Safety control of dangerous operation in gas holder maintenance

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Abstract. The maintenance of gas cabinet is highly professional, with many dangerous sources in the maintenance process, and the safety management is difficult. Through the hazardous source identification and hidden danger investigation and treatment, the safety control of dangerous operation is strengthened to realize the maintenance safety of gas cabinet.

Keywords: Gas cabinet maintenance, Safety control, Hazardous operation.

1. Preface

The gas holder of metallurgical enterprises is a major hazard source of dangerous chemicals. With the improvement of the management requirements of governments at all levels for major hazard sources, the operation and maintenance of the gas holder have been included in the key monitoring objects of local governments[1].

There are many dangerous factors in gas holder maintenance, which intersect with the production system, and the safety management is very difficult. Once the safety control measures are not in place, major safety accidents will occur. For example, a major production safety accident occurred during the maintenance of 80000 m3 converter gas holder of a company in 2012, resulting in poisoning of 13 operators, including 6 deaths. Drawing on the safety management requirements of chemical enterprises, our company has formulated the company's measures for the safety management of hazardous operations in accordance with the national regulations and specifications such as the safety code for special operations of chemical production units, so as to standardize the maintenance operation[2].

2. Risk factor analysis

The main dangerous operations of gas holder maintenance include limited space operation, hot work, etc. As a gas equipment, gas holder has the risk of gas poisoning and explosion. Taking the maintenance of curtain gas holder as an example, this paper analyzes in detail how to implement the safety control of dangerous operation in the maintenance process of gas holder around the operation in limited space and hot work [3].

2.1 Finite space

The gasholder itself belongs to a closed whole, and is equipped with inlet and outlet pipelines, which are connected with the upstream steelmaking og system, and the downstream is connected with gas users, and is equipped with purging energy media such as nitrogen. For example, the cutting off of energy medium is not in place, and the replacement of gas with nitrogen and nitrogen with air is not complete, which are prone to safety accidents such as gas poisoning and nitrogen suffocation[4].

2.2 Hot Work

The three elements of gas explosion are gas, closed space meeting explosion conditions and fire source. In the internal maintenance of the gas holder, it is mainly to solve the problem of explosive gas formed by the mixing of gas and air. Therefore, for hot work inside the coal gas holder, it is also

necessary to replace the gas inside the gas holder and confirm that the gas holder is reliably isolated from the external pipeline. The gas holder body is shown in Figure 1 below.



Figure 1 gas holder

3. Risk Management

The dangerous operation is carried out according to the closed-loop management mode of pre risk identification, in-process risk control and post summary improvement according to the type of operation. The project leader is required to formulate the safety technical scheme according to the classification of limited space, hot work and gas hazard sources, and apply for hazardous operation in ERP. After being reviewed by the technical director and approved by the department head, print the limited space operation permit, hot work permit and gas operation permit; On the day of commencement, the spot inspection party, the production party and the maintenance party shall confirm, and the supervisor of the operation unit shall go to the site to confirm that the safety protection measures are in place and issue the dangerous operation certificate before operation; Arrange gas protection personnel for on-site monitoring and relevant technical and safety management personnel for patrol inspection during maintenance; A brief summary shall be made after the maintenance of the day, and the maintenance unit shall be organized to participate in the discussion after the maintenance items are completed. Figure 2 below shows the risk structure decomposition.

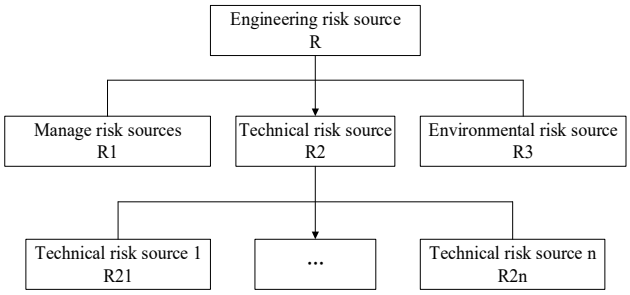


Figure 2 risk structure decomposition

3.1 Strengthen organization and management and improve maintenance scheme

1) Party A and Party B shall establish a gas holder maintenance project management team, establish a maintenance organization system and clarify the division of labor of members. The deputy director in charge of equipment of the Department shall be the leader of the project team. The project management team also includes: equipment spot inspection, production operation, safety management, gas protection station and other personnel. Implement the operations of gas cabinet shutdown, energy medium cut-off and replacement, clarify the production and maintenance interface, and assign the responsibility of on-site safety management to each person.

