Risk Identification Method and Safety Control Points of Chemical Process

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Abstract: Safety control is very important in the production process of chemical enterprises. To ensure the overall safety of chemical production, it is very important to do a good job in safety design of chemical process. The identification and control of risk factors is the key content of chemical process safety design. For chemical enterprises and production organizations, whether they can accurately identify risk factors in the production process and effectively control them will largely affect the safety of production. Based on the overall goal of safe production, this paper analyzed and discussed the key points of hazard identification and control in chemical process safety design, and then discussed the hazard control strategy in chemical process safety design according to current practice. It is very important to ensure the safety of chemical production to do a good job in chemical process safety design.

1. Introduction

Chemical process design refers to the process and plant designed by chemical engineers according to a single or multiple chemical reactions to convert raw materials into products required by customers [1-2]. In the process of design, the engineer will evaluate the economy, rationality and safety of the process. According to the conditions of the production process, the engineer will choose the appropriate production equipment, pipelines, instruments and other facilities [3]. At the same time, with the construction of the plant, the layout of the plant will be rationalized and optimized, and finally the plant will be completed and put into operation. In the process of chemical process production, the complexity of conditions, the danger of raw materials and the rigor of process all determine that the risk coefficient and accident rate of chemical industry production process are higher than those of general industry [4-5]. Therefore, effective identification and control of chemical process hazards can not only eliminate potential safety risks in chemical process production, but also effectively improve the efficiency and quality of chemical process production. It has important practical significance to promote the healthy development of chemical industry, which is also the fundamental starting point of this paper.

2. Key Points of Hazard Identification in Chemical Process Safety Design

Hazard identification is the basis and prerequisite of hazard control. Risk factors in chemical production process exist in many places. Therefore, in order to do a good job in chemical process safety design, we must focus on hazard identification from multiple perspectives, seriously consider the unstable factors in all aspects and links, ensure that all risk factors can be found in time, and take scientific control measures, so as to prevent accidents to the greatest extent [6-7]. Next, we will elaborate the key points of hazard identification in chemical process safety design from three main aspects.

2.1 Identification of risk factors in material

Material production is the basis of chemical production. The dangerous characteristics of various chemical raw materials are different, such as flammability, explosiveness and toxicity. To ensure the

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accurate identification of dangerous factors, first of all, we must be able to identify the types of materials correctly and grasp the dangerous characteristics of materials accurately, so as to accurately judge the dangerous factors in the process of storage, transportation and use of materials. This requires chemical production personnel and technical management personnel to have a solid grasp of the basic physical and chemical characteristics of various chemical process materials. In the face of a wide variety of chemical materials can be accurately identified, and should bear in mind the risk factors related to each chemical process materials, such as the conditions of flammable and explosive materials, the safety temperature and pressure of storage and transportation, and the functional requirements of the reserved materials [8]. In strict accordance with the production safety regulations and the actual dangerous characteristics of materials, identify the dangerous factors of safety inspection, so as to discover the hidden dangers of safety accidents in time.

2.2 Identification of Risk Factors in Reactor

Various chemical reaction devices are necessary infrastructure in chemical production process. According to the different raw materials and processes, the reaction devices used are relatively different, and there are some differences in the use conditions and operation requirements of different reaction devices, which also determines the identification points of risk factors for different chemical reaction devices are different. Therefore, the identification of dangerous factors in chemical reaction devices should first be based on the actual situation of different types, models, uses, operating environment and process characteristics of the devices to determine the identification points [9-10]. Consideration should be given not only to the key points of safe operation of chemical reaction units themselves, but also to the adaptability and consistency between the selection of chemical reaction units and the requirements of chemical process design, which is also one of the key points of hazard identification before the start of chemical production.The heat treatment curve of Cr5Mo shown in Fig. 1 is uncontrolled below 300 C. At the same time, the safety of chemical reaction device is also related to the correctness and standardization of operation. Therefore, when identifying the danger of reaction device, we should pay more attention to the process of operation. This requires the attention of safety managers, who must keep in mind the rules for safe operation of reaction devices, so as to discover the irregular use and operation problems of production operators in time and stop them in time. In addition, we should also understand the signs before the occurrence of various safety accidents, pay attention to the abnormal changes of the values displayed by various monitoring instruments on the reaction device, and take timely measures to control when the values are close to or beyond the safety limits, such as abnormal pressure and temperature, so as to avoid the occurrence of safety accidents.

