Meiting Niu *et al.* NEM:FOMI(2024)03
DOI: 10.62022/FOMI.issn3005-5466.2024.01.011

ISSN: 3005-5466
EISSN: 3005-5474

ARTICLE Open Access

Implementation Measures for Fire Work Safety in Gas Area of Metallurgical Enterprises

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Abstract: It is an important task to control the dangerous operation of gas fire and reduce the occurrence of gas fire and explosion accidents in ensuring gas operation safety in metallurgical enterprises. Combined with the requirements of current laws, standards and practical experience, the key points in fire safety management and control are analyzed to solve the gas fire safety problems.
Keywords: gas; fire operation; safety; countermeasures

Introduction

Gas, as a major byproduct of metallurgical enterprises, is a good secondary energy source and its application range is becoming increasingly wide. The characteristics of gas determine the existence of hazardous factors such as poisoning, flammability, and explosiveness. Once these hazardous factors are out of control, they can lead to the occurrence of various accidents. This article elaborates on how to ensure the safety of hot work in the gas area of metallurgical enterprises, combined with on-site practice and knowledge of gas hot work safety [1].

According to the gas safety regulations of industrial enterprises, gas hazardous areas refer to places where the carbon monoxide content in the air exceeds 30 mg/m^3, gas facilities, backup equipment, backup pipelines, gas pipelines, phenol wells or trenches that may contain or infiltrate gas [2]. Hot work in gas areas refers to temporary operations that may generate sparks, flames, and red hot surfaces during welding and cutting operations in gas areas, as well as the use of blowtorch, electric drill, grinding wheel, etc. in flammable and explosive areas. From the definition alone, it can be seen that the range of gas hazardous areas is relatively wide, indicating that gas hazardous areas are prone to various safety accidents due to the presence of gas or residual gas. The safety of hot work in gas areas has become one of the elements for the safe operation of gas systems in metallurgical enterprises. To ensure the safety of hot work in gas hazardous areas, the following aspects should be taken into account [3].

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1 Hot work management in gas hazardous areas

1.1 Classification and classification of gas hazardous areas

Firstly, determine whether it is a gas area, and then determine it as a special hot work, first level hot work, second level hot work, or fixed hot work area based on the degree of danger and difficulty of hot work operations. Special hot work refers to hot work carried out on flammable and explosive production equipment, conveying pipelines, storage tanks, containers, and other hazardous areas in production and operation [4]. Typically, special hot work includes operating gas equipment and facilities, hazardous source areas designated as Zone 0, pressurized hot work, and other pipelines connected to coal and gas equipment and facilities; First level hot work, except for special hot work carried out in flammable and explosive places, usually involves hot work near gas equipment and facilities, in hazardous areas designated as Zone 1, and in areas near gas equipment and facilities where gas exceeds the limit (with gas exceeding the limit and content below the lower explosive limit); Second level hot work, except for special hot work and first level hot work, where all production equipment or systems are shut down, and the equipment is cleaned, replaced, analyzed and qualified, and safety isolation measures are taken, can be managed according to second level hot work. Usually, there

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are gas pipelines, equipment and facilities that have been replaced and qualified, as well as gas hazardous areas within 5 meters without gas exceeding the standard. In case of holidays or other special circumstances, hot work operations should be upgraded and managed.

1.2 Hot work permit

Before starting hot work in gas hazardous areas, it is necessary to obtain a "Hot Work Safety Certificate". The process of obtaining a hot work permit is the process of determining whether the hot work safety measures are feasible and effective. The content of the hot work safety operation certificate should at least include the hot work time (start and end time), testing time, hot work location, hot work precautions, safety technical points, signatures of the testing personnel, hot work personnel, and fire monitoring personnel, as well as signatures and seals of the issuing unit or person. In principle, special hot work plans should be developed for special and first level hot work. Strictly implement hot work safety measures and strictly adhere to the "four no hot work principles" during hot work, which means no hot work without an approved hot work permit, no hot work when the on-site guardian is not present, no hot work when safety measures are not implemented, and no hot work when emergency rescue measures are not implemented. The hot work is over, confirm that there are no residual sparks [5].

1.3 Implementation of hot work

Hot work analysis and gas area hot work are different concepts. Hot work analysis focuses on whether it is within the explosion limit range, while gas area hot work not only needs to consider the explosion limit, but also the harm of gas to operators [6].

The safety of hot work is to take effective measures to prevent the three elements of combustion from coexisting, thereby ensuring the safety of hot work. The key to hot work safety is hot work analysis. According to the "Safety Code for Special Operations of Chemical Production Units" GB30871-2014, the determination criteria for qualified hot work analysis are that when the lower explosive limit of the tested gas or steam is greater than or equal to 4%, its measured concentration should not exceed 0.5% (volume fraction) and less than 0.5%. When the lower explosive limit of the tested gas or steam is less than 4%, its measured concentration should not exceed 0.2% (volume fraction). For gas, this method has a carbon monoxide explosion limit (12.5%~74.2%), which meets the standard and will not ignite or explode. However, gas is a toxic gas, with 0.5% equivalent to 5000×10^{-6}. According to national health standards, the maximum allowable amount of carbon monoxide in the air is 24×10^{-6}. For gas, hot work analysis should not only consider fire and explosion, but also focus on the risk of poisoning for operators, ensuring their own safety before conducting hot work. When the conditions for hot work analysis are met but the gas content in the area exceeds the standard, on-site forced ventilation can be used to dilute the gas content within the allowable range, or operators can wear air respirators for hot work operations.

