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Current Situation and Challenges of Safety Management of Chemical Laboratories in Universities: Problems and Countermeasures

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Abstract: University chemistry laboratory is an important base for teaching experiment and scientific research, and its experimental activities and scientific research results play an irreplaceable role in cultivating students' practical ability and promoting the development of the subject. However, with the increase of the frequency of laboratory use and the improvement of experimental complexity, the safety management of chemical laboratories in colleges and universities has become increasingly prominent. Laboratory accidents can not only cause serious harm to people and the environment, but can also have a negative impact on a school's reputation and the quality of education. Through the field investigation and data analysis of chemical laboratories in many colleges and universities, it is found that although many colleges and universities have established a set of safety management system, there are still many deficiencies in practical operation, such as weak safety awareness, imperfect safety facilities, insufficient safety training and lack of emergency plans. These problems not only threaten the safe operation of the laboratory, but also restrict the smooth development of scientific research and teaching activities. In view of the challenges facing the safety management of chemical laboratories in colleges and universities, safety education and training should be strengthened to improve the awareness and attention of teachers and students to laboratory safety. Secondly, it is necessary to improve the safety facilities and ensure that the hardware equipment of the laboratory can meet the safety requirements. In addition, a sound safety management system and emergency plans should be established to respond quickly and effectively in emergency situations.

Keywords: University Chemistry Laboratory; Safety Management; Present Situation; Challenge; Countermeasure.

1. Introduction

University chemistry laboratory is an important place for scientific research and teaching practice, which provides a platform for students and teachers to practice exploration, verify scientific theory and cultivate innovation ability. In scientific research, the chemical laboratory is a key position for basic research and applied research. Many important scientific achievements and technological innovations are derived from trial and error and deep exploration in the laboratory. The laboratory provides researchers with sophisticated instruments and controlled experimental conditions, so that they can carry out research on various chemical reactions and substance properties in a controlled environment, thus promoting the progress of chemical science. In terms of teaching, college chemistry laboratory is an important bridge for students to combine theoretical knowledge with practical operation. Through experiments, students can intuitively observe the process and results of chemical reactions and deepen their understanding of chemical principles and concepts. Laboratory operation can also exercise students' hands-on ability, observation and analysis ability and problem-solving ability, laying a solid foundation for them to engage in scientific research or related work in the future[1].

However, chemical experiments involve many chemicals, high temperature, high pressure and other risk factors, once improper operation or poor management, there may be serious accidents such as fire, explosion, poisoning and so on. With the deepening of experimental teaching and the increase of scientific research activities, the safety management of chemical laboratories has become an increasingly prominent problem, which has become a key problem to be solved in laboratory management in universities[2]. In recent years, due to poor management, improper operation and other reasons caused by laboratory accidents, these accidents not only seriously threatened the personal safety of teachers and students, but also caused immeasurable losses to the property of the school. Therefore, it is particularly important and urgent to strengthen the safety management of university chemical laboratories and prevent and control the occurrence of laboratory accidents. Under the current situation, the in-depth analysis of the current situation of chemical laboratory safety management in colleges and universities, the discussion of the challenges it faces, and the practical countermeasures are put forward, which will not only help to improve the safety management level of college laboratories, ensure the life and property safety of teachers and students, but also create a safe, stable and harmonious experimental teaching and scientific research environment for colleges and universities. Through the improvement of the safety management system, the enhancement of safety awareness, the strengthening of equipment maintenance and update, and the strengthening of safety training and other comprehensive policies, we can jointly build a safe, efficient and innovative college chemistry laboratory, and provide a solid guarantee for the training of scientific research talents in the new era.

The purpose of this paper is to analyze the current situation and challenges of the safety management of chemical laboratories in colleges and universities, and put forward feasible countermeasures and suggestions. Through this study, we hope to cause the university management and laboratory

personnel to attach great importance to laboratory safety, promote the improvement and implementation of the safety management system, improve the safety awareness and operational skills of laboratory personnel, and ensure the safe and stable operation of the laboratory. The research of this paper is also helpful to promote the improvement of scientific research and teaching quality in universities. A safe, efficient and standardized laboratory can attract more scientific research talents and students to participate in it, and promote the output of scientific research results and the cultivation of talents. The countermeasures and suggestions proposed in this paper can also provide reference for other similar laboratory safety management, and jointly promote the improvement of laboratory safety management level.

2. College Chemistry Laboratory Safety Management Status

2.1. Weak Safety Awareness

Safety awareness is the cornerstone of laboratory safety management. However, in college chemistry laboratories, some teachers and students have insufficient understanding of laboratory safety. They may think that laboratory accidents are low-probability events, so there is a fluke mentality, and often ignore the potential risks during the experiment[3]. This mentality can lead to a lack of respect for safety procedures in experimental operations, which increases the likelihood of accidents. For example, unsafe behaviors such as not wearing appropriate protective equipment, not storing chemicals in accordance with regulations, and eating and drinking in the laboratory may occur due to weak safety awareness.

