

METHODS AND COUNTERMEASURES OF STORAGE AND SAFETY MANAGEMENT FOR HAZARDOUS CHEMICALS IN UNIVERSITIES

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Abstract: In response to the storage and safety management requirements of hazardous chemicals. It is proposed that in order to avoid safety accidents, universities should start from the construction of storage environment, safety management system, waste disposal, personnel capacity and quality, safety management informatization, and emergency plan formulation to improve the storage, use, and safety management of hazardous chemicals. The methods and countermeasures proposed can provide guidance and reference for universities to achieve the safe use and management of hazardous chemicals. It is of great significance for the construction and development of university laboratories.

Keywords: University; Hazardous chemicals; Storage environment; Safety management; Method and countermeasures

1 INTRODUCTION

In the daily teaching and research work of universities, The hazardous chemicals is often used. Unlike general chemical reagents, hazardous chemicals have characteristics such as toxicity, corrosion, explosion, combustion, and combustion assistance, and their types are diverse and their properties vary greatly[1-2]. Once stored improperly or safety management problems arise, serious accidents can be caused and pose potential hazards to human health, facilities, and the environment. For example, in 2016, three graduate students from a university in Shanghai were involved in an experiment to synthesize graphene oxide. Due to violating safety management principles and operating in violation of regulations, an explosion accident occurred, one graduate student sustained minor injuries and two graduate students suffered from serious injuries due to accident. These tragic accidents have profoundly revealed the need for unremitting efforts in the storage and safety management of hazardous chemicals. To ensure the maximum reduction of the probability of safety accidents. At present, although universities attach great importance to the storage and safety management of hazardous chemicals, there are still certain problems and deficiencies. To further improve the level of storage and safety management, it is necessary to start from these issues, pursue scientific innovation in stable development, and explore the best methods and countermeasures for the storage and safety management of hazardous chemicals. This article conducts preliminary research on this topic, and the research results can provide theoretical guidance and reference for universities to do a good job in the storage and safety management of hazardous chemicals.

2 PROBLEMS IN STORAGE AND SAFETY MANAGEMENT OF HAZARDOUS CHEMICALS

2.1 The Environment and Equipment do not Meet the Storage Requirements

At present, there is still a certain gap between the construction materials and structural layout of hazardous chemical storage sites in some universities and the requirements of construction standards. The building materials and structural layout are not significantly different from other building facilities. There are deficiencies in explosion prevention, earthquake resistance, waterproofing, and fire prevention capabilities, and the resistance to natural disasters and fire accidents is poor. Once an accident occurs, it is easy to cause serious damage to the storage site, leading to safety accidents; In terms of the construction of safety supporting facilities, although ventilation equipment, air conditioning systems and other ventilation and purification facilities are installed in the storage area, the main way to eliminate toxic and harmful gases in the storage environment is through natural ventilation and local ventilation. There are problems with low ventilation frequency and limited scope of action, making it difficult to ensure the complete evacuation of polluted gases in the storage area. Moreover, most storage facilities do not have a micro overpressure environment, making it difficult to control the potential harm caused by toxic and harmful gases seeping into the external environment through gaps in doors and windows. In terms of the configuration of safety monitoring facilities, there is a lack of environmental detection instruments and temperature and humidity control devices. When the concentration of toxic and harmful gases in the storage area exceeds the standard or the temperature (humidity) is too high, warnings cannot be issued, resulting in personnel being unable to realize the existence of potential dangers and increasing safety hazards in accidents.

2.2 High Cost and Untimely Disposal of Hazardous Chemicals Waste

At present, most universities mainly rely on local relevant disposal institutions for waste disposal. This approach not only costs a lot, but also has strict regulations on the processing capacity of disposal institutions, which means that waste hazardous chemicals can only be disposed of by institutions after reaching a certain processing quantity. As a result, waste hazardous chemicals are stored in storage sites for a long time and cannot be processed in a timely and proper manner.

2.3 The ability and quality of management personnel need to be improved

At present, although universities have formulated strict safety management regulations and systems for hazardous chemicals, there are still some problems and shortcomings. Specifically, the existing regulations and systems only emphasize precautions and behavioral rules, and do not emphasize enough on the necessary abilities and qualities of personnel in the management of hazardous chemicals. If this issue is not resolved, it will limit the improvement of the level of chemical hazardous material safety management.