2 Safety measures for gas hot work

Hot work in gas areas can be mainly divided into regional hot work, displacement hot work, and pressurized hot work. The risks and difficulties of hot work vary, and different measures should be taken:

(1) Hot work in gas areas is the most common, and it is necessary to first detect any gas leakage within a 5-meter range of the hot work point. If there is no gas leakage, a second level hot work safety certificate can be obtained before starting hot work. If there is a gas leakage within a range of 5 meters, sealing treatment should be carried out first. If sealing cannot be implemented, an explosion-proof axial flow fan should be installed on the hot work site to diffuse the gas at the leakage point, ensuring that the gas at the hot work point does not exceed the standard before starting the fire. There is a significant gas leakage, and the gas at the ignition point exceeds 50×10^{-6}, but when the gas content is below 25% of the lower explosive limit, an air respirator can be worn for hot work.

(2) Replace hot work, first confirm that the gas source has been effectively cut off, and use steam, nitrogen, or other gases to blow away residual gas. The blowing plan should be developed according to the process to ensure that there are no dead corners and to avoid residual gas not being completely expelled. During the blowing process, fire sources are strictly prohibited within a 40 meter range of the released area, and personnel in the area should take measures to prevent gas or other gas poisoning and suffocation. After passing the blowing and sweeping, hot work analysis should be carried out, and the sampling and analysis points should be representative. Only after passing the hot work analysis can hot work be carried out. Hot work operations should take measures to prevent poisoning of operators. In addition, measures such as coking coal pipeline sediment ignition and sulfide spontaneous combustion need to be taken for hot work replacement.

(3) Hot work under pressure has the greatest safety risk. The principle of hot work under pressure is that the concentration of combustible gases is higher than the explosion limit, eliminating the possibility of gas and air forming a mixed explosive mixture. There is a lack of oxygen in the three conditions of combustion and explosion, so it is extremely important to control the oxygen content of gas pressurized hot work. Oxygen content analysis must be carried out for pressurized hot work. When the oxygen content in the gas is greater than 1%, hot work is strictly prohibited. Secondly, the pressure should be kept stable at 1000 Pa, and negative pressure hot work is strictly prohibited [7].

3 Measures to reduce and eliminate the risk of hot work

(1) Measures to prevent fire, such as blind plate isolation,

replacement, nitrogen protection, water injection, cleaning of flammable materials near the hot work point, equipping with appropriate and effective fire extinguishers, extinguishing steam, etc.

(2) Measures to prevent personnel poisoning, using an alarm to detect hot work points with a carbon monoxide content exceeding 50×10^{-6}. Operators should wear respirators, provide forced ventilation, or take other measures to prevent poisoning.

(3) Hot work shall be carried out by professional welders who have passed the assessment. In case of any abnormalities during hot work, the hot work shall be stopped immediately. The hot work area shall be measured for thickness, welding current shall be controlled to prevent welding leakage. Gas welding is strictly prohibited for hot work under pressure.

(4) The hot work analysis should be conducted no earlier than half an hour before the start of the hot work. If the hot work is interrupted for more than half an hour, the hot work analysis should be redone. The hot work analysis sampling should be representative and the sampling point should be determined based on the shape of the equipment and facilities.

(5) During hot work analysis and gas content detection, at least 2 units should be tested simultaneously to prevent false detection caused by detector failure.

(6) Remove all combustibles within a range of 5 meters around the hot work point, carry out hot work in pipelines and containers, and clean up combustible deposits within a range of 1.5 to 2 meters. After nitrogen protection is applied to flammable deposits in pipelines, external welding operations can be carried out.

(7) After the hot work is completed, the construction site should be cooled down in a timely manner and residual sparks should be removed.

4 Conclusion

In summary, the characteristics of gas determine the danger of gas operations. As a dangerous gas hot work operation, it is extremely easy to cause poisoning, fire, and explosion accidents during the operation process. Hot work analysis should comprehensively consider various factors. Through hot work approval management, hot work analysis, and the implementation of corresponding measures to reduce and eliminate hot work risks, hot work safety risks can be effectively controlled or reduced, ensuring the safety of gas hot work operations in metallurgical enterprises.

Received: January 22, 2024 Accepted: January 30, 2024 Published: March 20, 2024

Reference

1. Gao Yonggang. Gas safety operation [M]. Beijing: China Railway Publishing House, 2011.
2. Xie Quan'an, Tian Qinglai, Yang Qingbin. Gas safety protection technology [M]. Beijing: Chemical Industry Press, 2007.
3. Wang Yuecheng. The current situation and optimization measures of emergency management system construction in metallurgical enterprises [J]. *Metallurgical Management,* 2021 (**21**): 128-129.
4. Liu Xufeng. Analysis of Gas Safety Management Strategies in Metallurgical Enterprises [J]. *China Metal Bulletin,* 2021 (**11**): 108-109.
5. Surrounding. Research on Emergency Management System for Safety Production in Metallurgical Enterprises [J]. *Metallurgy and Materials,* 2021, 41 (**03**): 17-18.
6. Chi Shengdong. A Brief Discussion on the Current Situation of Safety Management in Metallurgical Enterprises [J]. *Metallurgy and Materials,* 2021, 41 (**02**): 171-172.
7. Wu Gang. Analysis of Emergency Management System for Safety Production in Metallurgical Enterprises [J]. *Metallurgical Management,* 2021 (**07**): 135-136.