

Research on Gas Monitoring Technology in High Gas Tunnel of the No. 2 Danjing Tunnel

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Abstract: According to the specific circumstances of the No. 2 Danjing Tunnel in the second ring highway of Chengdu (eastern), This article introduces the types of gas tunnel disaster and condition, monitoring purpose and content, the list of No. 2 Danjing tunnel gas monitoring of key parts, through monitoring technology of the gas (including: gas automatic monitoring system, manual monitoring) for all the key parts of real-time monitoring, to ensure the safety of high gas tunnel construction. At the same time, this paper also accumulates valuable experience for the construction of similar projects in the future.

Keywords: High gas; Tunnel gas; Monitoring technology

1. Introduction

The No. 2 Danjing Tunnel is a high gas tunnel of Chengdu Second beltway highway (East) at the junction of Jiayang and Shuangliu. The road is a two-way six lane highway, roadbed width for 33.5 meters, design speed of 100km / h. The No.2 Danjing tunnel is located in the same tectonic belts which have been built on top of the tunnel through gas formation of the Jurassic sandstone and mudstone. Some gas overflowed. The project has been designed all by high gas tunnel, so defined the No.2 Danjing Tunnel as a high gas tunnel. Left hole of The No.2 Danjing is 3371 meters, starting point ZK102+177, stop point ZK105+548. Right hole is 3404 meters, the starting point of the pile number is K102+174, stop point pile number K105+578. Left hole , right hole a total length of 6775 meters, the maximum depth of the tunnel is about 365m. Surrounding rock level is IV, V, single hole is designed by the three lane tunnel. The tunnel sited in Longquan Mountain natural gas overflow ,with No. 2 Danjing inlet see natural gas plant 1, drilling in case of sand body of reservoir performance is poor, with obvious characteristics of low permeability sandstone and reservoir characteristics, but good reservoir sand body with good permeability under low porosity and low permeability[1].

2. Content, Purpose and Basis of Gas Detection

2.1. Content of gas detection

Gas disaster is a kind phenomenon of gas impact on the human life and production [2], and the main disasters in gas tunnel engineering, such as: asphyxia, toxic, explo-

sive, flammable, coal and gas outburst etc, of which the disaster caused by gas explosion in tunnel construction is one of the greatest and most serious disasters [3]

The gas explosion caused by the need to meet certain conditions:

- Gas concentration
- Ignition temperature
- Oxygen concentration

From the above three conditions, the first two conditions are to be controlled by the artificial monitoring, third conditions are uncontrollable, because the oxygen concentration in the tunnel must be in 20%, to meet the people's living environment. Therefore, to achieve the purpose of safety in production, it is necessary to strict control gas concentration and the using of tunnel surface fire, through the real-time monitoring of gas, control and prevention of disallowed gas concentration is the key to preventing gas explosion occurred.

Gas monitoring is one of the main measures to prevent the gas accident, continuous monitoring and timely analyzing gas concentration of the tunnel excavation and vitiated air, realization of tunnel construction process, gas automatic monitoring, early warning and controlling. According to the related regulations, combined with No.2 Danjing tunnel construction with the actual situation, real-time monitoring and recording the changes in the parameters of the tunnel construction in the process of gas, carbon monoxide and hydrogen sulfide, and monitoring of tunnel ventilation, to dilute and toxic and harmful gas emissions, to ensure that the air quality in the tunnel conforms to the production standard.

2.2. Gas monitoring purpose

To develop the tunnel monitoring projects: tunnel gas concentration, CO concentration, concentration of H₂S; secondary lining trolley gas concentration and wind speed; vitiated air concentration, wind speed.

Prevent disasters which caused by harmful gas concentration exceeding, ensure the construction safety and construction of normal in construction process [4];

Based on the real-time feedback value of gas concentration monitoring, take different measures to take immediate action once overrun;

Observe the effect of gas drainage and prevention measures in tunnel all the time, scientific and rational guidance tunnel construction, provide the basis for the safety construction organization.

2.3. Monitoring basis and implementation standards

The No.2 Danjing tunnel gas monitoring mainly based on the “Interim Provisions of the Risk Assessment and Management of Railway Tunnels” “Code for Construction of Railway Tunnels” and “Safety Regulations of Coal Mine”, laws and regulations, the relevant literature , investigation and analysis of the safety risk of tunnel construction, the establishment of corresponding supervision measurement scheme.

3. Gas Monitoring System

3.1. Gas monitoring method

According to the regulations with the actual situation of Danjing tunnel, it combined manual detection of portable tester with gas automatic monitoring system. Through automatic monitoring, monitoring system covering the key parts of the tunnel and prone to gas accumulation of the site, to achieve real-time monitoring and early warning; through the manual monitoring, to achieve a full range of tunnel gas data acquisition and validation, the tunnel gas monitoring network structure shown in Figure 1.

