



Safety Precautions for Handling of Chemicals, Reagents, Solvents and Glassware in the Laboratory of Analytical Chemistry

G.M. Kadam

School of Chemical Sciences,

S. R. T. M. University, Nanded, Maharashtra State, India-431606

Email: gopal.kadam@gmail.com

Abstract: To ensure safety while working in the laboratory should be top most priority and to follow safety precautions, is the responsibility of researchers as well as all the personnel working in the laboratory of analytical chemistry, in order to have a safe working environment for all. The training of safety techniques to all associated professionals at regular interval is necessary including new joinees. An ignorance or a small mistake may lead to huge loss to human health, hence to work safely for safety is first priority by all for all. This article will help to beginners as well as professionals for self-safety and describes many of the precautionary measures to follow by personnel involved in the research or analysis activity as well as all the associated staff in the analytical laboratory for safe handling of chemicals, reagents, solvents and glassware or glass apparatus.

Key Words: Safety, Laboratory, Glassware, Chemicals, Reagents, Solvents.

1. INTRODUCTION:

Ministry of labour and employment (Government of India) has made national policy on safety, health and environment at work place [1] and The Factories Act,1948 [2] for safety and to work in safe environment. Handling of chemicals, reagents, solvents and glassware is very important because unsafe handling leads to laboratory accidents and poses risk to human health. Different chemicals have various types of effects on human health and the assessment of chemicals which poses risk is a continuous task. Different solvents have different abilities to react on human based on evaporation, solubility in water or through penetration through skin. Some of the chemicals which are dangerous in nature can enter into human body and are toxic. Glassware is manufactured by scientific technique and is used for scientific research work for different purposes. Glassware is manufactured by different manufacturers very efficiently with proper shapes and designs suitable to use in the laboratory with accurately calibrated so as to use for its intended purpose of quantification, in case of used for quantitative research work. Published data and safety policies available were searched and studied as a part of survey of literature [3-10]. To the best of my knowledge and as per my understanding as well as opinion, this paper briefs the safety precautions to explain in simple way.

2. SAFETY PRECAUTIONS IN THE ANALYTICAL LABORATORY:

- In case of an emergency, all the staff in the premises must be aware of sound generated from fire alarm installed.
- All the staff working in the premises should be aware about building evacuation procedures and emergency exits.
- All the personnel should be trained on precautions to be followed in laboratory safety and should be aware of emergency exits, safety wears along with their respective locations and application as well as usage. (e.g., fire extinguishers, eye washers, first aid kit, and safety showers).
- The glassware intended to be used for purpose of laboratory usage should not be used for food or beverage purposes and also it is not recommended to work alone in the laboratory
- Chemicals, reagents, and solvents should never be attempted to taste or should try to take smell as it is hazardous to human health.
- The chemical waste collected from analytical laboratory should be disposed as per the recommended method. The disposal method should be written and kept in proper place as well as respective personnel should be well trained.



- If anyone working in the laboratory notices any unsafe conditions then it should be immediately reported, get it rectified by the respective personnel and should be ensured the rectification.
- If anytime splashing of chemical occurs on to the skin or in the eyes, immediately affected area should be flushed with water and doctor check-up is required.
- Prior to start of experimental activity, it is essential for the researcher to check all the chemicals, reagents and solvents planned to use in the analysis for their hazardous effects so as to take proper precaution while conducting the experiments.
- While performing analytical activity, extreme care should be taken for usage of the solutions such as volatile liquids, refluxed solutions etc.
- It is recommended to carefully transfer sufficient quantity of chemicals, solvents and reagents as applicable or required from larger bottles/containers to smaller one with precaution and from smaller one to further use for experimental work.
- While performing any experimental activity such as heating, mixing of solutions/chemicals/mixture of solutions or measuring liquids, the face should not get exposed to such activities and sufficient distance should be always maintained as a precautionary measure, to avoid face exposure to protect from incidents, if happened.
- The mixing of acid solution into water is exothermic and water should not be added to concentrated acid solutions directly however the addition of acid solutions to water should be very slowly with stirring the solution on stirring plate or manually with the glass rod.
- While performing the experimentation, chemicals should be avoided to have the direct contact with skin.
- All the chemicals, reagents and solvents should have clear and legible labels along with date of opening and expiry.
- Before taking any chemicals, reagents and solvents, labels should be properly read to take specific bottles/pack for experimental use.
- Chemicals, reagents and solvents planned to use in the laboratory, are not recommended to be carried/transferred to other places outside premises without prior written permission and for valid reason with all precautions and proper packing.
- The use of fume hood is mandatory for volatile and flammable chemicals for researcher working in the laboratory.
- All the chemical waste collected should be disposed as per the applicable method and as per the government disposable permissions and rules.
- All the instructions given should be read and listened very carefully at each time communicated.

