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Identification of the Potential Hazards in a Teaching Chemistry Laboratory

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Abstract

Teaching and research laboratory staff members are continuously and hardly working to report any incident took place in their facilities. Furthermore, these incidents have been extensively investigated in depth with explicit report of the potential reasons for these incidents as well as suggesting feasible precautions to avoid them in the future. However, it has been realised that raising students as well as personnel in laboratories is important to hider any possibility for having any accident. The objective evaluation of the infrastructure which is necessary for conducting experiments as well as maintaining safety measures at all times and this job can be run by the chemistry safety standards committee (CSSC) within chemistry departments. Herein, we report for the first time a comprehensive evaluation for chemistry laboratories in terms of the infrastructure, incidents, and the renovations occurred at these amenities. Additionally, there is a detailed description for all laboratory staff or students misconducts with a roadmap to offer a better research or teaching laboratory that complies with international safety standards.

Keywords: Chemistry Laboratories; Hazards; Laboratory Assessment; Safety

Introduction

In Iraq, there are many chemistry departments in different universities across the country that have been working very hard to report and put a feasible ways to avoid accidents in chemistry laboratories. Nevertheless, due to the shortages of some necessary safety equipment in many chemistry laboratories has drastically affect their suitability for functioning as other chemistry laboratories in the world. Many of these shortages have been probed and identified in previous reports [1-5] .In this article, we report here some of the faults, misconducts, and some accidents occurred at a chemistry department. In addition, we unveil the roadmap adopted by us and the CSSC as well as making use of some established strategies from the literature [6-

14] to launch a promising procedure to avoid any serious damage to people or amenities. In the next sections, we shine a light on our observations, and evaluations for a chemistry laboratory in an elaborated description of our recommendations and vision to evade all possible hazards to people and infrastructure.

Installation for Personal Protective Equipment and Safety Practices

In our department, there were some demands on building necessary facilities in order to be used by students as teaching laboratories. This high demand had a crucial role in facilitating the process of construction of these important laboratories. However, the construction was not fully in compliance with the standard and ergonomic protocols. (Figure 1) demonstrates the improper installation of a fume hood in one of the chemistry laboratories which is located in the middle of a building mostly occupied by undergraduate and postgraduate students as well as staff members. The toxic fumes might be generated upon dealing with toxic chemicals inside the fume hood will definitely bring some adverse consequences on all people occupying the building.

Figure (1)*:* Fume hood installed improperly in one of the chemistry laboratories with poor quality and inefficient ventilation system

The problem with that fume hood is that the ventilation was not efficient enough to suck all of the toxic fumes coming out from the chemicals used within. For instance, chloroform is widely known for its toxicity as a liquid and even its fumes if it evaporates. Therefore, we always transfer chloroform and other liquids of similar toxicity strictly inside the fume hood. Unless we make sure that the fume hood is functioning well enough to prevent any damage to people, we could stop using that fume hood till it getting mended or replaced with a functional one. As a matter of fact, the CSSC presented a detailed evaluation report for this laboratory and other laboratories which have a similar issue and below we highlight the most important points the report exposed.

a) In a country like Iraq, where the summer season is extended to even more than 6 months a year, there must not be a direct exposure to the sunlight to these fume hood in case there are some chemicals stored inside as seen in (Figure 1). Otherwise, all volatile, flammable, and toxic chemicals must be stored away from direct sunlight in a completely dark cabinet below the fume hood cabinet and ensuring that the ventilation is enough within these cabinets.
b) The ventilation system is not enough to suck all toxic and hazardous chemical fumes. Furthermore, the ventilation fan speed should be variable upon the volume of harmful gases inside the fume hood. In other words, higher volume of fumes inside the fume hood must be sucked in a higher speed and vice-versa.
c) The sash was not moving up and down easily due to the poor design. This will lead to leaking some of the harmful gases from the fume hood as the ventilation is not efficient. Also, it is always a good practice to keep the sash down whenever there is a reaction inside or the fume hood is not in use.
d) The ventilation ducts supposed to be terminated at the roof of the building and not as seen in (Figure 2).