2.4 The Level of Information Management for Hazardous Chemicals Needs to be Further Improved

At present, most universities have invested a lot of material and financial resources in developing information management systems to manage hazardous chemicals. However, the functions of the management system are somewhat limited, only recording data information such as the storage location, quantity, and inbound/outbound status of hazardous chemicals. There are shortcomings in information acquisition, resource sharing, and auxiliary safety management, and the advantages of information technology in safety management have not been fully reflected.

2.5 The Emergency Response Plan for Accidents is not Detailed and Comprehensive Enough

In response to possible incidents and accidents related to hazardous chemicals, universities have developed emergency response plans for accidents. However, in terms of content, most plans are more similar to accident emergency response methods and measures, and fail to strictly develop accident emergency response plans from the aspects of disposal content, organizational responsibilities, personnel strength, task division, disposal resource allocation, and emergency action methods, resulting in deficiencies in the guidance, comprehensiveness, and practicality of the plans.

3 STORAGE AND SAFETY MANAGEMENT STRATEGIES FOR HAZARDOUS CHEMICALS

3.1 Improve the Environmental Construction and Safety Monitoring Level of Storage Facilities

For storage facilities, in terms of material selection, concrete and lightweight steel should be chosen as building structural materials. According to national standards, materials with fire-resistant, explosion-proof, and anti-corrosion properties such as glass magnesium board, fireproof board, silicate board, fiber cement board, and galvanized steel composite fiber cement board should be selected as panel materials[3]. Door, window, and floor materials should meet the requirements of fire prevention, anti-static, and anti-corrosion. Door and window glass should be tempered glass to meet the safety storage requirements of hazardous chemical warehouses. In terms of structural layout, multiple independent rooms should be built to classify and place hazardous chemicals, avoiding as much as possible the influence and reaction of volatile substances caused by the mixing of multiple hazardous materials, which can lead to accidents. Reasonable construction of structural columns and rings should be carried out, and the impact of accidents and explosions should be reduced by scientifically arranging side windows[4]. In terms of air conditioning and ventilation equipment, direct current air conditioning systems should be chosen as much as possible, which have the advantages of not recycling contaminated air in the warehouse, good safety and stability [5]. Comprehensive ventilation systems should be selected as much as possible for ventilation and purification, and micro overpressure regulation and control technology should be introduced to prevent toxic and harmful gases from entering the external environment through door and window gaps and causing harmful pollution.

In terms of security monitoring of storage facilities, infrared alarm devices and multi screen monitoring systems should be installed to timely understand the activities and movements of personnel near the storage site, as well as the storage status of hazardous chemicals, through rigorous and multi-directional automatic monitoring, in order to avoid theft, damage, and accidents. To effectively control the temperature and humidity changes in the storage area and monitor whether the concentration of harmful gases exceeds the standard, automatic temperature monitoring devices and toxic and harmful gas detection devices should be installed. The automatic temperature monitoring device can be interlocked with the air conditioning system for control[6]. When the temperature and humidity in the storage area exceed the standard, the automatic temperature monitoring device will send an indication to the air conditioning system. After receiving the indication, the air conditioning system will automatically adjust the indoor temperature to the specified value; When the air conditioning system encounters abnormal conditions and cannot regulate temperature, the automatic temperature monitoring device will issue an alarm prompt. Considering that universities have winter and summer vacations, there may be situations where personnel are not present. Therefore, the security monitoring system can be linked with the mobile phones of security supervisors, so that in case of any unexpected situations, they can be promptly informed for emergency response.

