Specialised gymnasium №8 with teaching in three languages
named after M. Kh. Dulati

Theme of the Project: «Automated complex for purification and mineralization of water»

Done by: students of the 11th B grade
Assilbekova Sabina, Madiomar Diyara

Scientific adviser: Physics teacher Gryaznov Yuri Petrovich

Reviewer: Head of the Department of Physics ,
South Kazakhstan State Pedagogical University ,
PhD Ualikhanova B. S.

Shymkent 2022

Annotation

Modern society is increasingly using various methods of analysis, purification and mineralization of water. At the same time, devices created by students play an important role. On the one hand, it is a means of developing technical thinking; on the other hand, it is a tool that can be widely used in everyday life.

The purpose of this work is to create a device that is a tool in the study of natural processes, improvement of the ecological situation.

In the introduction, the authors introduce the justification for the chosen topic and the environmental problems of modern society.

In the main part of the work, the authors describe the device and the principle of operation of the automated complex, electrical circuits and their purpose. Also illustrations of the circuits and blocks of the complex are presented, and they acquaint with its technical capabilities.

In conclusion, the authors present recommendations for using the results of the work for practical purposes.

Рецензия
на работу учащихся 11 класса специализированной гимназии №8
с обучением на трех языках имени М.Х.Дулати
Мадиомар Дияры и Асилбек Сабины
по теме: «Автоматизированный комплекс по очистке и минерализации воды»

В данной работе авторы рассматривают вопросы, связанные с созданием проекта, позволяющим провести анализ, очистку и минерализацию воды.

Содержание работы полностью раскрывает выбранную тему и отличается высокой степенью актуальности и новизны, задачи, сформулированные автором, решены в полном объеме.

Выполненная работа свидетельствует о знании авторами теоретических концепций по рассматриваемой проблематике.

Теоретические выводы и практические предложения по исследуемой проблеме вытекают из содержания работы, аргументированы, полученные результаты исследования значимы и достоверны, высока степень самостоятельности автора, работа носит творческий характер.

Работу отличают четкая структура, завершенность, логичность изложения, оформление работы, соответствует предъявляемым требованиям.

Авторами был собран и систематизирован материал по методам анализа посредством проводимости, очистки и минерализации воды. Рассмотрены возможности технических устройств, составляющих комплекс. Предложены методы очистки и минерализации воды с учетом технических возможностей автоматизированного комплекса.

Данная работа включает в себя два раздела: теоретическую и практическую часть. Проект может быть полезен для учащихся, которые захотят попробовать свои силы в создании подобных проектов, а также для использования в качестве наглядного материала. Материал освещен достаточно грамотно и обзорно, что позволяет учащимся полноценно изучать и закреплять теоретический материал, получаемый на занятиях. Практическая часть работы наглядно демонстрируют компетентность авторов в исследуемом вопросе.

При создании комплекса использовались природные материалы, что позволяет многократно эксплуатировать автоматизированный комплекс. Неоспоримым преимуществом является возможность эксплуатации устройства в дистанционном, ручном и удаленном формате (посредством интернет-приложений). Кроме того, авторами предусмотрена возможность применения приложений Windows для анализа чистоты воды.

Данная работа составлена в соответствии с требованиями и положениями об научно-исследовательских проектах. В целом работа заслуживает положительной оценки.

Зав.кафедрой физики
ЮКГПУ, доктор PhD Уалиханова Б.С.

REVIEW
of the supervisor
on the scientific- research work done by the students of the 11th B grade of the specialized gymnasium №8 with teaching in three languages named after M. Kh. Dulati

Assilbekova Sabina, Madiomar Diyara

on the theme: «AUTOMATED COMPLEX FOR WATER PURIFICATION AND MINERALIZATION»

The work has studied the subject and methods of water purification and mineralization and described the theoretical principles of the device operation and its practical application.

The results of the work present practical significance and can be used in everyday life.

Considering all these ideas, Assilbekova S. and Madiomar D. fulfilled their work on the extremely up-to-date theme. Developing the theme of the work, they revealed their initiative, high level of preparation, independence while working with literature and practical materials. They could put into practice their knowledge in the sphere analyzed in the project. These qualities helped them to write the work which brightly displays the high level of the authors in the chosen direction and usage of ICT.