Figure (2): Incorrect and unsafe installation of the ventilation ducts at a very low height and not to the roof of the building.

e) Using a chemicals fridge for preserving food and drinks which completely contradicts with safety measures and practices inside any scientific laboratory as displayed in (Figure 3). Drinks and food might be contaminated with chemicals which are all considered as hazardous materials. This contamination may lead to death even with very minimum amounts of those materials, such as selenium, or may be harmful to specific organs for the long run, such as methanol which may cause visual impairment or even full blindness in some serious cases.

Figure (3): A fridge inside the laboratory which supposed to be used for storing chemicals and was used to preserve food instead.

f) The cooling system is supposed to be central and not as separate units (Figure 4.) in each laboratory and also the electrical cords must be covered with at least a protective PVC tubes to protect them from being in contact with liquids especially water [15]. Also, these electrical cables might be dangerous as electrical shocks are possible in case one of these cables was not properly insulated.

g) Some electrical cords were found in a very close proximity to some obsolete drainage pipes as shown in (Figure 5). These old pipes might be leaking due to old seals, and fittings. This leakage on these electrical cords may yield a catastrophe and cause a severe damage to the property and people as well.

Figure (4): A cooling split unit installed in one of the laboratory with cables fixed on the wall with no cover.

h) There was not any safety training program designed to staff members as well as students. Also, the committee did not find any safety and precautionary flyers inside the laboratory, nor a clear safety evacuation procedure in case there was an accident.

i) As a consequence of that evaluation by the CSSC, the laboratory was closed for refurbishment and to involve all staff

members in a comprehensive training course.

Figure (5): The old drainage with some electircal cords in the vicinity.

Roadmap Implemented

The strategy we have adopted to renovate laboratories and ensuring that all of them comply with the safety measures was feasible and promising to avoid any potential dangers to workers as well as students. Despite the fact that we have not had any accidents since the establishment of our department, there must be a precautionary safety practices and procedures to at least minimise the risk of chemicals. Hence, we put a set of compulsory rules for any person working in a chemistry laboratory whether they were students or staff. These rules include for example a safety induction for all staff members and laboratory personnel. Those laboratory and staff members need to make sure that all of their work inside the laboratory is in agreement with international safety measures. Thereafter, those staff members teach their students how to deal with chemicals inside the laboratory and what are the safety practices that should be followed in order to keep the risk as low as possible to ensure a safe environment.

It was also proposed by the CSSC that there should be an inclusion of safety measures and safety rules in all laboratory manuals, so as to allow students to read all of them carefully prior to perform their experiments. Given that almost all of the experiments in the curriculum include only non-toxic, and non-flammable chemicals, still there is a necessity to teach students how to deal with chemicals very carefully to avoid any danger to them even these chemicals were of low risk score.

The CSSC also launched a regular laboratory audit, which includes checking up all chemical storages inside the laboratory, containers use for storing chemicals whether they are suitable or not, and making sure that they all have got a readable and proper labelling. Making sure those students especially postgraduates who conduct research are all aware of the risk of the chemicals they use in their reactions. Also, it is mandatory for all of those students to have at least an electronic copy of the safety data sheet (SDS) of every material they use in their projects. These SDS documents must be shared with their supervisors and a CSSC committee member can obtain it upon request during the audit.

The CSSC during their audit confirmed that chemical must not be disposed to the sink, and instead must be disposed into waste bottle and the waste bottle should be carefully chosen. For instance, organic liquids, such as toluene, must be disposed to a glass bottle as toluene can react with plastic containers. The CSSC still working on finding an environmentally benign way to dispose waste after the collection to prevent any damage to our environment. The CSSC also acknowledged that any future electrical or plumping renovations must be under their agreement and direct supervision and according to safety rules.

Conclusion

In the light of the present case study, we report some faults and improper usage of the personal protective equipment, such as fume hood and how to properly and safely store chemicals in a chemical laboratory.

Furthermore, we proposed a clear and feasible roadmap to renovate the laboratory after conducting a detailed evaluation for it with spotting all wrongdoings and recommending better safety practices. As we followed previous pivotal laboratory evaluation by other academic institutions in Iraq, we recommend other chemistry departments within the country to conduct a similar evaluation for their laboratories as we believe that safety must be prioritised in every chemistry department.

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