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USE OF MODERN EQUIPMENT IN PERFORMING A CHEMISTRY LABORATORY

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ABSTRACT

In chemical research and teaching, the use of modern instrumentation is essential for obtaining data, performing chemical reactions, and calculating results. The field of chemistry has made remarkable progress over the years, and much of this progress is due to the use of modern equipment in chemical laboratories. From analytical instruments to automation systems, these tools have revolutionized the way chemists conduct experiments, collect data, and make new discoveries. In this article, we will look at the importance of modern equipment in the chemistry laboratory and how it has increased the accuracy, efficiency and safety of chemical research, how the importance of using modern equipment in the performance of the chemistry laboratory and some examples of them.

Key words

methodology, laboratory training, modern, equipment, experience, teaching, interesting, didactic, small group, lesson.

ИСПОЛЬЗОВАНИЕ СОВРЕМЕННОГО ОБОРУДОВАНИЯ ПРИ ВЫПОЛНЕНИИ ХИМИЧЕСКОЙ ЛАБОРАТОРИИ

Аннотация

Использование современного инструментального оборудования в химических исследованиях и учебных процессах имеет решающее значение для получения данных, проведения химических реакций, и расчета результатов. За прошедшие годы область химии добилась выдающихся успехов, и большая часть этого прогресса связана с использованием современного оборудования в химических лабораториях. Эти инструменты, от аналитических инструментов до систем автоматизации, произвели

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революцию в том, как химики проводят эксперименты, собирают данные и делают новые открытия. В этой статье мы рассмотрим важность современного оборудования в химической лаборатории и то, как оно повысило точность, эффективность и безопасность химических исследований, как важно использовать современное Инструментальное оборудование при выполнении химической лаборатории и несколько их примеров.

Ключевые слова

методика, лабораторное занятие, современное, оборудование, эксперимент, обучение, развлечения, дидактика, малая группа, урок.

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ABSTRACT

In chemical research and educational processes, the use of modern instrumentation is essential for obtaining data, conducting chemical reactions, and calculating results. The field of chemistry has made remarkable progress over the years, and much of this progress is due to the use of modern equipment in chemical laboratories. From analytical instruments to automation systems, these tools have revolutionized the way chemists conduct experiments, collect data, and make new discoveries. In this article, we will look at the importance of modern equipment in the chemistry laboratory and how it has increased the accuracy, efficiency and safety of chemical research, how the importance of using modern equipment in the performance of the chemistry laboratory and some examples of said.

Key words

methodology, laboratory training, modern, equipment, experience, teaching, interesting, didactic, small group, lesson.

Enter. The Law "On Education" and the "National Program of Personnel Training" assign highly responsible tasks to the educational staff. In the process of implementing this task, a new approach to the education of students requires teachers to be very demanding towards their profession and students. Replacing the outdated technology of the pedagogical process with a new one, approaching education based on the requirements of the time, and applying the project of new methods to the lesson has become one of the urgent tasks of today [1-2].

The development of chemistry in our country, the improvement of the quality of education and the effectiveness of science in this direction are among the priorities of the State Program "Year of Science, Enlightenment and Digital Economy". After all, in-depth training of our sons and daughters in chemistry will

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encourage the establishment of new production enterprises in the regions, the rapid development of pharmaceutical, oil, gas, chemical, mining, and food industries that create high added value, and ultimately, the living conditions of our people. and prepares a solid ground for increasing their income [3]. To fundamentally improve the quality of education in chemistry, to introduce a completely new system of teaching this subject in secondary schools, to provide educational institutions with modern laboratories, textbooks and other educational equipment, to attract qualified teachers and trainers to this field, to train personnel and In order to establish close communication and cooperation between the fields of education, science and production in the use of scientific results, 14 basic specialized schools specializing in chemistry and biology were gradually established in each region of the republic, in which Abu Ali ibn Sina specialized boarding schools for young biologists and chemists were adjusted to the status of these schools [4]. In addition, it is planned to gradually establish 150 schools specializing in in-depth teaching of chemistry and biology in the republic, districts (cities) [5]. In order to coordinate the effective teaching of chemistry and biology in basic specialized schools and specialized schools, 55 departments of higher education institutions are assigned to them, and 47 departments that train middle-level personnel in the fields of chemistry and biology in order to effectively establish a system of middle-level personnel training for production branches. 11 scientific-research institutes and production branches of the Academy of Sciences were attached to their 74 departments in order to organize production enterprises in professional educational institutions and an effective educational process in the fields of chemistry and biology in higher educational institutions [6]. Having studied the potential of general education schools, the interest of students in chemistry and biology, and the demands of parents, the activities of basic specialized schools and specialized schools were established on their basis [7].