2.2. Management System is not Perfect

The management system of university chemistry laboratory plays a vital role in ensuring laboratory safety. However, the management system of chemical laboratories in some universities is not perfect. First, the lack of clarity about responsibility is a significant problem. In laboratory management, the specific responsibilities of managers and operators at all levels should be clarified[4], but in actual operation, this link is often ambiguous, leading to loopholes in safety management. In addition, the failure to implement the management system effectively is also a major problem. Even if there is a sound safety system, if the implementation is poor, it can not guarantee the safety of the laboratory. For example, laboratory usage records, chemical storage and disposal regulations, etc. may not be strictly followed, which can lead to safety incidents.

2.3. Equipment Aging and Insufficient Maintenance

Laboratory equipment is an important tool for scientific research experiments, but there are aging problems in some chemical laboratories in colleges and universities. Some devices may have been in use for many years, performance degradation, and even security risks. At the same time, due to the lack of timely maintenance and update, these devices may fail during use, resulting in safety accidents[5]. For example, the old heating equipment may cause the experimental temperature to be out of control due to the failure of the temperature control system, or the aging gas detection system may not be able to detect harmful gas leaks in a timely and accurate manner, thus endangering the safety of the experimenter.

2.4. Safety Training is Inadequate

Systematic safety training is very important to improve the safety awareness and operation skills of experimental personnel. However, in some college chemistry laboratories, safety training for teachers and students is obviously not systematic and comprehensive enough. This may lead to the lack of necessary emergency response ability for experimental personnel to effectively deal with safety issues in the face of emergencies[6]. For example, the experimenter may not be familiar with the response to an emergency such as a chemical spill or a fire, and may not be able to act quickly and effectively in the event of an accident, leading to an escalation of the situation. Therefore, it is an urgent task to strengthen safety training and improve the safety literacy and emergency handling ability of experimental personnel. The challenges faced by the safety management of chemical laboratories in universities.

3. The Challenges Faced by the Safety Management of Chemical Laboratories in Universities

3.1. Chemical Management is Difficult

University chemistry laboratories usually store a large number of chemicals, some with flammable, explosive, toxic, harmful and other characteristics. Chemicals need to be stored separately according to their properties to ensure that no chemical reactions or hazards occur. For example, oxidizing agents and reducing agents can not be mixed, flammable materials should be away from the fire source. Each chemical needs to be clearly labeled, including the name, risk, date of production, expiration date and other information. At the same time, it is also necessary to have detailed inbound and outbound records to ensure the traceability of chemicals[7]. The waste generated from chemical experiments often contains toxic and harmful substances, which need to be treated in strict accordance with regulations to prevent harm to the environment and human body.

3.2. The Experimental Operation is Complicated

Chemical experiment operation usually involves multiple steps and various instruments, and the operation process is complex and requires precision. High temperature, high pressure, vacuum and other conditions that may be encountered in the experiment increase the risk of operation[8]. Therefore, experimental personnel need to master the use of various instruments and understand the principles and conditions of chemical reactions to ensure the accuracy and safety of the experiment. High temperature, high pressure and other experimental conditions can easily lead to fire, explosion and other accidents. In addition, some chemical reactions may also produce toxic gases or corrosive substances, which pose a threat to the health of the experimental personnel.

3.3. Large Turnover of Personnel

The frequent turnover of students and researchers means that there is a constant need for safety training and education of new members. New personnel entering the laboratory should receive systematic safety training and understand the rules and regulations of the laboratory, safety operation procedures and emergency handling measures. Staff turnover

also increases the difficulty of laboratory management. It is necessary to establish a sound responsibility system and supervision mechanism to ensure that each member can strictly comply with safety regulations.

3.4. Equipment Maintenance and Aging

Laboratory equipment is an important support for chemical experiments, but over time, these equipment will gradually age and performance will decline. Old equipment not only affects the accuracy and efficiency of the experiment, but also may cause safety accidents due to failure. However, the maintenance and updating of the equipment is not easy. On the one hand, universities have limited capital investment in equipment maintenance, and may not be able to afford frequent maintenance and replacement costs; On the other hand, even with sufficient financial support, the procurement, installation and commissioning of equipment requires a lot of time and effort[9].

3.5. Long-term Safety Awareness and Training

Cultivating the safety awareness of all staff is one of the core tasks of laboratory safety management. However, due to the differences in personal cognition and the diversity of experimental habits, it is not easy for everyone to maintain a high level of safety awareness at all times. Safety training is also a long and ongoing process. With the continuous progress of scientific research and technology and the constant change of laboratory environment, safety knowledge and operating skills need to be constantly updated and improved[10]. This requires that the laboratory must organize safety training activities regularly to ensure that the experimental personnel always have the latest safety knowledge and operational skills.

