

Analysis of Safety Management Issues and Countermeasures for Construction Operations of Petroleum Refining and Chemical Equipment

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Abstract: The economic operation in modern society is closely related to petroleum, and petroleum refining products play a great role in various industries such as military, transportation, agriculture, light industry, and textile industry. Refining and chemical enterprises belong to fixed asset intensive enterprises, among which the equipment used for oil refining is the most important asset in fixed assets. Improving the operational safety of equipment plays an extremely important role and significance in improving and enhancing the economic benefits of enterprises. This article starts with the analysis of safety hazards at construction sites and explores potential risk factors such as human factors and equipment failures. A series of safety management measures are proposed to address safety issues, improving the effectiveness of safety management by establishing a sound safety management system, applying advanced safety equipment and technology, and developing effective emergency response and post-disaster recovery plans.

Keywords: Petroleum refining; refining equipment; construction operations; safety management; management issues.

1. Introduction

Petroleum refining units are the core link in the energy supply chain, which mostly processes oil, natural gas, coal and their products as raw materials to obtain various products. Due to its unique construction environment, high-risk process, and complex human-machine interaction, the safety management of petroleum refining equipment construction operations faces many challenges and risks. Since the raw materials and products of the equipment are mostly flammable, explosive, and toxic substances, improper use of the equipment may lead to fires, explosions, and poisoning. Ensuring that the safety of construction operations has a positive impact on the rapid development of the energy economy, this article aims to conduct an in-depth analysis of the safety management issues of petroleum refining equipment construction operations and propose corresponding countermeasures to improve the safety and reliability of construction operations.

2. Analysis of Safety Management Issues in Construction Operations of Petroleum Refining Equipment

2.1. Safety Hazards Caused by Human Factors

The situation in the construction site of petroleum refining equipment is complex, and workers face a complex working environment and high-intensity work pressure, which give rise to problems such as negligence and careless behavior. Therefore, any careless act of the workers may lead to safety accidents. For example, accidents may occur due to neglecting safety regulations, not wearing safety equipment correctly, or not following prescribed procedures. Although relevant regulations have emphasized the importance of safety regulations multiple times, safety accidents still occur frequently. The main reason is that workers lack awareness of construction risks, and some workers lack awareness of safety, or awareness of hazardous factors, or prevention awareness,

making them easy to overlook safety risks. In addition, the technical level and operational skills of workers also have a significant impact on the safety of construction sites. If the workers is of low technical level and their operational skills are not proficient, it can also lead to improper or erroneous equipment operation, increasing the possibility of accidents. Inadequate human resource management is one of the important reasons for safety hazards. At the construction site, problems such as excessive or insufficient personnel, low personnel quality, and uneven technical levels may have adverse effects on the safety of construction operations. For example, Insufficient number of personnel may lead to excessive workload and increase the work pressure and fatigue of workers, and thus increase the risk of accidents [2].

2.2. Risk of Equipment Failure and Unsafe Operation

Once equipment failures occur in petroleum refining facilities, such as pipeline leakage, pipeline corrosion, heat exchanger leakage, and cooling tower paralysis, it will increase operational risks, not only seriously affecting the safety and production efficiency of the construction site, but also leading to accidents. The working environment of petroleum refining equipment is extremely harsh, with large temperature differences, making it easy to cause damage to the pipeline itself, loose connections, corrosion of pipeline materials, or even leading to pipeline leakage. In case the leakage is not detected in time, the leaked liquid or gas may enter the surrounding environment, causing environmental pollution and production interruption, and even serious consequences such as fire and explosion. During the construction operation of petroleum refining equipment, pipelines are often affected by corrosion for a long period of time, which may lead to thinning of pipeline wall thickness and deterioration of pipeline material quality, resulting in problems such as pipeline rupture and water leakage. Especially for pipelines transporting high-temperature, high-pressure, and corrosive substances, the problem of pipeline

corrosion is more prominent, and it is necessary to strengthen monitoring and protection of pipeline corrosion. Heat exchanger is one of the commonly used equipment in petroleum refining unit, used for the heat exchange process of substances. Due to long-term operation and poor quality of circulating water, It is easy to cause leakage in the heat exchanger. Once the process medium leaks into the circulating water system, it will cause abnormal changes in the water quality of the entire circulating water system, resulting in a decrease in heat exchange efficiency, an increase in energy consumption, and an increase in costs, which will affect the normal operation of the production equipment. If the heat exchanger leaks, it can lead to the leakage of the medium, causing serious material loss and environmental pollution, and even posing a threat to the safety of workers. In chemical enterprises, if the heat generated by the normal operation of various devices and equipment cannot be discharged in a timely manner through the cooling tower, which is the equipment used to cool high-temperature media in petroleum refining equipment, once the cooling tower is paralyzed, it may lead to production interruption, equipment damage, process parameter loss, and other problems, seriously affecting production efficiency and product quality.

