LABORATORY SAFETY AND CHEMISTRY TEACHING

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Abstract

A chemistry laboratory is usually a room or space equipped with useful hardware and chemicals for practically teaching chemistry as a physical science. To work with chemicals and various hardware (glass and nonglassware) demands high level of care on the parts of the teacher, laboratory workers and students alike. This paper surveyed what laboratory safety entails, possible laboratory accidents, level of safety required and safety index in Nigerian school system. Appropriate recommendations were also made.

Introduction

Any chemistry laboratory, especially an organic chemistry laboratory, can be a dangerous place in which to work. In a general term, the chemistry laboratory is a confinement full of hazardous substances in terms of chemical and equipment meant for use toward the enhancement of human living. Understanding what to do and what not to do certainly will serve well in minimizing danger in the laboratory (Pavia, Lampman and Kriz, 1976).

Safety entails freedom from danger and can be ordered with due respect to possible sources of danger. Accidents in workshops and laboratories claim far too many victims and according to Dolan (1979), approximately 70 percent of these accidents are caused by neglect or carelessness on the part of the workman and experimentalist. Avoiding accidents is always a good policy. We should note that if one is involved in a serious accident it will not be reversible; a dead chemist (teacher or student) contributes no more to the growth of knowledge / science. Furthermore, it is of interest to note that a tidy bench reflects a tidy, methodical, business-like mind, which is the basis of accident prevention. Chapman (1975) observed that statistics gathered of individual accidents showed that: of every three accidents, which occur, two are caused by the personal element of the victim, and one by means beyond his control.

Consequent upon the above, it is very obvious that the need for care and special safety measures cannot be overemphasized in our laboratories especially at this time of global economic recession. This forms the basis for this paper.

What is Laboratory Safety?

A laboratory is a term associated with a room or space having some equipment and facilities and in which practical works are carried out. Mere is a paradox: A wealthy farmer after clearing (brushing) his bush decided to use motor-saw to fell the trees by himself. The motor-saw uses petrol as a source of energy. The farmer made a fire to prepare food in the same bush and after filling the tank of the motor-saw with petrol, he kept the left-over in a nearby place. The same farmer was in a haste and cut many of the trees half-way each and thought of cutting a more central tree completely so as to pull others along as it falls. Unfortunately, all the trees actually fell at the same time, breaking the petrol jerrycan, which caught fire against the big farmer. Also the falling trees fell against the man and he had no way to escape and he died and was burnt beyond recognition. What a wonderful and careless so-called wealthy farmer!

The chemist in his laboratory is like the paradoxical farmer described above who has a lot to contend with as he works with chemicals (some of which are poisonous and dangerous) and nonchemical substances. The farmer had good intentions about his work but with high level of carelessness and negligence perhaps. He died because he did not plan a way of escape in case of any eventuality.

Laboratory safety entails the pulling together of both human and materials resources toward the provision of safety in the laboratory and this should be the primary concern of chemical educators, laboratory assistants, attendants, technicians and technologists. Lzeugbor, et al (1986) noted that lack of trained laboratory assistants and finance to procure safety equipment and poor laboratory design form the main constraints to ensuring laboratory safety in the institutions. The care in handling

 equipment and facilities for science (chemistry) teaching enhances the life of such apparatus and of the teachers in addition to increase in their experimental dexterity. Idris (1981) has proved that proper laboratory practice and effective organization of practicals

by the teachers and laboratory assistants will reduce laboratory accidents which normally result in breakages of the glassware and hardware.

Kenneth (1990) observed that safety in the chemical laboratory has received a great deal of attention over the years and has been the subject of numerous publications. In fact, safety considerations form the primary occupant of the mind of any chemical educator whose goal is success at work developed toward growth of scientific knowledge and humanity. As pointed out by Chapman (1975), a large number of accidents occur in the factories in most countries everyday. These sometimes result in death, sometimes in permanent disablement and in many cases, fortunately, in nothing worse than a few days or weeks absence from work or duty. Even if an accident does not render the victim unfit for work it makes him liable to infection, or any other of the ills, which may be contracted as a result of injury and shock. Confidence is a necessary part of our character and without it we should be of little use in a chemical laboratory. Over-confidence, however, is to be guarded against at all costs.

Possible Accidents in the Laboratory

Various kinds of accidents can be found in the laboratories, especially in the chemistry laboratory. Such accidents include fire out-breaks, burns, eye accidents, fainting and cuts. These are as a result of negligence, carelessness and sometimes:

(a) Fire Out-Break: Perhaps the chief danger in practical organic chemistry is that of fire, since many of the liquid chemicals and solvents are highly inflammable substances (Smith and Waldron, 1980). The use of naked lire in the laboratory in general when the gas system is open also causes fire out-break and a lot of casualties, hence it is very highly advisable NOT TO SMOKE IN THE LABORATORY under any condition. Many beginners make the mistake of heating an inflammable liquid in an open vessel over a naked (lame. It is here recommended that for any liquid suspected to be inflammable, the procedure should be to heat the liquid in a vessel having a reflux condenser on a water or steam bath. Approved electric hot plate; or immersion in a bath of hot water with the burner extinguished may also be used either. It is necessary to say that it is extremely *dangerous* to use water on chemical fires.

(b) Eyes Accidents: The eye is one of the most sensitive sense organs in the body. Any time taken and for whatever amount it may requite to care for and protect the eye from any form of accident in the laboratory is most advantageous. Various eye accidents are known in the chemical laboratories in general. These include acid in eye, caustic alkali, bromine, glass pieces in the eye and general gaseous explosion into the eye (Smith and Waldron, 1980; Fonche, 1983).