3. TRANSPORTATION, SAFE HANDLING AND STORAGE OF CHEMICALS, REAGENTS AND SOLVENTS:

- For identification and ease to find, all the chemicals, reagents, and solvents should have proper detailed information on label.
- Appropriate carriers should be used for small as well as large bottles of chemicals, reagents, and solvents.
- While keeping the chemicals, reagents, and solvents in the carriers with precautions, containers should be kept by the use of both hands and one hand should be underneath the bottle to avoid fall down incidents.
- The incompatible chemicals should not be carried in the same carrier.
- In case of transportation of chemicals from one place to another, it should be moved in protected packing/containers i.e., with outer package and should have sufficient amount of adsorbent material, if spillage/leakage occurs.
- In order to keep large containers/packs of concentrated solutions of acids like sulphuric acid, nitric acid and hydrochloric acid, special cabinets (e.g., corrosion proof) are recommended to use. Storage cabinets with multiple features such as corrosion proof, different sizes or as per the specific customized requirements are manufactured and are available from different suppliers.
- In order to store organic solvents such as ethanol, methanol, acetonitrile and other different flammable substances, closed storage racks/cabinets with fire proof feature should be used. Different types with different capacity (size) of commercially available fire proof cabinets are available from different manufacturers.



- If spillage occurred accidentally which may release chemicals, there should be prior proper arrangement such as adequate containment and adsorbents to avoid for spills in the storage.
- For toxic substances, chemicals or carcinogens there should be additional packaging to be used i.e., all these substances should be in secondary container with outer additional container.
- Hazardous chemicals/substances are placed in the closed cabinets with ease of access instead of keeping in high shelves to avoid any accidents. The storage cabinets should not be overloaded and should have sufficient space for the placed bottles/containers i.e., sufficiently apart from each other to handle with comfort and shelves should be fixed e.g., preferably to the wall and/or floor so that its movement will not happen and due to any movement of rack, possibility of incidents of accidents can be avoided.
- The inspection by the designated/responsible person to check chemical store/warehouse at regular time intervals should be made mandatory. The storage packs/containers should be free from rust and any deformation. All the stoppers or caps or covers of the storage containers should be properly as well as securely placed. During inspection, the responsible person should check for such mentioned points as well as any spillage/leakage, rust and any deformation. There should be proper labelling for hazardous chemicals on storage racks.
- Every storage container/pack should have detailed information on label for the purpose of identification of the particular substances present in the container.
- Expired or out of date chemicals, reagents, and solvents should be discarded as per chemical waste and disposable policy document.
- Material safety data sheet (MSDS) should be read before for each activity planned to use in the analysis and readily available for all the chemicals to know the hazardous and safety aspects.
- The storage containers/packs should be in good or proper condition and should be checked periodically for leakage.
- Empty storage containers should not be disposed in waste unless cleaned properly as per written procedure. The residues remaining in the storage containers should be completely removed and then safe disposal should be done as per disposal policy.
- Whenever unsafe conditions are observed, should be immediately reported and get it rectified on priority.
- Safety is the primary duty and responsibility of working personnel in the laboratory.
- Researchers/analysts should wear specified protective equipments such as goggles, aprons, gloves, masks etc., as applicable while working and handling of chemicals, reagents, solvents and glassware.

4. HANDLING AND PRECAUTIONS FOR SPILLAGE IN THE ANALYTICAL LABORATORY:

- Any spillage in the laboratory should be reported to the responsible authorities immediately to take due action to rectify the issue.
- Spillage occurred at the site may be dangerous to personnel present in the affected area, hence all the personnel at the site of spillage should be moved from there at the safe place and entry should be restricted.
- Some of the immediate actions should be performed when spillage occurred and if it does not pose danger to personnel by following all the safety measures, such as moving the equipments/instruments (if possible, like small portable instruments), putting adsorbents on and around the spilled area, and to prevent further contamination.
- Aprons contaminated should be removed and eyes or skin should be flushed with water.
- If the spilled material poses risk of flammability, then all the switches, heat sources, and electrical equipments should be switched off.
- If fume hood is nearby then all the ventilation should be open to full extent and exterior openings such as windows and doors should be opened for ventilation so as to pass out non-toxic vapours.
- If the spillage observed is covered over small area or to the small extent from acids or bases then neutralizing agent or an adsorbent should be put to control its further spread.
- If the spillage occurred is at small area or to the small extent then non-reactive material such as clay or dry sand can be used to absorb the spill.
- If the spillage occurred is at large area or to the large extent such as acids or bases then water can be used to flush however it should be ensured that water should not react or damage further. If water is non-reactive to



spilled area, then need to use for flushing and precaution should be taken that water should not come in contact to water-reactive chemicals, if are stored in same area.

- If spillage of chemicals is non-reactive to water, then after flushing with water, affected area/instruments or equipments should be well cleaned or wiped properly wherever necessary.
- If the spilled substances are extremely volatile then it should be allowed to evaporate it completely by switching on laboratory hood or exhausts.
- If the spills are solid and non-toxic then the area should be suitably cleaned with proper precautions and should be discarded as per disposal procedures where as if the spilled solid material is toxic then it should be cleaned with protective equipments as well as grooming and should be disposed as per written procedures available in the laboratory.
- It should be ensured that all the packs or containers should have proper caps and each time after usage it should be properly capped to avoid any spillage.
- The persons in the laboratory should not get panic in case of any incidents and should handle the situation with proper care taking utmost precautions and considering safety of human lives as topmost priority.
- Everyone working in the laboratory should have proper knowledge of safe working and periodical trainings should be conducted to keep aware and updated for safe working environment.