3. Research on Safety Management Countermeasures

3.1. Construction of Safety Management System

3.1.1. Safety Responsibility System

The safety responsibility system aims to clarify the responsibilities and obligations of management personnel and employees at all levels in safety management, increase the random inspection of the implementation of the "Three Major Disciplines", and focus on the quality of external operation inspections and internal operation monitoring. Strictly control the direct operation process, organize pre-operation risk identification and JSA analysis, carry out equipment entry inspection, personnel qualification and safety measures implementation verification, actively carry out "Anti-three Violations", and ensure on-site safety during the construction process.

Firstly, clarify the safety responsibilities of management personnel at all levels. Senior management shall take overall responsibility for safety work, formulate safety policies and objectives, provide necessary resources and support, and promote the development of safety management activities. Middle level management personnel shall be responsible for specific safety management work, organize and implement safety training, inspection, and supervision, and timely discover and handle safety hazards. Front line management personnel shall implement safety responsibilities, guide employees to use safety equipment correctly, strictly follow safety operating procedures, and ensure the safety of the construction site. Improve Detailed Rules for the Evaluation of Three Star Guardians in 3rd Refining Departments, specify the eight specific contents and requirements of guardianship responsibilities, and enhance the standardization and institutionalization level of on-site guardianship. Incorporate contractors into the daily management of the operations department, conduct weekly special inspections and notifications, establish a three-level mechanism of assessment, deduction of points, and interviews, in order to promote the implementation of safety responsibilities by contractors.

Secondly, clarify the safety responsibilities of employees. Employees are the main body of the construction site, and their safety awareness and behavior are directly related to the safety of the construction site. Therefore, it is necessary to establish a scientific safety education and training mechanism to improve the safety awareness and skill level of employees, so that they can correctly understand and respond to safety risks. At the same time, it is essential to establish a strict safety management system, clarify the safety responsibilities and obligations of employees on the construction site, strengthen the binding force of safety behaviors, ensure that employees comply with safety regulations, strictly prohibit illegal operations, and effectively ensure the safety of themselves and others.

Finally, establish an effective safety management mechanism, including the formulation of safety objectives, division of safety responsibilities, establishment of safety rules and regulations, and implementation of safety supervision and inspection, to ensure the implementation of safety responsibility system. By utilizing a safety feedback mechanism, encourage employees to actively participate in safety management, propose safety improvement suggestions, promptly identify and solve safety issues, and form a virtuous cycle of safety management.

3.1.2. Safety education and training

By providing comprehensive and systematic safety education and training to workers and management personnel, their safety awareness and skill level can be improved, enabling them to correctly respond to safety risks on construction sites and reduce the probability of accidents.

Safety Lessons for prevention, management and training for operation in winter shall be properly organized. In the construction operation of petroleum refining devices, complex process flows and hazardous chemicals are involved. Workers and management personnel must have certain safety knowledge and skills to ensure the safety production on the construction site. Through safety education and training, safety knowledge could be taught to workers and management personnel to strengthen their safety awareness and improve their safety skills so that they can correctly respond to various safety risks and effectively prevent accidents from occurring. In addition, other measures shall be taken, including but not limited to quantifying the allocation of supervision indicators, actively participating in inspections, monitoring and other work, and carrying out full coverage and mesh-style inspections for the anti-freezing and anti-condensation of all devices, repeatedly confirming the implementation of anti-freezing measures for system pipeline heating, air cooling tube bundles, and blind spots.

Build a strong protective wall for equipment management. The content of safety education and training shall be comprehensive and systematic, covering multiple aspects of information such as safety awareness education, safety knowledge training, safety skills training, etc., so that the trainees can fully understand safety regulations, operating procedures and procedures, identification and handling of hazardous chemicals, emergency rescue measures, and other aspects. In addition, targeted professional skills training shall be provided for workers and management personnel in different positions to improve their safety operation level.

Management and control of construction activities shall be properly conducted. To improve the effectiveness of training, the forms and means of safety education and training shall be diverse, such as lectures, training courses, on-site exercises,

case analysis, etc. Through different forms of training, trainees can have a more vivid understanding of safety knowledge and skills, enhancing their interest and participation in learning. In addition, based on the actual situation on site, targeted training shall be organized to improve the pertinence and practicality of the training.

Daily construction supervision and job safety briefing shall be carried out in a comprehensive and proper manner, to establish a dynamic safety risk prevention mechanism through the implementation of Three-level Risk identification of "Points, Lines, and Regions", and improve the level of pre-operation control. Safety management personnel shall visit the site every day to inspect and guide operations from various aspects such as risk identification, implementation of safety measures, safety protection, and compliance with work permits. If necessary, they shall witness and supervise to ensure the safety and standardization of work processes.