The scheme is a special procedure formulated according to the industry specifications, safety regulations and operation regulations in combination with the actual operation and maintenance needs,

so as to achieve one case and one policy. The maintenance scheme includes gas holder shutdown scheme, gas holder replacement scheme, construction scheme, including JHA hazard source analysis table, special safety technical scheme, etc.

①The shutdown plan of gas holder shall include the shutdown operation steps of gas holder, and the list of facilities such as closing gas valve, nitrogen valve and blocking blind plate.

②The cabinet replacement plan includes the purging process diagram, nitrogen entry point, release point, test sampling point, and the person in charge of the test. During nitrogen replacement, pay attention to avoid replacement blind area at the inlet and outlet pipe of gas holder. If there is air leakage on the bottom plate of the gas holder before shutdown, gas will accumulate in the gap between the bottom plate of the gas holder and asphalt concrete. Keep the pressure with nitrogen for one night, and use nitrogen to replace the gas under the bottom plate. After the nitrogen replacement is qualified, disconnect the nitrogen pipeline from the gas holder pipeline or block the blind plate. When replacing nitrogen with air, blind areas should also be avoided. During the operation of the two-stage diaphragm gasholder, there is leakage of the diaphragm. The truss space between the large piston and the small piston on the upper part of the piston is narrow, which is easy to gather gas. When air replaces nitrogen, the gasholder needs the piston to walk up and down several times in the whole stroke to replace the remaining gas in the truss between the pistons[5].

③The technical indicators and safeguard measures of each maintenance link shall be clearly specified in the construction scheme. The construction unit is required to use LS analysis tool to formulate JHA hazard source analysis table according to the risks of limited space operation, hot work and gas operation involved in the maintenance content. In the analysis table, safety technical measures shall be formulated for the risks of limited space operation, hot work and gas operation item by item, and finally a special safety technical scheme shall be formed according to the formulated safety technical measures.

2) In order to make all plans well, it is necessary to determine the fit between the plan and the actual situation on site. Party A shall organize a plan review meeting, organize relevant personnel to observe the site before the meeting, and discuss all plans through brainstorming. The deputy director in charge of equipment shall organize the technicians of relevant production operation, equipment management and gas protection station to participate in the audit, fully listen to the opinions of all parties, improve the scheme, and absorb the advanced experience of other units through the introduction of the construction unit. Organize site survey again if necessary.

3) The application for hazardous work permit can only be carried out after all schemes are reviewed and approved. For the limited space operation, hot work and gas operation involved in the maintenance of gas holder, the corresponding limited space, hot work and gas dangerous operation certificate shall be applied. First, the person in charge of project spot inspection uploads the construction scheme, special safety technical scheme and scheme joint review opinion form to the company's ERP dangerous operation module and starts the application process of dangerous operation. The dangerous operation process is reviewed by the senior engineer of equipment management, the local operation chief of gas holder, safety management personnel and gas protection station, and finally approved by the head of the Department. After approval, the person in charge of spot inspection of the project shall print the fire operation certificate, limited space operation certificate and gas operation certificate from the ERP dangerous operation module for use in on-site safety confirmation[6].

4) Although the gas holder maintenance construction unit and personnel have rich maintenance experience, they are not necessarily clear about the management system requirements of each company and the actual situation on site. Therefore, the following measures need to be taken:

Before the entry of external construction personnel, the Security Department of the company shall carry out factory safety training on the management requirements of the company's rules and regulations, and issue the entry certificate after passing the examination.

The plant Department shall carry out targeted safety education and safety disclosure for the personnel of the construction unit. The training contents include the dangerous factors in the

maintenance coal and gas holder area, the production forbidden area, maintenance safety management, etc.

The construction unit shall also organize training and learning, especially the learning of construction personnel on the construction scheme. The technicians of the construction unit shall organize all construction personnel to carry out technical disclosure and learn the construction scheme and special safety technical scheme to ensure that the construction personnel are clear about the construction technical requirements and safety protection measures.

Before commencement, Party A shall organize the construction personnel to reply the scheme, and check the mastery of the construction personnel on the construction contents and safety protection measures in the construction scheme and special safety technical scheme in the form of question and answer. The scheme reply proves that the technical disclosure of the construction unit's personnel is qualified. If the scheme reply fails, the construction unit shall be required to make a new disclosure[7].

3.2 Operation safety control

After the gas holder is shut down, the blind plate is blocked and the replacement is qualified, the gas holder has the conditions to be handed over to the construction unit, and the maintenance work is officially started.