At some stages of the work over the project Assilbekova S. and Madiomar D. experienced some difficulties connected with the selection and systematization of gathered materials and theoretical sources, and also technical difficulties, but gradually they managed to overcome them to reach the goal and produce the quality device on time.

The work is framed in accordance with the requirements specified in the regulation on holding a scientific and practical conference. It deserves the positive assessment. This research work is recommended for participation in the research project competitions among the students.

Scientific adviser: Physics teacher Gryaznov Yuri Petrovich

Contents

Introduction

Water occupies one of the most important places in human life. To maintain life, a person must regularly consume a certain amount of water, and the water must be safe for the body. In addition, a person needs water not only for drinking but also for food production. The quality of water is of great importance, because water containing harmful impurities is very dangerous.

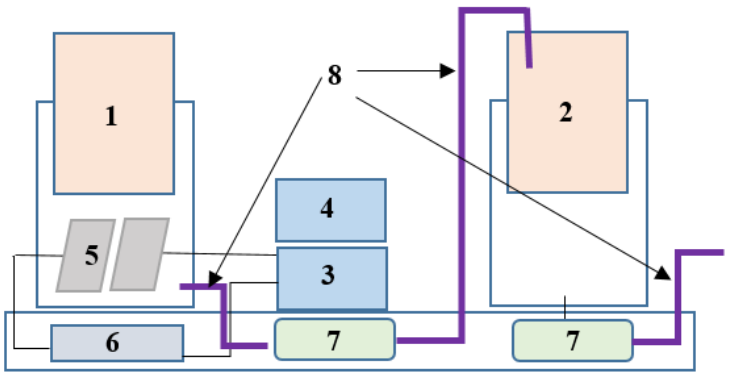
Mankind is currently facing a global threat of shortage of clean drinking water, the reserves of which are depleted due to environmental pollution by industrial waste, unreasonable human activities. To solve this problem, you can use various methods of water purification, recycling of already used or contaminated water. One of these methods is the use of various types of filters, which are produced both on an industrial scale and in individual projects. Often, after the purification process, water loses a number of useful properties, due to the fact that, in addition to removing harmful substances and compounds, useful microelements necessary for human health are removed from it. Long-term use of such water can lead to the emergence of many diseases associated with a lack of important trace elements for humans.

To analyze the suitability for drinking water, analyzers that allow to determine the degree of suitability of water for consumption are used.

The purpose of this work was to make a theoretical description and installation of a device that allows to conduct multi-level water purification with subsequent mineralization with useful microelements and to check the operation of the device in action.

The structure of the device.

The device «Automated complex for purification and mineralization of water» consists of four modules and corresponding elements. Structural scheme of the device is shown in Fig.1.

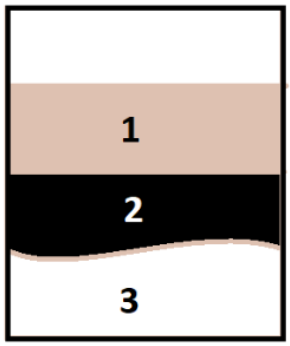


Conventions
1 – coarse filter
– fine filter
3 – voltage divider electronics
4 – remote control unit
5 – electrodes
6 – voltammeter
7 – pumps
8 – switching tubes

Fig.1 Scheme of device

The unit is designed for several operating modes: manual mode and remote control mode using the remote control or through the application on the smartphone.

At the primary stage, a coarse filter is used, which is a washed quartz sand and cellular fabric. In addition, activated or charcoal can be used as an additional filter layer. At this stage the filter retains large particles contained in water. When passing through it, water is mechanically cleared of suspension and heavy chemical elements.



1 – sand
2 – activated or charcoal
3 – cellular fabric

Fig.2. Coarse filter

Checking the electrical conductivity of the water

The next stage is checking the electrical conductivity of the water. A school physics course indicates that pure (distilled) water does not contain impurities and therefore does not conduct electricity. This is because water molecules are dipoles and therefore do not have free charge carriers. Ordinary drinking water contains various salts and trace elements that ensure its conductivity. It is impossible to determine the purity of water by eye. Therefore, the electrical resistance of water can determine, to one degree or another, its purity. To more accurately determine the conductivity of water and to avoid errors in direct measurements in our device, we used the electrical circuit shown in Fig.3.