3.2. Safety Equipment and Technology Applications

Reasonable allocation and correct use of safety protection equipment can effectively reduce the probability of accidents on construction sites, ensuring the physical health and life safety of workers. During the construction of petroleum refining equipment, workers may face various hazardous factors, such as high temperature, high pressure, toxic gases, etc. Without proper protective equipment, serious accidents may occur, endangering the safety of workers. Common safety protection equipment includes helmets, protective goggles, protective masks, protective gloves, protective clothing, protective shoes, etc. This equipment can effectively protect the operator's head, eyes, face, hands, body, and feet, and prevent harm from the external environment. For example, helmets can prevent objects from falling from heights and causing head injuries, protective goggles can prevent harmful substances from splashing into the eyes and causing irritation or injury, protective masks can prevent inhalation of toxic gases, protective gloves can protect hands from chemical substances, and protective clothing can prevent flames and high temperatures. Therefore, the correct use of these safety protective equipment is crucial for the safety of workers.

Workers need to choose appropriate protective equipment, based on the specific situation and working environment of the construction site, to ensure effective protection of worker's safety. Workers must wear and use safety protective equipment correctly during construction operations, and must not take it off or use it carelessly. They must also regularly inspect and maintain the protective equipment. Before each use of the protective equipment, they must check whether it is in good condition and promptly maintain and replace it to ensure its effectiveness. At the same time, safety education and training shall be strengthened to improve workers' awareness and skills in using safety protection equipment through safety education and training, and enhance their safety awareness and self-protection awareness.

Based on the production and operation characteristics of the equipment, each professional management team shall take the lead in conducting item-by-item inspections of key instruments, important units, rainwater and sewage diversion device, distribution rooms, and cold exchange equipment in cabinet rooms, forming a special inspection log and implementing rectification one by one. At the same time, strengthen the quality inspection of basic work such as air and

cold water cooling regulation, LDAR testing, and important pump monitoring, and strictly implement the company's requirements for safe and stable production. Pay close attention to key areas and weak links, coordinate the preparation of the cleaning plan for the single furnace cut-out of the III coking plant and the quality management of asphalt production. Firstly, taking the advantage of the low load operation of the III coking plant to eliminate safety hazards such as leaks in key parts, cold exchange equipment, high-temperature pumps, valves, etc., and focus on ensuring the reliability and safety of the single furnace cut out; The second is to standardize the operating procedures for asphalt production in order to ensure that all personnel strictly follow the regulations to control the safety risks of asphalt loading.

3.3. Application of Advanced Technology in Safety Management

Monitoring and early warning system is one of the important applications of advanced technology in safety management. By installing monitoring cameras, sensors, and other equipment on the construction site, real-time monitoring of process parameters, equipment status, and worker activities on the construction site can be achieved. When abnormal situations are detected, the system can automatically send warning signals to remind management personnel to take timely measures to prevent accidents from occurring, so as to effectively improve the monitoring and management level of safety conditions on construction sites, timely discover and handle safety hazards, and reduce the incidence of accidents.

Advanced virtual reality (VR) and augmented reality (AR) technologies can also be introduced in safety training and drills. Through VR technology, workers can conduct simulation operations and training in a virtual environment, simulate real construction scenarios and workflows, and improve their understanding and proficiency in safety operating procedures and emergency plans. At the same time, AR technology can overlay virtual objects onto the real environment, helping workers to get more intuitive understanding and comprehending of the hazardous factors at the construction site, and thus improve their safety awareness and response capabilities.

3.4. Emergency response

Preparing emergency plans is an important measure to respond to emergencies and disasters. Conduct a comprehensive risk assessment and identification of various safety risks and emergencies that may be faced at the construction site, identify potential safety hazards and disaster risks, prepare necessary emergency resources and equipment in advance, including emergency supplies, rescue equipment, communication tools, etc., to ensure timely and effective response to emergencies and disasters. Establish an emergency management organizational structure, clarify the responsibilities and obligations of management and staff at all levels, and establish a scientific and effective management system. Utilize a comprehensive monitoring and early-warning system to monitor the safety status of the construction site in real time, and promptly identify and warn of potential safety risks and disaster events.

Regularly organize emergency drills and training activities, simulate various unexpected events and disaster scenarios, and improve the emergency response ability and cooperation level of staff. Once an emergency or disaster occurs, immediately activate the emergency plan, quickly organize

personnel for emergency response, take effective measures to control the development of the situation, and minimize losses. Timely release emergency information, inform relevant personnel and units of the development of the situation and response measures, maintain good information communication and coordination, and ensure the smooth progress of emergency response work. Evaluate and summarize emergency response and disposal work afterwards, analyze existing problems and shortcomings, adjust and improve emergency plans in a timely manner, and improve the ability and level of responding to emergencies and disasters.

4. Conclusion

As a high-risk industry, major safety accidents often occur in petroleum refining. The safety management of construction operations in petroleum refining facilities has always been a major challenge. It is necessary to timely identify hazardous and harmful factors, prevent accidents, and improve the safety production level of enterprises. Safety management for the construction of petroleum refining equipment shall be carried out comprehensively and orderly. No omission is allowed and all regular and irregular safety inspections must be carried out strictly after which any safety hazards found shall be promptly rectify. Focus on high-risk areas such as high

pressure, high temperature, and flammable and explosive materials to ensure that relevant equipment and operations meet safety requirements. Strengthen communication and collaboration with relevant parties, and jointly study and solve safety issues.

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