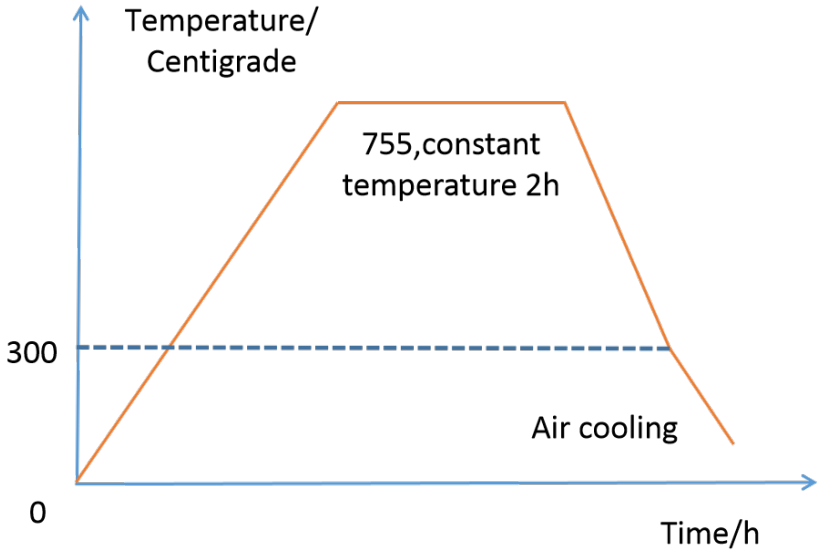

Figure1 Heat treatment curve

2.3 Identification of Risk Factors in Pipeline Transportation

Pipeline generally plays the role of transportation in chemical process. Both liquid and gaseous substances in chemical process need to be transported by pipeline. The substances transported by pipeline are usually flammable, explosive or corrosive substances. If these substances are carelessly leaked, it will cause serious harm to the environment and even cause major safety accidents. Therefore, in the process of hazard identification of chemical process safety design, it is necessary to do a good job of Pipeline Hazard identification, which requires safety management personnel to fully consider the chemical and physical properties of the transported substances [11-12]. Clear its requirements for the nature and function of the pipeline, accurately judge the applicability and reliability of the selected pipeline materials, and do a good job in the daily work of pipeline leakage inspection, through pressure monitoring, odor monitoring and external inspection and other ways to ensure timely detection of pipeline leakage problems, to avoid major accidents caused by leakage.

3. Method and Key Points of Risk Identification in Chemical Process

3.1 Hazard identification method for chemical process

SCL, which is often referred to as safety checklist method, is suitable for identifying static risks such as production process, production equipment and standardization mechanism, including “software” such as management system, operation process, emergency plan, and “hardware” such as process equipment, production site and warehouse.

JHA is what we call work hazard analysis method, which is suitable for identifying dynamic risks such as process equipment operation, individual unsafe behavior, including process equipment start-stop operation, start-stop, inspection and maintenance, product transportation and other activities.

HAZOP is a popular method of hazard and operability analysis. It mainly finds out the deviations in hazardous chemical processes, key equipment and production processes, analyses the causes of deviations and possible risks, and finally puts forward specific preventive measures. For example, in order to maintain the stability of the pressure at the top of the low boiling tower and ensure that the material is transported to the high boiling tower to remove the monomer of low boiling matter, the HAZOP parameters as shown in Table 1 can be designed.

Table 1 HAZOP analysis table

Deviation/possible cause	Consequences/implementation measures	L/S/R
High/tail refrigeration and tail exhaust valve failure; excessive evaporation of reactor reboiler; weakening of heat transfer function of top condenser.	Leakage/timely switching of tail discharges and periodic inspection	1/1/1
High pressure and liquid level of water sparator	Tail material leakage, system shutdown, explosion / adjustment of valve opening in rectification system, exceeding standard emergency stop.	1/1/1
Error/thermometer failure	Tail material leakage, system shutdown, explosion / adjustment of valve opening in rectification system, exceeding standard emergency stop.	1/1/1
Error/pressure gauge failure	Tail material leakage, system shutdown, explosion / adjustment pressure after rectification system, adjustment of liquid level, adjustment of material flow rate, and exceeding standard emergency stop	1/1/1
Deviation/possible cause	Failure to accurately read tower top temperature/periodic inspection	1/1/1
High/tail refrigeration and tail exhaust valve failure; excessive evaporation of reactor reboiler; weakening of heat transfer function of top condenser.	Failure to accurately read tower top pressure/periodic inspection	1/1/1

3.2 Key Points of Hazard Identification in Chemical Process

Risk identification of raw materials for production

In the process of chemical process production, it is inevitable to use various raw materials with high risk. These raw materials are different in terms of physical properties, chemical properties and products after chemical reaction. Because of the differences in combustion characteristics, structural stability and chemical reactivity, many raw materials are prone to explosion, corrosion and toxicity in the process of production. Therefore, it is necessary to strengthen the risk identification of raw materials in chemical process and control them in a reasonable range.

3.2.1 Hazard identification of process equipment

Whether raw materials or semi-finished products, finished products, before putting into process production, we must do a good job of storage, if there are security loopholes in storage equipment, it is easy to bring unpredictable damage. In addition, chemical process production needs special equipment to support, and these equipment must meet the chemical reaction characteristics of raw materials and material quality requirements and technical standards. Once the process equipment has performance defects, it is easy to cause unpredictable damage.The application of security technology and products is shown in Figure 2.