From 2021, measures are being taken to create educational and scientific literature on chemistry and biology for educational institutions on the basis of advanced foreign experience, and to increase the share of practical training in natural sciences curricula in order to form the practical skills of students in general secondary educational institutions in the 2021-2022 school year [8].

Literature analysis. The discovery of many theoretical laws in chemistry is the result of experiments carried out with a specific goal in mind. Any opinion and judgment expressed in chemistry, which is one of the natural sciences, must be confirmed with the help of experience. In the early stages of the development of the science of chemistry, A. Viurs, O. Thenar, Gay-Lussac, W. Charles, Berselius, Cooper, Kekule, Völler, Mendeleev, JBBio, Faraday, Beilstein, O. Laurent, Mollus

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and many other chemists later in the science many experiments were carried out, which led to the discovery of important laws. It was their work that became an important factor in the development of applied chemistry [9-10].

Methodology. Instrument equipment is quite important in modern chemical laboratories. This equipment is used to conduct chemical research in the laboratory, to obtain data, and to calculate the results. This equipment includes a number of technical tools and devices. Some of the basic modern chemistry laboratory equipment are:

1. Spectrometers: Spectrometers are used to analyze chemical elements and their compounds. There are different types of spectrometers such as mass spectrometer, NMR spectrometer, UV-Visible spectrometer [11].

2. Chromatography devices: Gas chromatography (GC) and liquid chromatography (LC) devices are used to separate and analyze chemical elements [13].

3. Laboratory Equipment: Laboratory operators require variable heat, cold, and pressure equipment.

4. Analytical Instruments: Analytical instruments are one of the laboratory equipments that you get for chemical research. This is used to read and calculate the results [14].

5. Chemical reagents: Chemical reagents are necessary for chemical research. These are chemicals and chemical agents that have special properties for various chemical studies.

6. Microscopes: Biological, electron, and optical microscopes include a device and are used to view chemical elements or the results of recent research [15-16].

7. Automated research tools: Computers, robots, and sensors form part of the physical instrument equipment for control and automation of results.

Some advantages of modern equipment in chemical laboratories:

Accuracy in analysis. One of the main advantages of modern equipment in chemical laboratories is accuracy in chemical analysis. Instruments such as mass spectrometers, nuclear magnetic resonance (NMR) spectrometers, and high-performance liquid chromatography (HPLC) machines provide extremely precise and reproducible results. These tools are essential for the identification and quantification of chemical compounds in various samples , helping chemists to understand the composition of substances at the molecular level [17].

Automation and efficiency. Automation has become a hallmark of modern chemical laboratories. Automated fluid handling systems, robotic platforms, and computer-controlled experiments have simplified many laboratory processes. These systems not only improve the efficiency of experiments, but also reduce the

risk of human error, as repetitive or time-consuming tasks are now performed by machines. Chemists can focus on experimental design, data interpretation, and innovative research, while automated equipment takes care of routine aspects of work [18].

Increase security. Modern laboratory equipment also plays a crucial role in ensuring the safety of chemists and researchers. For example, fume hoods and biological safety cabinets are equipped with advanced ventilation systems that protect users from exposure to hazardous fumes and chemicals. In addition, safety interlocks and emergency shutdown features on many devices provide an additional layer of protection. This is especially important when working with toxic or volatile substances [19].

Data collection and analysis. The integration of computers and software into modern equipment enables real-time data collection and analysis. Researchers can monitor reactions, track changes, and record results immediately. Advanced software aids in data processing and interpretation, making it easier to draw meaningful conclusions from experiments. This capability accelerates the pace of research and supports informed decision-making [20].

Impact on the environment . Many modern laboratory instruments are designed with sustainability in mind. They often have energy-efficient features and are designed to consume fewer resources. This environmentally friendly approach is not only cost-effective, but also fits with the growing focus on reducing the environmental footprint of scientific research [21].

Multi-threaded applications. Modern equipment in chemical laboratories has expanded its use in various scientific disciplines. For example, mass spectrometry is used not only in chemistry, but also in biology, ecology, and clinical research. This interdisciplinary versatility allows researchers to collaborate across fields and address complex problems with an integrated approach [22].

Conductometric instrument. The HI5321 is an advanced research grade EC/TDS/Salinity/Resistance meter that is fully customizable with a color LCD display, large capacity touch buttons and a USB port for PC connection.