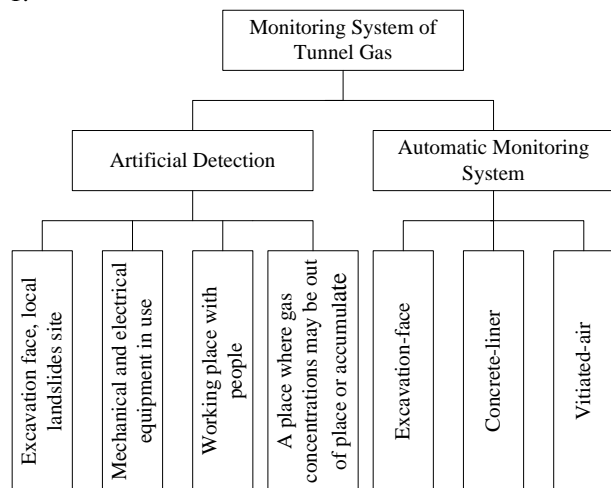


Figure 1. The tunnel gas monitoring network structure

3.2. Key Parts of Gas Monitoring

According to the requirements of the gas control, the focus of the No.2 Danjing tunnel is as follows:

- Excavation face and the wind flow in the vicinity of 20m;
- The change of section at the junction of the upper, lining and lining at the junction of the upper and the not so easy to accumulate inside lining gas areas;
- The air flow in the 20m range of the local fan;
- Vitiated air;
- Cavern and tunnel;
- Mechanical, electrical equipment and switches in the vicinity of the 20m range;
- Welding operations, cutting operations in the vicinity of the site 20m;
- Gas overflow in rock fracture, karst cave, fault or goaf;
- Local bad ventilation section.

4. Gas Monitoring Method

4.1. Manual monitoring of gas

Gas monitoring by the monitoring unit and the construction team together, the gas automatic monitoring and control by the monitoring unit, the construction team (automatic monitoring of the signal line protection, sensor suspension set aside for the hook and protection).

The production of Chongqing light interference methane portable gas detection instrument CJG-10 or portable methane detector JCB-4 artificial monitoring, construction teams each work team is also equipped with tile inspection instrument, particularly is welding operations, in the construction process at any time to check the gas concentration. Manual monitoring of the implementation of 24 hours of uninterrupted inspections to detect, reduce the risk of accidents, ensure the safety of construction. Construction work teams and groups are also equipped with the necessary inspection staff. The gas inspection must comply with the provisions of the relevant rules and regulations, and related certificates, see the following car with gas system

The inspector must be qualified by a qualified department and the person who has obtained the qualification certificate. The inspector shall be responsible for the ventilation and gas work in the area under the jurisdiction;

Personnel should be equipped with the necessary safety equipment when working with the gas detector;

Instrumentation equipment: should be equipped with a number of CJG-10 type light interference methane detector and a portable methane detector JCB-4 for the inspection of the power of the person and gas control technology;

Place a check: tunnel face, return air, gas abnormal emission point, advance drilling when drilling, hole fire place in 20m and other locations;

4.2. Automatic gas monitoring

The No.2 Danjing tunnel real-time monitoring using wireless remote real-time monitoring technology, into the hole and the hole are respectively provided with a center field control station, layout in the tunnel mouth about 20 meters position, field station set to host computer 1, printer a, 1 set of data communication interface, video encoding converter A, wireless data receiver a, switches. The gas sensor, the wind speed sensor, the camera, the power down instrument, and so on, are arranged according to the fourth chapter. Each sensor monitoring data through the wireless data transmitting module, after 3G wireless bridge and relay amplifier is transmitted to the field center control station wireless data receiving module, wireless data receiving module are connected by a cable network and data communication excuse, data communication interface through the data line and a host computer connected. Host computer monitor signal via the Internet remote real-time transmission, transfer to the project owners, construction units, supervision office and monitoring command center tunnel signal no need for optical fiber transmission cable, only through the wireless bridge could be transmitted, thereby greatly reducing the circuit protection of the work.

In the layout of gas sensor, each hole of the tunnel face installed three gas sensor (installed in cross section maximum gas position), in secondary lining trolley installed three. With the construction of the working face, the layout of the gas sensor can be adjusted dynamically. At the same time in the face and two lining trolley return, install anemometer for the tunnel speed monitoring.

In order to ensure the gas concentration in the tunnel, it is necessary to reduce the loss of the gas concentration in each hole, 1 sets of automatic power failure instrument, the specific location and the scope of power cut by the construction unit according to the construction process to determine.

The automatic monitoring system of setting alarm gas concentration is 0.75%, gas concentration reached 1.5% when the instrument automatically start off. In principle, the gas concentration in the tunnel is less than 0.5%, so that the normal operation can be carried out.

4.3. Gas monitoring implementation

Of tunnel of tour gas inspection frequency: non gas section, tunnel face, return to the tour gas inspection for every 8 hours gas inspection not less than 3 times; gas, when the tunnel gas concentration is less than 0.5%, once every 1 hour detection; when the tunnel gas concentration is greater than 0.5% should be detected at any time, shall not be allowed to leave the tunnel face, it is found that the abnormal gas should be promptly reported to; advance borehole drilling gas-inspector each section of the drill pipe inspection first drilled gas; blasting must be

carried out when the "three check" and checked once every 10 minutes when a fire inside the cave.