3.6. Dynamic Changes in Regulations and Standards

National and local governments will constantly update relevant regulations and standards according to the development of scientific research and technology and the needs of laboratory safety. These regulations and standards not only involve the storage and management of chemicals, the use and maintenance of experimental equipment, but also include the operation specifications and safety protection measures for experimental personnel. University chemistry laboratories must pay close attention to the changes in these regulations and standards, and adjust their own safety management measures in time to ensure compliance. At the same time, with the increase of international exchanges and the deepening of scientific research cooperation, university chemistry laboratories also need to pay attention to and try to integrate with international standards to improve their competitiveness. College chemistry laboratory safety management countermeasures.

4. University Chemistry Laboratory Safety Management Countermeasures

4.1. Strengthen Safety Awareness Education

Colleges and universities should regularly carry out safety knowledge lectures, invite professionals or campus safety management experts to explain the importance of laboratory safety, common safety hazards and preventive measures. In addition, it is also crucial to organize emergency drill activities, through the simulation of possible laboratory emergencies, such as chemical leakage, fire, etc., so that teachers and students can experience and learn how to respond quickly and effectively in emergency situations.

4.2. Improve the Management System

Colleges and universities should formulate detailed safety management procedures, clarify the responsibilities and authority of managers at all levels, ensure that each link is responsible for the formation of a strict safety management network. At the same time, the laboratory use registration system is established, and the use of the laboratory, chemical storage and use are recorded in detail, so that when problems occur, the cause can be quickly traced and measures can be taken[11]. Regularly review and update the management system to adapt to the changes in the laboratory environment and experimental needs to ensure the timeliness and effectiveness of the safety management system.

4.3. Strengthen Equipment Maintenance and Update

Colleges and universities should develop equipment maintenance plans, and regularly carry out comprehensive inspection and maintenance of laboratory equipment to ensure that the equipment is in good working condition. Replace or maintain aging or damaged equipment in time to avoid accidents caused by equipment failures. At the same time, the equipment use file is established to record the use of the equipment, maintenance records and replacement information, so as to carry out comprehensive management and monitoring of the equipment.

4.4. Strengthen Safety Training

Colleges and universities should regularly organize safety training courses, including laboratory safety rules and regulations, safety operation procedures, emergency treatment measures, etc. Through theoretical explanation, case analysis, practical operation and other ways, teachers and students can have a comprehensive understanding of laboratory safety knowledge, improve safe operation skills and emergency response ability. For new students and teachers entering the laboratory, necessary safety education and training should be conducted to ensure that they understand and comply with the safety regulations of the laboratory.

4.5. Establish Chemical Management System

Colleges and universities should classify and store chemicals, clearly label the name, nature, danger level and other information of chemicals, and designate special personnel to be responsible for the management and use of chemicals. Establish a sound registration system for the use of chemicals to record the purchase, use and disposal of chemicals to ensure the traceability of chemicals. In addition, regular inventory and inspection of chemicals are carried out to discover and deal with the existing safety hazards in a timely manner to ensure the safe use of chemicals.

5. Conclusion

University chemical laboratory safety management is a systematic project, which needs the joint efforts of schools, colleges, laboratories, teachers and students. Only by strengthening safety awareness education, improving management system, strengthening equipment maintenance

and update, strengthening safety training and establishing chemical management system can we effectively improve the safety management level of chemical laboratories in colleges and universities and ensure the personal safety of teachers and students and the safety of school property.

University chemical laboratory safety management needs the joint efforts and close cooperation of schools, colleges, laboratories, teachers and students. First of all, the school level should provide policy support and financial guarantee to ensure that the laboratory infrastructure and safety equipment are updated and maintained in a timely manner. The College shall establish a strict supervision mechanism, conduct regular safety checks on the laboratory, investigate hidden dangers and rectify them in time. As the directly responsible unit for safety management, the laboratory not only needs to ensure the normal operation of experimental equipment, but also needs to regularly organize safety training and emergency drills to improve the safety awareness and self-rescue ability of teachers and students. In addition, the laboratory should also establish a sound chemical management system, strictly manage flammable, explosive, toxic and harmful chemicals, and ensure that the storage, use and disposal of chemicals are in line with safety norms. As the main users of the laboratory, teachers and students should strictly abide by the safety regulations of the laboratory, correctly use the experimental equipment and chemicals, and timely report any abnormal situation in the process of the experiment. At the same time, teachers and students should also actively participate in safety training, and constantly enhance their safety awareness and operational skills.

To sum up, only schools, colleges, laboratories and teachers and students work together to strengthen safety awareness education, improve management systems, strengthen equipment maintenance and update, strengthen safety training and establish chemical management systems, etc., in order to effectively improve the safety management level of chemical laboratories in colleges and universities. The implementation of these measures will greatly reduce the occurrence of laboratory accidents, ensure the personal safety of teachers and students and the property safety of the school, and provide a strong guarantee for the smooth development of scientific research and teaching activities in colleges and universities.

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