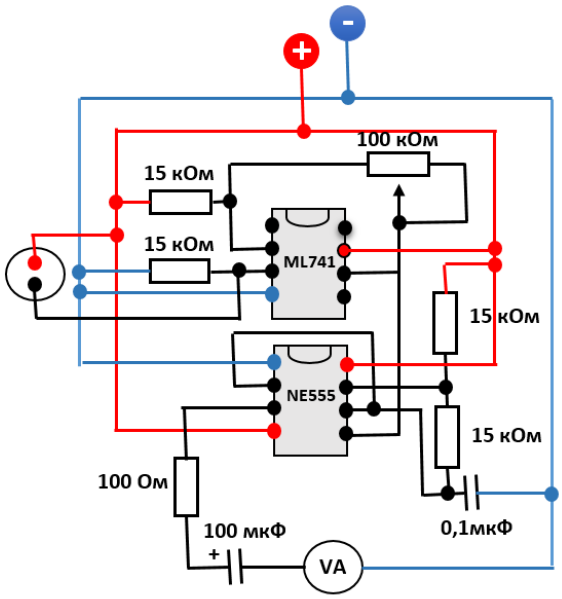


Fig.3 Scheme of voltage dividers on two microcircuits

A simplified voltage divider circuit can be seen in Fig.4

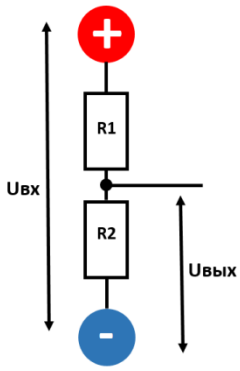


Fig.4

The principle of operation of the circuit is as follows: an input voltage Uin = 9V is applied to the device circuit, resistor R1is a resistor whose resistance remains unchanged, and the value of resistance R2 changes depending on the resistance of the investigated liquid(water). The ML741 chip allows you to compare the input and output voltage signals, amplify the signal and more accurately determine the difference in their values. The value of the output voltage of the divider fully depends on the electrical conductivity of the given water and is determined in accordance with the formula:

$U_{out}=U_{in}\cdot R$, where $R=R_2/(R_1+R_2)$

The output signal parameters are fixed using an ammeter and a voltmeter.

According to the readings of the ammeter and voltmeter, the water resistance and its electrical conductivity are determined (the reciprocal of the resistance).

$$R = \frac{U}{I};\ \ G = \frac{1}{R} = \frac{I}{U}$$

G – electrical conductivity of water, Siemens unit: [cm]=[1/ohm]. The degree of water pollution, i. e. the presence of salts and trace elements in it is determined by a value called electrical conductivity - measured in μS / cm or S / m.

In order to make the measurements as accurate as possible, stainless steel is used as electrodes in the device. The area of each plate is 1 cm, the distance between them is 1 cm.

Below is a table that shows the maximum allowable values of the electrical conductivity of purified water at different temperatures.

Table. Maximum allowable values of specific conductivity of water

Temperature scale, ºC	**Specific electrical conductivity of water, μS/cm**
0	2,4
10	3,6
20	4,3

25	5,1
30	5,4
40	6,5
50	7,1
60	8,1
70	9,1
80	9,7
90	9,7
100	10,2

When calculating the specific conductivity of water, we referred to the digital characteristics presented in the table.

After taking readings with the voltammeter, the analysis of the initial data and the calculation of the conductivity of water are entered into a spreadsheet made in the Excel application. The resulting calculations are compared with the normative ones, and a message is displayed on the suitability of water for consumption (Fig.5)

