Laboratory Instruments Classification and Risks Use with Safety for Less Mistakes

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Abstract. The safety and security in physiochemical and biological labs needed for many conditions being ideal for workers when prevent or at least reduce the risks on it. The details of work include classification for the laboratories according the nature of the process that made. This work divided into many parts the first deals with classical instrument which used in the laboratory. The second specific instrument includes the instrument that may found in labs which characterized by should use after training with apparatuses. The second section of this work we reported five of common devices that used in the field of nanotechnology.

Keywords: classification of laboratory, risks of apparatuses, radiation, laser, electricity.

1. Introduction

Most of reported works which deal with safety and securities in chemical and biological labs concern with the parameters that causing risks for the workers [1] such poor design and laboratory equipment with weakness of professional diligence. The weakness includes all the scientific information for the chemical materials and how to deal with emergencies. In this research, we try to report the laboratory devices which located in the laboratory with a statement, and what could causes of risk to employees. The biological, physical and chemical laboratories include many apparatus used for preparation, purification and characterization of the synthesized or extracted materials. Some of instruments [2] kept in the lab due to unnecessary require privacy in the employment and working conditions in a way that makes it imperative isolated in private places. In another handsome apparatus need for specific care, such location, temperature of working circumstance, isolation from the universe and from non-professional person. From the introduction that mentions the laboratories can be classified to the following:

1.1. Educational laboratories

This lab used to conduct observations and examinations with studies of various scientific phenomena. The experiments were listed under the title of the traditional educational experiments [3] which given to undergraduate students in the colleges and institutes. The main objective of these laboratories is to give the students practical skills in the laboratory that commonly converted from theoretically information's. Generally, this lab includes many of classical instrument that used mostly with a low level of risks. Figure 1 shows some of the instruments that used for this purpose, such magnetic stirrer, centrifuge, oven and benzene burner.
Figure 1: different common apparatus that exist in labs

All the apparatus that mentions in figure 1 include simple systems for use without any complicated conditions only few steps to switch on and rearrange the apparatuses for many measurements.

1.2. Research laboratories

As is customary, these laboratories are experiments [4] for master and doctoral students as well for research by various scientific authorities. The processes that are made in these laboratories require using special equipment with the possibility of dealing with various chemicals. These chemicals, mostly require special treatment in use during the laboratory work and need to re-treatment of waste after used. Figure 2 includes many apparatuses that classify as specific instrument should be used after training.

Figure 2: different apparatus that exist in specific locations of labs

The aims behind classified the instrument as mentions above not only to understand the importance of these apparatuses but also for the notes below:
1. The coast of this instrument makes imperative to separate this in specific places with Assigned to specific persons who's responsible to use it.

2. The ideal technical conditions to operate the device which needed for isolated in a space to provide optimal conditions for working, mostly limiting the number of people working on it.

3. Some instrument used specific types of energy such laser or vacuum conditions with accelerating electrons or x-ray radiation. This instrument like Raman spectroscopy, SEM, XRD and TEM mostly needed for professional persons with higher abilities to treatment with complicated computerized programs.

1.3. Specialized laboratories

This kind of laboratories includes specific apparatus such XRD, TEM, SEM and HIM as shown in

![Figure 3: The common apparatus that cannot find in all labs](image)

X-ray powder diffraction is used mostly for qualitative phase analysis of samples for scientific material-analysis. For this purpose two modern diffractometer “Bruker D4 Endeavor” and “Bruker D8 Advance” are available. The D4 Endeavor is characterized by its ease of use and its high sample effort, while the D8 Advance can be used for special tasks, like small angle diffraction and temperature-depending diffraction.

**The Raman spectrometer** for example from Bruker Senterra is predominantly designed as an high-performance analytical instrument. It is equipped with an Olympus BX series with the FlexFocus™ system for confocal depth profiling and a set of objectives with long and short working distances. The CCD is an ANDOR DU420-OE with a thermoelectric cooling system with the highest sensitivity between 400 – 900 nm.

**Transmission electron microscopy** TEM represents the most important requirement in the science of nanotechnology. Fig. 3 shown this tool which now obtains very high-quality images for the investigation of many physical and chemical properties with a resolution reaching 100-1000 Kiev. This includes the size, density and nature of surfaces, as well as their electronic and magnetic properties. Chemically they are represented by the strength of the bond between the components of the samples in addition to the change that occurred for the materials after the reaction. The process depends on electrons, whereby one type of ionizing radiation is capable of removing one of the tightly bound inner-shell electrons from the attractive field of the nucleus.
The incident light should be concentric in the fixed ring of the wavelength, which requires a higher efficiency lens not yet found; however, this problem can be reduced by using many lenses to raise the activity for the TEM resolutions. In this case, they accelerated the electrons by 100-1000kV, which could reach the speed of light and the magnitude of magnitude to increase the resolution of the TEM.

**Scanning Electronic Microscopy SEM** [5] produces an image by using electrons instead of light to form an image that scans the surface of a specimen inside a vacuum chamber. A beam of electrons is focused on a spot volume of the specimen, resulting in the transfer of energy to the spot, excluding electrons from the specimen itself. The removed electrons, also known as secondary electrons, are attracted and collected by a positively biased grid or detector, and then translated into a signal.

These bombarding electrons used in many applications such as topography and morphology, chemistry, crystallography, and orientation of grains. In a scanning electron microscope (SEM) the probe very carefully with electrons, with an energy up to 40 KV is focused on the surface of the sample. The working mechanism of this system depends on the number of phenomena that occur on the surface which comes under the influence of electrons. Those most important to the microscope and the emission of secondary electrons with energies of a few tens of volts and the re-emission or reflection of electrons with a high energy counterattack from the primary beam.