1) Daily safety training

Access control management shall be implemented in the gas holder area. Before gas holder maintenance, the gas holder area shall be completely separated from the production area by enclosure. Party A shall arrange special personnel to register the incoming and outgoing personnel and standardize the operation route of construction personnel. Before the commencement of construction every day, all construction personnel shall line up at the door for safety training, and the management personnel of Party A and the management personnel of the construction unit shall make the operation disclosure of the day, including the construction content of the day, safety requirements, yesterday's construction problems, etc. After receiving the disclosure, the construction personnel shall sign on the safety disclosure on the same day. After the disclosure is signed, the access control management personnel of Party A shall allow the construction unit to enter the construction area.

Before commencement, the person in charge of spot inspection of Party A shall be responsible for printing the hot work permit, limited space operation permit and gas operation permit. The spot inspection personnel, operators and the construction unit shall implement safety measures item by item according to the construction scheme and dangerous operation permit. The department head shall issue the dangerous operation permit after checking that the safety conditions meet the requirements. The construction unit can start the maintenance operation after the operation permit takes effect.

2) Limited space operation

First of all, we should make a reliable partition of gas. The effective partition and replacement of gas holder is the safety foundation provided by Party A to the construction unit. Party A shall close the inlet and outlet pipeline valves of the gas holder and seal them with water before maintenance according to the gas holder shutdown scheme and cabinet replacement scheme. After the gas tank stops completely, install blind plates on the inlet and outlet pipes to achieve three protective measures: valve, blind plate and water seal. The sign of "no operation for blocking blind plate" shall be hung on site, and the valve locking measures shall be taken.

The personnel of the gas protection station shall be responsible for the acceptance and inspection of air replacement. The inspection is divided into the upper part of the piston and the lower part of the piston. The upper part of the piston shall be inspected by the personnel of the gas protection station wearing air respirator, CO alarm and oxygen alarm. The large piston and small piston shall be inspected by entering the upper part of the piston, with emphasis on the truss between the large piston and the small piston. During the inspection, all the working movable surfaces shall be detected. After the manhole at the lower part of the piston is opened, the personnel of the gas protection station shall also wear air respirator, CO alarm and oxygen alarm for detection. The oxygen content of 19.5%-21%

is qualified. After air replacement, the CO content in the gas holder should be 0ppm. If CO is found, the reason should be found out. If the operator fails to enter the site for more than 30 minutes after the inspection, it shall be re inspected. If the operation is interrupted for more than 60 minutes, it shall be re monitored and analyzed. The validity period of the work permit in limited space is 24 hours. If the time is exceeded, it shall be re handled and re confirmed.

After passing the inspection, the gas holder is officially delivered to the construction unit for maintenance. Before entering the gas holder for maintenance, the construction unit shall appoint the on-site person in charge and safety supervisor. The person in charge of the site shall be fully responsible for the internal operation safety of the gas holder, be responsible for arranging personnel to enter after confirming that the operation environment, operation scheme, protective facilities and supplies in the gas holder meet the safety requirements, and organize personnel to withdraw in case of abnormal conditions during operation in the gas holder. The safety supervisor is responsible for monitoring the safety of the personnel entering the gas holder outside the gas holder. When any abnormality is found, he will immediately send an evacuation alarm to the operators, help the operators escape from the limited space, and call for emergency rescue immediately.

When multiple manholes of the gas holder are opened, one shall be designated as the entrance and exit of personnel, and the other manholes shall be cordoned off with a "no entry" sign. During the operation, the safety supervisor shall be at the inlet and outlet of the gas holder in the whole process, be responsible for supervising the signature of the inlet and outlet personnel, counting and registering the tools brought into the gas holder, regularly contacting the internal personnel to confirm the status of the internal operators, and detecting whether the internal CO and oxygen contents are qualified every 2 hours. Temporary fixed audible and visual alarm CO alarm shall be installed in the gas holder, and all operators shall evacuate when the alarm gives an alarm. Operators entering shall carry two co alarms and two oxygen content alarms.

When entering the gas holder for maintenance, the lighting lamps shall be no higher than 12V. At present, our company mostly adopts portable LED headlights. Class III hand-held electric hand-held tools are preferred. Try to avoid laying temporary cables inside the gas holder. If it is necessary to lay, a leakage protection switch with an action current of no more than 15mA and an action time of less than 0.1s shall be set at the upper end of the cable.