The HI5321 is feature-rich with 4-point calibration, auto-sort, data logging, alarm settings, comprehensive GLP and more, while maintaining ease of use with a dedicated key for simple operation and virtual keys that guide the user through configuration options [6]. Capacitive touch pad HI5321 pre-programmed with USP

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method auto-ranging over a wide range from 0.000 µS/cm to 1000.0 mS/cm* HI76312 four-ring conductivity probe with wide range from 0.000 mS/cm to 1000.0 mS/cm* is provided [7]. The meter can be set to auto-ranging, where the meter selects an appropriate conductance range from seven ranges, or fixed-range, where the meter displays only mS/cm or mS/cm readings. All readings are automatically compensated for temperature changes with a built-in temperature sensor. The temperature correction factor is adjustable from 0.00 to 10.00%/C [23].

Using a conductometer.

1. Performance Limitations

2. Conductivity meter when making measurements

The conductometer should be placed on the workbench in suitable conditions.

2.1. It is forbidden to carry out measurements in solutions containing chemical solvents that can damage the electrodes and the body of the conductivity sensor.

2.1.2 When working with the conductivity meter, protect the converter unit and the conductivity sensors from impacts, because some parts of their design are made of fragile materials [24].

Attention: disassembly of conductivity sensors **is strictly prohibited!**

2.2 Indication of safety measures;

2.2.1 Employees who have studied this manual and the rules for working with chemical solutions are allowed to work with the electrical conductivity meter.

2.2.2 The electrical safety of the operating personnel is guaranteed because the conductivity meter uses an autonomous power supply with a voltage of 2.2 to 3.4 V [11].

2.3 Conductivity meter preparation for operation;

After receiving the product, you should open the package and check it. Completeness and safety of packaged products MUST be ensured. After leaving the conductometer in cold air, it should be kept at room temperature for at least 1 hour [25].

2.3.1 Connecting the power source;

To connect the autonomous power supply, remove the battery compartment cover located on the back panel of the battery. Converter unit. Install two volt batteries (AA) or two pre-charged nickel-metal hydride batteries (AA) in the position corresponding to the markings inside the battery compartment b. Close the battery compartment cover [16]. When the conductivity meter is turned on, the display shows the battery charge. The number of sections on the battery symbol corresponds approximately to the battery charge: one section - 25%, two sections - 50%, three sections - 75%, four sections - 100%.

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Note 1: strictly follow the polarity when connecting the power supply. Failure to comply with this condition may cause failure of the conductivity meter!

Note 2: Connect the power supply only when the conductivity meter is switched off! To prevent the loss of time, date and data recorded in the electronic notepad, the replacement of batteries or galvanic batteries should be done within 30 seconds. Nickel-metal hydride batteries are charged using a voltage of 5 V when the conductor is connected to the USB port of a personal computer (computer) or when connected from a switching power supply IES4-050150 with a stabilized output voltage of 5 V. The symbol A ("**Caution!**") is placed next to the battery compartment, warning that the analyzer should not be connected to the USB port or external power source when galvanic batteries (AA) are installed. They must be removed from the battery compartment and two batteries (AA) installed before connecting to a USB port or external power source [16].

Power connection: Connect the 12 Vdc adapter to the power supply socket.

Note: This instrument uses non-volatile memory to retain meter settings, even when unplugged.

For electrode-to-sand bonding, conductivity, resistance, TDS, or salinity measurements, connect the conductivity probe to the DIN connector on the back panel of the instrument.

Launch the tool

Please make sure the si gim keyboard is not covered by your hand or other objects on the meter, the power is on. Turn on the device from the power button located on the back panel of the device. Please wait until the tool completes the initialization process [17].

Note: It is normal for the download process to take a few seconds. If the device doesn't do this, show the next screen, restart the meter using the power button. If the problem persists, contact a professional. The following display configurations are available for measurement mode:

Main, Graphic and Magazine.

History. There is a GLP display for conductivity and percent salinity scale.

Main. The main measured value and its units are displayed on the LCD, along with the temperature value, temperature probe status and basic calibration data (if available). To select the main display mode:

DISPLAY in Measure *mode* click The message "Select display configuration" is displayed in the reminder message area [18].

Click ***BASIC.*** The tool displays basic information for the selected measurement mode. **GLP** (Conductivity and Salinity Percent Scale Only). Detailed GLP information is displayed on the dedicated LCD display for the conductivity and

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percent salinity scale: Last calibration date and time, Calibration standards and general information about the standards, calibration temperature, temperature compensation mode, date and time. To access the GLP display option:

Press ***DISPLAY*** in Measure mode. The message "Select display configuration" is displayed in the reminder message area [19].

the GLP button The tool displays detailed GLP information. When this option is selected, an online graph (conductivity, resistivity, TDS, salinity, and seconds) is displayed that is logged in real time. If there is no active log, the previously entered data for the selected parameter is displayed. To access offline/online graphics:

Press ***DISPLAY*** in Measure mode. The message "Select a display configuration" is displayed in the reminder message area. Click ***GRAPH.*** Click ***START LOG*** to start the online graph.