The working mechanism for this system depends on the use of electrons instead of light to form an image. A beam of electrons is produced at the top of the microscope by heating a metallic filament. The electron beam follows a vertical path through the column of the microscope. This column fixes the direction of the path directly through electromagnetic lenses which focus and draw the line towards the beam down towards the sample. As soon as it hits the sample, other electron backscatter or the secondary ones are ejected from the sample.

**Scanning Helium Ion Microscopy** This technique refers to it by (SHIM, HeIM or HIM) is scanning helium ion beam can make an observation at sub-nanometer resolution. The advantages [6] of Helium Ion instead of use photons or electrons as the emitting source represented by the ability to obtain scan not achievable by conventional microscopes. The reason behind that can be related to, the short De Broglie wavelength of the helium ions, which is inversely proportional to their momentum and very high source brightness. The device depends on interacts the helium ion beam with the sample, which concern with small volume, thus provides sharp images, a large depth of materials. Fig. 5 shows the ORION ion microscopy, made by the ALIS corporation represents an ideal system for Helium ion microscopy.

**Figure 4:** Photo of a helium ion Microscope (HIM)
The ion source [7] consists of needle supplied with high voltage and under vacuum and low temperature. The concentric electric field causes many helium atoms convert to ions which accelerated away from the needle. The accelerated ions will emit at 1 A in size, which forming brightness beam equal to 4x10⁹ A/cm² sr.

2. The risks of advance apparatuses

2.1. Laser Safety

The laser apparatuses as well as laser microscopes. The training may be completed by attending a classroom lecture. This moderate-risk which represent by lasers, should be take care and prevent to expose for the radiation with not to look into the laser beam. The dangerous laser radiation Require the following Caution:

1- Kept the laser key switches and supply units in isolated location with prevent any persons not authorized to use it.
2- Remove any reflecting objects into the beam path.
3- Never open any covers for the laser instrument during working the apparatus.

2.2. Radiation Safety

The many instrument, apparatus required radioactive materials which produce specific rays, such X-ray diffractometers that depend on X-ray for identifying many materials. X-rays are a valuable tool in verities research, but there are many risks to health due to the capable of traversing great distances and penetrate the material. Generally, exposure to the radiations mostly causing Burns, sickness and long-term effects of exposure to radiation. However, Radiation levels can be controlled and monitored which may continue at less influence than many other technologies. Thus, there are some notes that deal with the disadvantages, are as follows:

1- A long time is required for the preparation of the sample to be examined.
2- Only a small part of the sample can be examined.
3- The electron beams used in these techniques cause damage to samples such as living objects, biomolecules, and inorganic substances.

2.3. Electrical risk

All the apparatuses use electrical power to switch on the system, thus it should take care when using it in addition to existing in the lab for any purpose. Most risks with electricity represent by direct and indirect effect, thus to prevent accidental electrocutions Many of procedures can be followed such:

1- Equip all electrical power outlets in wet locations with ground-fault circuit interrupters, which designed to “trip” and break the circuit when a small amount of current begins flowing to ground.
2- Prevent use cord insulation as a substitute for permanent wiring. The cord insulation should be in good condition and continue into the plug ends. Never repair cracks, breaks, cuts, or tears with tape. Either discard the extension cord or shorten it by installing a new plug end.
3- Take care not to run extension cords through doors or windows where they can become pinched or cut.
4- The use of hanging for electrical outlets mostly widespread in a research lab to ensure keep cords off out of the way.
5- Sweep plastic protective tubes over florescent bulbs prior to mounting screens onto the fixtures.
6- Ensure to provide all the apparatus for electrical outlets with earthed

At least it should be noted that avoid to fix or adjust anything, due to we are not responsible or specialized because most of the equipment is expensive.
3. Conclusion:

An important principle in protecting worker health is represented by workplace hazards which include the abilities to use different instruments in addition to the ideal use of chemical materials. All the workers in the chemical, biological, and physical labs treated with different apparatus that used electricity and many types of radiations. From all of the information which has mentioned before could be represent sources real dangers Threatening the safety of workers even though they professionals in using it. Anyway, with proper behavior, we can find and correct any mistakes in preventing injury.

4. References:

[1 ]"Safety in Academic Chemistry Laboratories," 8th editions American Chemical Society ,1155 Sixteenth Street, NW Washington, DC 20036, 2017.
[2 ]Laboratory Quality Management System," handbook, world health organization, 2011.
[3 ]Safety in Academic Chemistry Laboratories-Accident Prevention for College and University Students. A Publication of American Chemical Society Joint Board-Council Committee on Chemical Safety. 7th Edition-Vol 1.
[4 ]Lisa Moran and Tina Masciangioli, "Chemical Laboratory Safety and Security," THE NATIONAL ACADEMIES PRESS Washington, DC, 2011.
[5 ]D. Mcnullan, " Scanning Electron Microscopy 1928–1965" SCANNING Vol. 17, 175–185 (1995).
[6 ]Michael T. Postek, and Andras E. Vlada´ R," Helium Ion Microscopy and Its Application to Nanotechnology and Nanometrology", SCANNING VOL. 30, 457–462 (2008).
[7 ]Joy D, Griffin B, Notte J, Stern L, McVey S.: Device metrology with high performance scanning ion beams. SPIE Adv Lithography 6518, 11–1 (2007).