During anti-corrosion operation inside the gas holder, ventilation measures shall be strengthened, and explosion-proof fans shall be set at the manhole to blow into the gas holder to prevent volatile substances in the paint from forming explosive gas. The single operation time of the operators shall not exceed 2 hours. It is strictly prohibited for the operators to carry kindling in the gas holder. During anti-corrosion operation, derusting, grinding, hot work, etc. are prohibited for the gas holder.

1) Hot Work

For the first hot work without gas after the shutdown of the gas holder, the first-class hot work permit shall be obtained, and the valid period of the permit is 8 hours. Before the hot work of gas holder, the department head shall go to the site to confirm the safety conditions. After the equipment spot inspection management personnel, production operators and maintenance units have taken safety measures according to the safety technical scheme for gas holder maintenance, the department head shall confirm and issue the hot work permit on site[8].

Pay attention to the gap between the bottom plate and asphalt concrete before the fire of the bottom plate of the gas holder. If the floor leaks, maintain the pressure with nitrogen in the replacement stage, and replace the gas in the gap under the bottom plate by the method of bottom plate leakage. Or use the mechanical starting hole method to open the hole at the highest point of the bottom plate. During the opening process, start while pouring water to prevent sparks. After the hole is opened, inject water under the bottom plate, and replace the gas in the gap under the bottom plate with the method of irrigation. The above measures shall be taken. Before hot work, the exhaust CO alarm shall be used to detect other measuring holes on the bottom plate of the cabinet, and hot work shall be carried out after passing the test.

2) Gas operation

The most common operation with gas in the gasholder is the spot inspection and adjustment work inside the piston when the gasholder is in operation. When the gasholder equipment is in good condition, there will be no CO on the upper part of the piston, so the risk of entering the gasholder is relatively small. Under special circumstances, when CO has been found on the upper part of the piston of the gas holder, the risk is the greatest when entering the upper part of the piston, which is prone to poisoning and suffocation[9].

Strengthen the intelligent detection and monitoring of the operation process, and equip the monitoring equipment for gas high-risk operation. The system consists of two mobile monitoring background and 10 sets of operator terminal equipment. Each operator can conduct real-time communication with the gas concentration through a walkie talkie, a respirator and a background wireless signal transmission camera, including a wireless walkie talkie. This set of gas high-risk operation monitoring system can help the safety management personnel grasp the status of operators at all times, and timely command the operators to evacuate in case of abnormal operation heart rate, cylinder pressure and environmental CO concentration. Technicians can observe the operation activities of operators through the portable camera carried by the personnel and guide the operation.

3.3 Summary and evaluation

During the maintenance period, the "daily reading" system is implemented, which is organized by the person in charge of the project site. Every afternoon, the equipment, production, maintenance and other three parties meet on the site to communicate the maintenance situation of the day, require the relevant parties to rectify the problems existing on the day, and predict the problems that may occur tomorrow. Ensure smooth on-site contact and communication mechanism[10].

A discussion shall be conducted after the maintenance of the gas holder. The project management team shall evaluate the construction unit according to the maintenance safety management. The main contents of the evaluation are risk identification, hidden danger investigation and treatment and illegal behavior in the construction process. Implement the violation scoring management system, and deduct the corresponding scores according to the violation scoring management measures and the detailed rules of scoring terms for the violations of the construction unit. During the maintenance process, the safety management personnel will upload the found illegal units, illegal behaviors and deducted scores to the ERP scoring management module, which will automatically accumulate the illegal scores of the construction unit, and conduct safety evaluation and default assessment according to the system. The violation scoring of the construction unit will be used as the evaluation basis for the project bidding of the company in the future.

4. Epilogue

Since it was put into operation in 2007, our company has organized many gas holder maintenance, and the maintenance safety is generally controlled, which benefits from the effective implementation of the company's dangerous operation management system and control mode. Since its implementation, the system has been revised for many times. At present, it has been implemented within the scope of overhaul and technical transformation of the whole company, which has laid a foundation for the safety management of overhaul and technical transformation of the company. With the improvement of national requirements for safety management of metallurgical enterprises, the metallurgical industry should be included in high-risk industries, and the level of safety management should be improved accordingly. With the implementation of the new safety law, people-oriented and life first, employees' demand for safety will also be greatly improved. While improving the intelligence and essence of equipment, it is particularly important to explore effective maintenance safety management modes and methods, especially the effectiveness of safety management and control of dangerous operations, which is also the direction of our unremitting efforts in the future.

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