To enlarge the graph

DISPLAY, then ***GRAPH*** appears on the < ***and*** > ***virtual keys.***

Use **<** and **>** to move along the X (Time) axis of the graph.

SETUP to enter the scaling menu for the Y-axis. Use ***ZOOM IN*** or ***ZOOM OUT*** to zoom in on the Y (parameter) axis. Press ***ESCAPE*** to return to the main menu.

When an offline graph is displayed: g Use the arrow keys to navigate the X (Time) and Y (Parameter) axes of the graph. Press ***the SETUP button*** to enter the scaling menu for the X and Y axes. ***ZOOM TIME***, or ***ZOOM COND*** to switch between active zoom axes. / ***ZOOM RESISTIVE.*** Use / ***ZOOM TDS*** / ***ZOOM SALINITY.*** Press ***ZOOM IN*** or ***ZOOM OUT*** to zoom in on the selected axis. Note: There is no ***MODE*** button in the zoom graph menu. Press ***ESCAPE [20]*** to return to the main menu.

Log history. When this option is selected, the measurement is displayed along with the LOG history:

1) Last saved log data (Not actively registered);

2) the last recorded data from the active ***logging lot;***

3) Blank display - ***NO LOTS*** stored, not registering now

The log history list contains the main measurement value, the temperature, as well as the record timestamp. To access the Show Log History option:

Press ***DISPLAY*** in measurement mode. The message "Select a display configuration" is displayed in the reminder message area. Click ***LOG HISTORY , the tool displays the log history for the selected measurement mode [21].***

Notes: Logged entries will contain an exclamation mark "**!**" when the alarm condition is active. If you are logged in to Auto-Hold, your registered entries will have the letter " **H ".** If another measurement mode is selected, the log history will

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be reset. If the temperature unit is changed, all recorded temperature values are automatically displayed in the new temperature unit. "A" means automatic temperature compensation. "M" stands for manual temperature compensation.

Access system settings. Press the ***SETUP button*** in measurement mode. Press ***SYSTEM SETUP*** and the system setup parameters will be displayed on the LCD screen. To access the system configuration option:

Use or ∨to highlight the option you want. ∧Press ***SELECT*** to access the selected option. Below is a detailed description of the system setup option screen [22].

Analysis and results. The use of modern equipment in chemical laboratories has redefined the way chemical research is conducted. It offers accuracy in analytics, automation for efficiency, improved security, and the ability to collect and analyze data more effectively. Along with the development of technology, the capabilities of modern laboratory equipment also increase, further expanding the boundaries of chemistry. Researchers and scientists can look forward to a future in which the tools at their disposal will enable them to make new discoveries and solve complex problems in chemistry and beyond [23].

The use of modern equipment in chemistry classes and extracurricular activities can be used to support an active learning process. But using them can cause problems. Therefore, virtual experiences in chemistry education have the following advantages, such as:

conducting experiments that are not available in the school chemistry laboratory;

remote seminars and laboratory work, including interactions with children with disabilities and regional remote school students;

work speed, save reagents; - to increase the interest of schoolchildren in learning.

no need to reassemble all the equipment before each lesson , spend time checking the tools, putting them in place;

security equipment is much higher than normal conditions;

you can conduct several different experiments in a short time, then summarize the results and draw conclusions;

display time can be slowed down or accelerated [24].

Discussion. Although this process is very important, it should also be taken into account that chemistry teachers cannot completely abandon real laboratory work, because in the teaching of science, visual thinking is more developed than the method, and in the future, if it is based on the theoretical level of summarizing the process of teaching students, a computer that develops students' logical

thinking models can be used. I would like to emphasize that the use of modern equipment in experiments performed on the basis of high accuracy allows for faster and deeper mastering of the studied topic, helps to understand difficult-to-perceive issues, and increases interest in the topic [25]. Usually, laboratory training is conducted in specially equipped rooms under the guidance of a teacher, and special attention is paid to the rules of technical safety. The effectiveness of laboratory training is closely related to the methodology of its organization and conduct.

First of all, the goal of the laboratory exercise is clear and students should be able to achieve it.

Secondly, all objects, reagents and modern equipment necessary for conducting laboratory training must be ready [26].

Thirdly, during laboratory training, the structure of modern equipment, principles of operation should be explained orally and in writing.

Fourthly, it is necessary to have an opportunity for each student to be active in using the equipment during the laboratory session.

Fifthly, keeping clean during laboratory training should form students' aesthetic taste, compliance with technical safety rules when working with modern equipment [27].

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