(e) Swallowing Poisonous Substances: Poisonous substances may be in the form of solids or liquids. In some cases, the substance stops within the buccal cavity (mouth) and can be easily spat out and the mouth, quickly washed and rinsed with copious water. On the other hand if the substance is completely swallowed in error (Diojomah, 1986), an antidote should first be given to the victim depending on the nature of the poison swallowed and rushed to a medical doctor without further delay.

Accidents of swallowing poisonous substances include taking of such substances as arsenic or mercury compounds, acids including ethan-1, 2-dioic acid (oxalic acid), caustic alkalis and salts of heavy metals.

(cl) Explosions: Explosions form another type of accidents in the chemical or chemistry laboratory. A case of explosion caused by fire is most unpreventable; though care should be well taken to avoid the occurrence of such fires in the laboratory. Explosions may also occur when all exits to an assembly of apparatus for reflux or distillation are blocked (Smith and Waldron, 1980). The attempt to carry out any distillation to the end is dangerous since the last traces may be explosive, and vacuum distillations MUST not be carried out in the fume chamber because it is not safe to do so.

Explosions also arise from inadvertently mixed chemicals. According to Pavia, Lampman and Kriz, (1976) there is always the chance that one may accidentally pour back some foreign substance which may react with the chemical in the stock bottle in an explosive ‘

manner. Hence pouring chemical substances back into bottles is not only dangerous inconsiderate, but also unscientific.

Level of Safety Required

Every chemical educator is expected to be highly conscious of his life and that of the students and materials things in the laboratory. There is no effort made towards ensuring safety in the laboratory that is too much. The teacher should be knowledgeable in safety measures. He should open the use of any laboratory work by extensively discussing the safety measures with the students. The teacher may have to go beyond just verbal discussion but to make charts of safety measures and regulations to be hung at strategic points in the laboratory. Ochonogor (1993) observed that such a chart in organic chemistry laboratories should contain instructions like:

1. You should know the location of the nearest fire extinguisher in the laboratory. Improvised extinguishers e.g. buckets of dry sand should be easily located.
2. You should always wear approved safety glasses or goggles in the laboratory.
3. Put on the laboratory coat with handkerchief or duster in the pocket always.
4. Experiments in which poisonous fumes are evolved should be performed in a fume chamber.
5. Exercise care in handling all reagents particularly those known to be corrosive. Trioxonitrate V acid, Bromine, concentrated tetraoxosulphate (VI) acid and concentrated sodium or potassium hydroxides are common reagents, which will cause painful skin damage in a short time.
6. Never boil a beaker of flask containing inflammable liquids like ether, or ethanol in a naked flame. Make use of a water-bath instead.
7. Unnecessary flame should be put off. If despite all precautions, a fire does occur, it is essential that you remain clam and *not* extend the fire by your haste to extinguish it. As minor fires occur in flasks or beakers, put them off by *covering* the vessel with a watch class.

As general rules (Chendo, 1994) the following are also part of safety measures and regulation in the chemistry laboratory.

8. Do not perform any experiment without the guide of the teacher or laboratory assistance.
9. It is improper and unsafe to remove the label on any container. The content may be rendered useless by such act.
10. Interchange of stoppers MUST be avoided. Also do not use glass stoppers to cover reagent bottles containing sodium hydroxide solution.
11. Do not test chemicals with the tongue.
12. No eating in the laboratory.
13. Do not add water to acid but acid to water.
14. There should be no running about of any sort in the laboratory.

Tidiness as a Measurement of Safety

The place of tidiness cannot be overemphasized in ensuring safety in any chemical workshop like the chemistry laboratory. James and Prichard (1974) observed that any contamination of chemicals, which invalidates experimental results, must be eliminated: spilling of liquids, mercury and other chemical which could cause permanent damage to instruments, interfere with precise measurements or be a potential health hazard, must be cleared up immediately. Chapman (1975) put it that tidiness implies such order, cleanliness and method in one's working that the experiment/job seems to proceed smoothly without any obvious effort. An experimentalist should ensure that only the materials and reagents for his experiment are found by him on the bench at a time. A bench loaded with clustered irrelevant materials is a good source of accident and should be avoided during experiments.

Who is to Provide What?

The business of ensuring safety is the duty of both the teacher and the school. In fact, provision of safety should be a primary thought for chemical educators - the chemistry teachers and

authorities of institutions where chemistry is being offered. Safety professionals are one possible source of up-to-date information on chemical laboratory safety (Kenneth, 1990). Provisions of safety gadgets including various kinds of tire extinguishers, approved goggles, masks and laboratory coats and phone boxes in the laboratory offices; are functions of school/college and university management. The teacher should be able to prepare safety rules and regulations for use in the laboratory and give a copy to each student and provide improvised fire extinguisher (bucket of dry sand) (Ochonogor, 1996).

Recommendations

To conclude this paper, the author puts the following recommendations forward.

(1) There is certainly a need to enforce good laboratory practices and sensible safety measures for students.
(2) Chemical educators are themselves expected to be knowledgeable in safety measures and even first-aid administration.
(3) Authorities of institutions should always organize and sponsor training in safety measures for the chemistry teachers using safety professionals.
(4) Information on chemical safety can be obtained from the American Chemical Society, Chemical Health and Safety Referral Service titled "Safety in Academic Chemistry Laboratories" for prudent practice in the chemical laboratory. The Chemical Society of Nigeria also has such information for use. The guidelines contained can be used in laboratories using chemicals, including research, clinical, quality control, and development laboratories.

Conclusion

Working in the laboratory is like working in a hazardous zone and a trace of neglect can result in physical impairment and general failure in science programme.

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