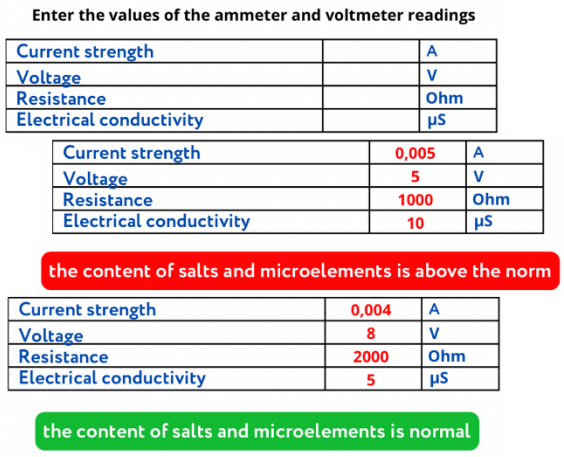


Fig.5 Application in test mode

Of course, primary water purification does not allow us to conclude that the water is fully usable. This is due to the fact that in addition to microelements and salts, water can contain microorganisms, bacteria, harmful chemical compounds that the coarse filter cannot cope with. In addition, the primary filter can remove beneficial microelements necessary for living organisms from the water. For further purification and mineralization of water, a fine filter is used.

The fine filter contains bulk layers in its design, consisting of unique natural minerals: shungite and zeolite.

Brief review of shungite and zeolite properties

Zeolite is a natural mineral with a wide range of physical and chemical properties such as:

- Ensuring fast ion exchange and selectivity
- Reversible hydration and dehydration
- Very high ability to adsorb gases dissolved in water
- Resistance to temperature influences
- Exceptional insensitivity to aggressive surroundings

Zeolite has the ability to adsorb ammonia, heavy metals, radionuclides, gases with unpleasant odors, such as ammonia (a waste product of microorganisms). In addition, zeolite does not affect the pH level of water.

Shungite is a porous mineral, which in its essence is a nanofilter and water mineralizer. The cells of its crystals are filled with fullerenes (they act as antioxidants for the human body) – spherical molecules consisting of tens of carbon atoms.

This mineral does an excellent job of destroying bacteria in the water. The most important property of shungite is that this stone can not only qualitatively purify water from impurities of various kinds, but also retain its properties for a

sufficiently long period of time. It is this property of shungite that was the key factor in our choice of it as a filter filler for water purification. Under the influence of shungite, organic compounds contained in an aqueous solution decompose into simple oxides. Shungite turns insoluble substances into a precipitate and allows them to linger in the filter structure. Thus, the water is completely purified from harmful impurities.

Remote control of the device

As already mentioned, the device can operate in ‘manual’ and ‘remote’ modes.

Remote mode is carried out using the remote control or using the application installed in the smartphone. For managing pumps operation the device has a wireless RF switch with an operating frequency of 433 MHz and a remote control (Fig.6), as well as a wireless Wi-Fi switch that can connect to devices of different types and brands (Fig.7)

Fig.6 RF switch

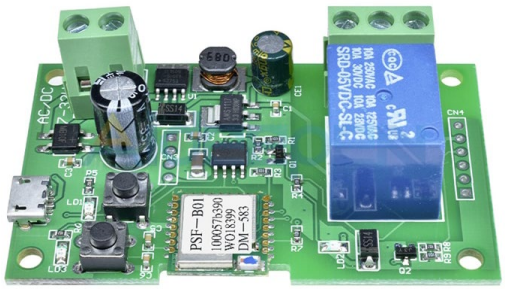


Fig.7 Wi-Fi switch

To ensure the operation of the Wi-Fi switch, you need to download the eWeLink application to your phone in the AppStore or GooglePlay.

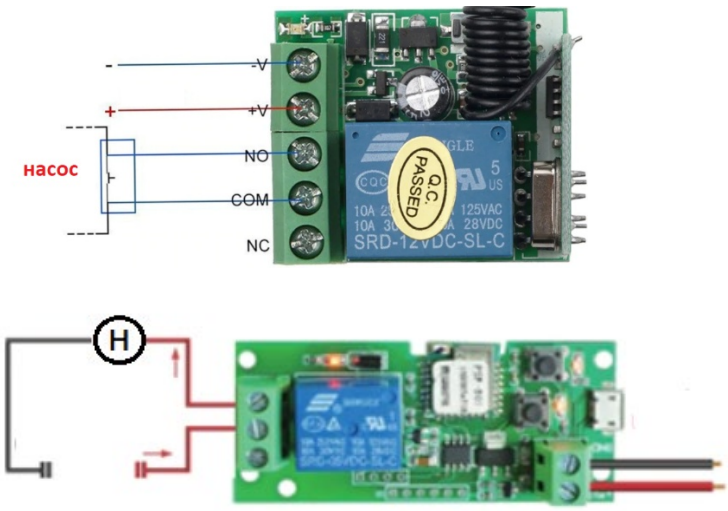


Fig.8 Diagrams for connecting remote modules to a controlled circuit

Conclusion

The role of water in human life is very important. Without water, a person can last two weeks, but the presence of water cannot guarantee that it is safe for human health. For water purification, various kinds of devices are used, manufactured in the factory and handicraft.