3.2 Disposal of Waste through a Combination of Self Disposal and Specialized Disposal

Chemical hazardous waste has a strong toxic effect. In order to avoid endangering people's health and affecting the environment, it can be disposed of by local institutions authorized by the state. untreated chemical toxins are strictly prohibited from being discarded or dumped [7]. Given that there are strict regulations on the quantity of hazardous chemical waste to be disposed of through professional handling institution, it is recommended to adopt a combination of self disposal and professional handling to handle hazardous chemical waste. Universities can construct small-scale chemical hazardous material disposal facilities to self destruct and dispose of waste materials that are less difficult to dispose of and in smaller quantities. The disposal device should include a reaction chamber and a waste liquid recovery device. After reaction treatment, the waste is converted into non-toxic substances and discharged into the waste liquid recovery device to achieve harmless treatment of the waste. To ensure the safety of disposal, relevant operating procedures and safety disposal plans should be formulated. The disposal personnel should adopt strict protection and operate according to the regulations. Once an accident occurs, it should be immediately disposed of according to the plan, thus achieving the maximum avoidance of accidents. For some difficult to dispose of and large quantities of waste, it should be sealed and stored. When it meets the requirements of outsourcing disposal, it should be handed over to the outsourcing unit for disposal. By combining self destruction with specialized agency destruction, not only can hazardous chemical waste be disposed of in a timely manner, reducing safety hazards, but it can also save a significant amount of disposal costs. Effectively solve the problem of difficult disposal of hazardous chemical waste.

3.3 Strict Safety Management, Improving the Professional Ability and Quality of Management Personnel

According to the principle of "understanding in place, leadership in place, system in place, and responsibility in place", strengthen the safety management of hazardous chemicals, and ensure that there are rules to follow and regulations to be followed. Establish a regular inspection system to conduct regular checks on the types, quantities, and storage status of hazardous chemicals, in order to promptly identify storage issues and safety hazards and prevent accidents from occurring before they occur; Strengthen the safety management of experimental personnel, requiring them to be familiar with the properties, characteristics, and emergency response methods of storing hazardous chemicals, proficient in the operation methods and regulations of various experimental instruments and equipment, and strictly follow the reaction conditions for experimental operations to prevent accidents caused by illegal operations[8]. Strengthen safety inspections of chemical hazardous material warehouses. For chemical hazardous materials with unstable properties and easy decomposition and deterioration, dedicated personnel should be arranged to conduct regular performance inspections and keep relevant records. Intensify training efforts for management personnel to enhance their abilities and qualities. By inviting experts to give lectures and regular training, the business ability and quality of management personnel can be improved, and the possibility of chemical hazardous material accidents caused by human factors can be minimized to the greatest extent possible.

3.4 Strengthen the Design of Information Security Management and Promote Information Exchange and Sharing

Currently The chemical hazardous materials management software used in universities basically meets the daily management requirements in terms of data processing, but there is still significant room for improvement in assistant decision-making management. We should strengthen information technology design, upgrade and transform existing chemical hazardous material management software, and improve its auxiliary decision-making function. It can be achieved by adding knowledge of chemical hazard management and emergency response database modules. Through these modules, not only can knowledge about the physical and chemical properties, toxic characteristics, and protective measures of hazardous chemicals be obtained, but also relevant regulations and standards for chemical hazard safety management can be learned, and the principles and methods for handling typical chemical hazard accidents can be understood. Through upgrading and transformation, the safety management system is linked with the temperature control device, toxic and harmful substance detection device, and monitoring alarm device of the storage site. Personnel can always understand the temperature (humidity) changes, whether the concentration of toxic and harmful substances exceeds the standard, and whether there are any abnormal situations in the storage site through the safety management system. Thus, the implementation of a safety management system not only records the types, quantities, and storage conditions of hazardous chemicals, but also provides information support for personnel to assist in safety management, achieving the goal of fully utilizing information technology to manage hazardous chemicals. Strengthen information exchange and sharing between universities and relevant local institutions in the management of chemical hazardous materials safety. Through information exchange, learn from each other's strengths and weaknesses, draw on experience, and provide reference and guidance for further improving the level of safety management.

3.5 Improve the Scientific, Practical, and Comprehensive Nature of Emergency Response Plans

To improve the scientific, practical, and comprehensive nature of emergency response plans. Based on the types of hazardous chemicals stored, the possible types and characteristics of accidents should be analyzed, and an emergency response plan should be developed from the aspects of formulation basis, organizational structure, division of responsibilities, disposal guarantee, and emergency response procedures and methods. In terms of organizational