Check the gas filling system is implemented, tile inspection staff in the field testing data must timely fill in, do artificial field inspection records, including location and pile number, work content, detection time, gas concentration, testing personnel.

Gas-inspector implemented the scene shift, no air leak class;

When the gas gauge, cut off the power supply in the tunnel, to stop the operation, the withdrawal of personnel, processing and immediately report to the leadership and field operations personnel on duty. When the gas concentration is down to 0.3%, it can inform the workers to enter the scene, and resolutely stop the gas overrun;

Check the gas safety hidden danger in the tunnel construction, find the problem and deal with it in time, and report to the relevant person in charge;

According to the operating procedures for gas inspection, do a good job in the daily maintenance of the inspection instrument. Monitoring personnel operating procedures and matters needing attention:

The monitor of the certificate, master the performance monitoring system, proficient in the operation of monitoring system and daily maintenance. :

Every day to check into the tunnel monitoring system, sensor substation and transmission line is intact, found that the problem should be timely treatment.

Every day to enter the tunnel must carry a portable gas-alarming, check the accuracy of the monitoring system sensor. Found that the error is more than 8, should be less than 0.2% hours in the help of the tile inspector to complete the debugging work, and do a good job of record. Inform to the relevant leaders in time after going out the tunnel.

Gas monitoring system can't be closed, to ensure the normal operation of the system, found that the system failure, must be dealt with as soon as possible, and to report to the relevant leaders.

Duty officer must be careful to fill in the records of system operation, and with the next shift personnel face to face.

In the presence of gas overrun alarm, must immediately notify the inspectors and the project Department of the person in charge.

System operation records, monitoring the daily sheet and host data and curve must be permanent safekeeping for future reference, forbids anyone to delete the history data of host.

4.4. Construction teams each operation team

The Constructing teams in the construction work, to strengthen the safety and safety of gas control and other safety work, note that the following:

The hole will be prohibited lighters, matches and cigarette into the cave, in principle, can't carry the mobile phone into the hole;

Into the hole must wear a safety helmet and other protective measures, trolley aerial work safety belt;

Construction team the operations team must carry portable gas alarm into the hole, before the operation of the operating range of 20m near gas detection, gas concentration is less than 0.5%, to begin operations, engineering operations need the gas alarm apparatus in the suspension within the operating range, especially with fire, welding, drilling and easy to produce spark homework but also to strengthen the gas self inspection work;

In accordance with the relevant guidelines, the automatic monitoring of gas sensor alarm concentration was 0.49%, in order to cause the operation of emergency response personnel, only excessive gas alarm (CO and H₂S alarm sound off, because as long as blasters, CO and H₂S will be exceeded, if the alarm, long time workers will be paralysis), CO and H₂S excessive response at any time to project department; if the alarm, taking measures immediately: firstly all operations, strengthen the ventilation and timely reporting, gas concentration dropped to safety and construction work.

After blasting, must and 15 minutes before entering cave construction. If excessive gas or CO and H₂S exceeded more serious, the need to strengthen ventilated, and the gas concentration to greatly reduce the security range and concentration of CO and H₂S to entering cave construction.

Strengthen the ventilation is one of the most efficient methods for the prevention and control of gas, therefore, the tunnel should always ventilation, before blasting it not prematurely shut down fan. After blasting shall be timely open fan.

In order to ensure the safety and speed up the construction progress, the construction team should cooperate with the artificial and automatic monitoring work:

Inform gas monitoring units to implement the "three check" system before charging and blasting.

Before shooting to protect the face of the sensor and signal line, pay attention to mobile and mobile trolley back protection signal line.

Attention to the movement of the signal line and the protection of the two liner trolley.

In the construction process, the left and right tunnel construction teams pay attention to the protection of the signal line.

At the beginning of the lining, every 30m in the left hole: vault, right arch waist, right arch foot; right hole: vault, left arch lumbar, left arch foot set aside hook (can be used with steel hook), used to hang gas sensors and signal lines.

5. Conclusion

The profound analysis gas monitoring purposes: to ensure the safety of the tunnel construction, and strictly control the gas tunnel in toxic and harmful gas concentration is very important; gas concentration control of tunnel gas has become the prerequisite for construction safety.

The monitoring technology of high gas tunnel of the No. 2 Danjing was used to combine the automatic monitoring system with the manual monitoring system. This in-depth study of gas monitoring technology, sums up the light interference characteristics of portable methane gas detection instrument CJG-10, a portable methane detector AZJ-2000 such as artificial monitoring and discuss the key parts of gas monitoring, analysis of the gas circuit monitoring frequency, as well as the "three check" scheme; at the same time, summed up the gas automatic detection instrument, instrument selection, reasonable layout of monitoring probe. For the effective grasp the gas concentration inside the tunnel must be combined with artificial detection and automatic gas detection technology, through the automatic detection, monitoring and surveillance system coverage and key parts of the tunnel and prone to gas accumulation in the site, to achieve real-time monitoring and early warning; supplemented by artificial monitoring, to achieve a full range of tunnel gas data acquisition and validation, in order to achieve a full range of tunnel, no dead angle of dynamic monitoring.

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