5. SAFETY PRECAUTIONS FOR HANDLING OF GLASSWARE IN THE ANALYTICAL LABORATORY:

- Glassware or glass apparatus are fragile, may break or shatter while using in different situations /circumferences.
- Glassware while using for experimental work may break such as if it gets bumped, dropped, too much pressure is applied or sudden increase or drastic change in temperature above or beyond its limit of acceptable limit and lead to accident, hence glassware should be handled properly with utmost care.
- Some of the accidents happened due to glassware/glass apparatus injury may be minor however some may be very dangerous hence safe handling skill and training should be taken by everyone working in the laboratory.
- It is the responsibility of every user to inspect the glassware thoroughly prior to start of experiment the specific glassware planned to use for that particular experiment.
- All the analytical method of analysis should be followed with proper care and safe handling.
- Specific handling procedures for glass apparatus like beakers, volumetric flasks, glass bottles, volumetric pipettes, test tubes, jars, measuring cylinders, etc. planned to use in the laboratory should be available.
- Researcher should have knowledge about compatibility of glassware to use for experimentation with mentioned chemicals as per test method such acids or alkalies. Some of the chemicals may react with glassware/glass material of apparatus intended to be used or often heating may also lead to damage.
- Sometimes glassware may be having manufacturing defect and may not be useful for further for application, such glassware should not be used.
- Glass apparatus like round bottom/volumetric flasks should never be hold at the neck of the flask and also beakers only by one hand, instead it is always better to use two hands in such a way that one hand should be from below to have the support.
- It is recommended to use hand gloves while performing experiments and specially laboratory purpose gloves are useful.
- The glassware should be used for heating purpose only when it is designed for such purpose, provided its maximum temperature limit should be checked. Hot glassware (e.g., round bottom flask) used for boiling purpose should never be kept at cold place.
- There should be proper place assigned to place and work for keeping/working for hot glassware.
- During the glass apparatus it always recommended to release the pressure generated inside at certain intervals while shaking or sonication and should be gently shaken.
- If large number of glass apparatus is to be carried from one place to another such as from wet laboratory to instrument laboratory, then trolley should be used to carry the glassware.
- Dissolution vessels/jars should be carefully handled while placing before start of use or removing after end of experiment.



6. CONCLUSION:

Preparation of protocol or procedures to follow handling of chemicals, reagents, solvents and glassware along with safety precautions are very important documents which guides to follow the safe handling methods and it should be updated/revised for the new information for updates, modification or changes observed in the research domain and should include the latest information. Appropriate precautions should be followed by all the personnel in the analytical laboratory. Training, awareness and safe behaviour of each staff working in the analytical laboratory ensures safe environment by everyone for all. Safe behaviour is the responsibility and also the duty of all involved in the laboratory activities.

ACKNOWLEDGEMENT: The author is thankful to all the teaching and non-teaching staff of the department.

REFERENCES:

1. National policy on safety, health and environment at work place by Ministry of labour and employment, Government of India, Available: <https://labour.gov.in/sites/default/files/SafetyHealthandEnvironmentatWorkPlace.pdf>
2. The Factories Act, Ministry of labour and employment, Government of India, 1948. Available: https://labour.gov.in/sites/default/files/Factories_Act_1948.pdf
3. Romklao A., Investigating undergraduate students scientific understanding of laboratory safety, *Procedia- social and behavioural sciences*, 46, 5058-5062, 2012. Available: <http://dx.doi.org/10.1016/j.sbspro.2012.06.385>.
4. Robert H., The emergence of laboratory safety, *Journal of Chemical Health and Safety*, 14-19, 2007. Available: doi: 10.1016/j.jchas.2006.10.001.
5. Dave H. and Jim R., Safety practices with laboratory glassware, *Journal of Chemical Health and Safety*, 17-20, 1999. Available: [https://doi.org/10.1016/S1074-9098\(99\)00051-9](https://doi.org/10.1016/S1074-9098(99)00051-9).
6. Identifying and Evaluating Hazards in Research Laboratories, Hazard Identification and Evaluation Task Force of the American Chemical Society's Committee on Chemical Safety, 2015.
7. Prudent practices in the laboratory, Handling and management of chemical hazards, National Academies Press (US), 2011.
8. Prudent practices in the laboratory, Handling and disposal of chemicals, National Academies Press (US), 1995.
9. Care and safe handling of laboratory glassware, Corning. Available: https://www.sigmaaldrich.com/deepweb/assets/sigmaaldrich/marketing/global/documents/404/391/glass_care_safe_handling.pdf.
10. Nagesh A., Supriya A and Amita B., Biochemistry laboratory safety rules for undergraduate medical students, *international journal of scientific research*, ISSN-2277-8179, Volume-9, Issue-10, 2020.