structure and division of responsibilities, in addition to the unit at the same level, it is also necessary to clarify the higher-level leadership department and organizational structure to ensure that in the event of an accident, the unit at the same level can quickly report the situation to the higher-level department and complete emergency response under its leadership; In terms of disposal support, the types and quantities of various disposal equipment such as protection, firefighting, decontamination, and first aid should be clearly defined; In terms of emergency response methods and procedures, the timing, principles, procedures, and measures should be clearly defined to ensure the scientific and rational nature of the contingency plan. After the completion of the contingency plan, relevant departments and experts in the field must be hired to conduct a strict review, confirm its reasonableness, and make modifications and improvements before it can be used to guide emergency response to chemical hazardous material accidents. It is necessary to conduct an effectiveness test on the emergency response plan to ensure its practicality and reliability. It can be combined with the plan to organize personnel for accident emergency response training and drills. Through training and drills, potential problems and deficiencies in the actual application of the plan can be identified, and the plan can be adjusted and improved to ensure that the emergency plan can scientifically and efficiently guide the emergency response of chemical hazardous material accidents.

4 CONCLUSION

As the top priority in safety management, universities must make great efforts to do a good job in the storage and safety management of hazardous chemicals. Only by constantly thinking about the construction of conditions and strengthening management and disposal, and constantly improving and innovating, can the probability of accidents be minimized. To this end, the following methods and countermeasures can be adopted:

- a. In terms of storage condition construction, ensure that the building materials have strong explosion-proof and seismic resistance, and that the panel, door, window, and floor materials meet the standards of fire prevention, corrosion resistance, and anti-static. Use DC air conditioning systems and micro overpressure technology to achieve comprehensive ventilation purification and pollutant leakage; By closely monitoring multiple parties, theft incidents and accidents can be avoided. Through automatic temperature and humidity control devices linked to the air conditioning system, abnormal problems can be avoided;
- b. By combining self disposal with specialized disposal, the disposal of hazardous chemical waste can save disposal costs and avoid the accumulation of large amounts of waste, which may cause safety issues;
- c. Implement safety management for hazardous chemicals based on the four in place principle, implement a regular inspection system, strengthen the safety management of laboratory personnel, and enhance the safety inspection of hazardous chemicals with poor stability. By teaching with experts and conducting regular training, we aim to enhance the abilities and qualities of management personnel;
- d. Strengthen the auxiliary decision-making function of the information security management system, and achieve information linkage between the security management system and the temperature control and detection devices in the storage area. Strengthen information exchange and sharing among universities and between universities and relevant local departments;
- e. Improve the scientific nature, practicality, and comprehensiveness of emergency response plans. Once the plan is formulated, it must be reviewed by experts and tested for effectiveness through drills before it can be used to guide emergency response to chemical hazardous material accidents.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

- [1] He Feng, Zhang Xiaohan, Chen Hulin. Discussion on the Current Situation and Strategies of Hazardous Chemical Management in University Teaching Laboratories. *Yunan chemical industry*, 2024, 51: 154-151.
- [2] Xing Jiahuan. Storage strategies for hazardous chemicals. *Liaoning Chemical industry*, 2024, 53: 863-864.
- [3] Cai Ying, Zhang Guoguang, Li Yubin. Exploration on construction standard of hazardous chemicals warehouse in colleges and universities. *Experimental Technology and Management*, 2021, 38: 299-302.
- [4] Zhao Guizhang, Li Bingxian. Design of Ventilation and air conditioning system for chemical Reagent Storage in nuclear power plant. *Industry and Science tribune*, 2017, 16: 74-75.
- [5] Fan Bing, Lin Haidan, Qi Wentao. Study on design of architectural and structural safety of chemical reagent warehouse in colleges and universities. *Experimental Technology and Management*, 2017, 34: 6-9.
- [6] Li Yang, Wang Hao, Bai Ke. Dynamic intelligent risk assessment of hazardous chemical warehouse fire based on electrostatic discharge method and improved support vector machine. *Process Safety and Environmental protection*, 2021, 145: 425-434.
- [7] Hajar Housni, Karima Bendahhou, Mohamed Tahiri. Compliance Assessment of scientific Research Laboratories with legal requirements regarding the integrated management of chemicals and hazardous waste. *Chemistry Africa*, 2022, 5: 1167-1189.
- [8] Zhang Hongwei. Discussion on safety and fire protection of Chemical Dangerous Goods warehouse. *Modern Chemical Research*, 2024, 6: 191-193.