer Apparatus in Coal Mines

According to the operating principle, the self-rescuer has three types: filter, chemical oxygen, and compressed oxygen self-rescuers. The technical data for the three self-rescuers are given in Table 2.

The choice of self-rescuers with different duration of use times depends on the distance between the miner's working place and the down-cast shaft or the main airway. The longer the distance, the longer the duration of use time.

The coal and methane outburst mines must choose the chemical oxygen or the compressed oxygen self-rescuer. Most of the outburst mines choose the chemical oxygen self-rescuer for its cheaper price and lighter weight.

The mine rescue member must be fitted with the compressed chemical oxygen self-rescuer as

spare equipment for rescuing miners in toxic atmospheres.

Most of the coal mines are more likely to choose the filter self-rescuer, since it can be stored for a five-year period and used for a three-year period. After three years of use, the filter self-rescuers can be repaired by technicians at the mine maintenance shop. The technicians must have training approved by the national Coal Mine Safety Products Quality Test Centre, which also monitors such repair work.

At present, the coal managers are training the miners to use the self-rescuers, improve their self-rescue consciousness, and to use the self-rescuers quickly and correctly.

Items Type		Duration of use (min)	Weight (kg)
Filter	AZL-40	40	≤1.1
	AZL-60	60	≤1.1
	AZL-90	90	≤1.1
Chemical oxygen	AZH-10	10	1.2
	AZH-20	20	1.7
	AZH-40	40	2.3
	AZH-60	60	2.7
Compressed oxygen	AZY-15	15	≤2.5
	AZY-30	30	≤3
	AZY-45	45	≤3.5
	AZY-60	60	≤5.5

Table 2. Self-rescuer technical data.