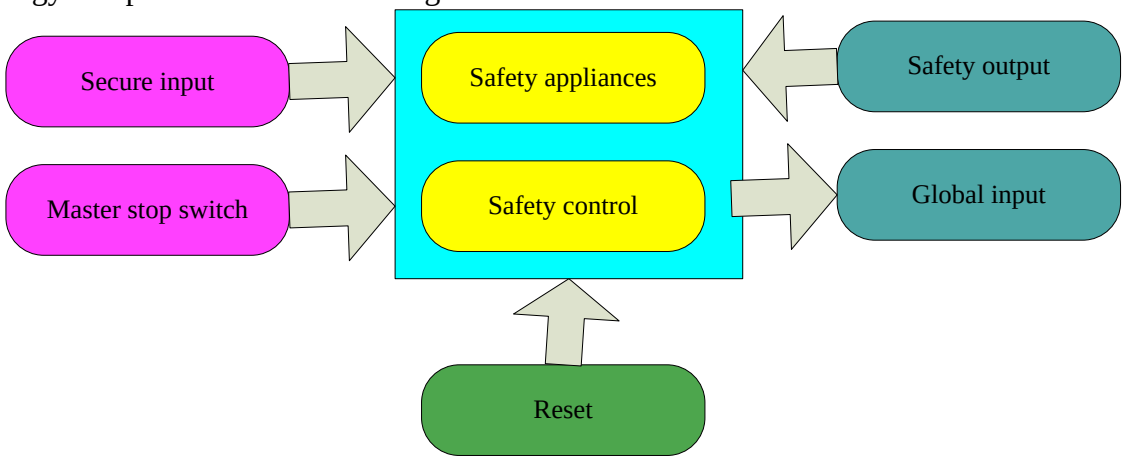

Figure 2 Application of safety technology and products

3.2.2 Risk identification of pipeline

In the process of chemical process production, the main bodies concerned must strengthen risk identification of pipeline, especially when transporting dangerous chemicals, they should also ensure the integrity of pipeline performance, ensure that the pipeline has strong resistance to high temperature, explosion and corrosion, and avoid the leakage of harmful substances. In the danger identification of pipeline, we must focus on identifying the connection and corner of pipeline to ensure pipeline tightness.

4. Effective Measures to Strengthen Risk Control in Chemical Process Design

4.1 Improving the professional quality of safety management personnel

In the process of factory production, it is better to do preventive work in advance than to do everything. In order to put the concrete work into practice, the relevant managers should fulfill their duties conscientious and do their job well. Chemical factories should regularly carry out vocational training for employees and safety management personnel, so that the work of safety administrators will be more scientific and standardized. At the same time, through some usual safety simulation exercises training, the managers can do well in order to face danger when factories are in danger. Safety in factory production process is particularly important. All departments should raise their own safety awareness and understand that it is their job responsibility. It is a meaningful thing to avoid danger and reduce accidents. As the management of chemical plant, it should demonstrate for

the specific execution department and staff. The relevant management department should formulate strict working rules and safety standards, and ensure their implementation. Restrict all production links, for those who violate management should make certain penalties, so that staff can attach importance to it. Whether it is a process designer or a specific production workshop staff should understand that this is a major matter related to their own safety, the relevant management departments and regulatory departments should inspect and supervise from time to time, and do a good job of supervision to ensure the safety of process design and factory production.

4.2 Improving chemical production technology and improving comprehensive management and control

With the progress of science and technology, China's chemical design and production technology has made some progress, but there are still some potential safety problems in the current chemical production can not be effectively solved. It is necessary to constantly improve production technology to ensure the safety of production. Chemical production is not limited to the use of chemical technology. As long as it can serve the design and production links, biological and physical technologies can be applied to chemical production. Moreover, the risk control can be improved by using a combination of multiple technologies. We should adopt diversified technology and diversified management control mode. Chemical plants should set up technical departments to specialize in technology research and development or introduce advanced production equipment. Relevant R&D personnel can also be invited to guide the design work and production links of chemical plants, and put forward suggestions, timely corrective measures, keep pace with the times, improve their management concepts and adopt scientific management.

5. Conclusion

The progress of science and technology has greatly changed the mode of production and improved the efficiency of work. Chemical process design is the key of factory production, and safety management is the guarantee of factory production. Therefore, in chemical production process, we should not only pay attention to the improvement of technology, but also pay attention to its safety management and prevention, so as to promote the improvement of factory production efficiency and safety management. This paper is only a part of the key points of hazard identification and control in chemical process safety design. It is necessary to ensure the safety of chemical production and strengthen management and control in a more comprehensive way so as to realize the safe and stable development of modern chemical process technology in China.

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