The main objective of the project was to create our own device capable of not only cleaning, but also mineralizing water, endowing it with health- promoting properties. During the implementation of the project, we not only got acquainted with various methods of water purification, but also with devices manufactured by domestic and foreign manufacturers. In addition, we have achieved the main objective of the project: to design and implement our own workable device that meets the stated requirements. In the course of the project, we encountered a number of problems related to the fact that not all the details were freely available. We had to order them through online stores, which slowed down the timing of the project. There were also difficulties associated with the electrodes through which the readings of electrical quantities in the test liquid were measured. Since the electrodes in industrial installations are made of expensive metals, we had to replace them with stainless steel electrodes although this did not significantly affect the performance of the device.

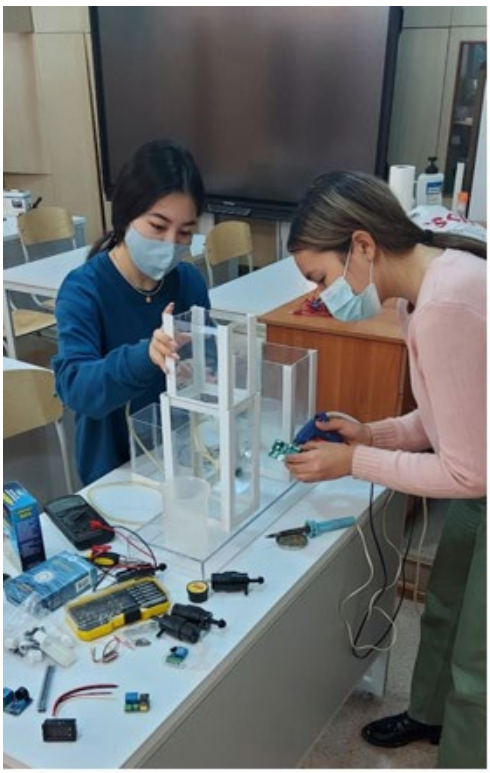
The device showed its effectiveness and in practice proved positive results. Water that has been purified and mineralized in terms of its taste and technical qualities does not differ from spring or bottled mineral water. In addition, the resulting water can be used in cosmetology, medicine and as a liquid for cooking.

In the future, we plan to continue working on studying the topic of the project, consider ways to modernize the device and improve performance of its components as well as reducing its cost. Moreover, as a part of the Safe House Project, we plan to assemble the air purification device.

References

1. Chekalin H.V., Shakhparonov M.I. Dielectric relaxation and structure of water, alcohols and aqueous solutions. //On Sat. "Physics and physico-chemistry of liquids". Issue. I. -M., Ed. Moscow State University. 1972
2. Stromberg, A. G. Physical chemistry: a textbook for universities / A. G. Stromberg, D. P. Semchenko. - M.: Higher school, 2001. 2 Workshop on physical chemistry: textbook for universities / ed. I. V. Kudryashova. - M .: Higher school, 1986.
3. Natural zeolites - http://www.dpzzz.com/ru/
4. Maximum allowable values of the specific conductivity of water - https://pharmacopoeia.ru/fs-2-2-0020-15-voda-ochishhennaya/
5. Voltage divider - https://usamodelkina.ru/18639-pribor-dlja-proverki-provodimosti-vody.html
6. Foming, G.S. Water. Control of chemical, bacterial and radiation safety according to international standards: a reference book / G.S. Foming, A.B. Cheskys; ed. S.A. Scoundrels. - M .: Publishing house "Helikon", 1992
7. Drinking water - http://www.vodoobmen.ru/01-pityevaya.html
8. Shungite - https://www.filter.ru/content/29-shungit
9. Zatsepina G.N. Physical properties and structure of water. - M.: Ed. Moscow State University, 1987г.
10. Devices for testing water quality - https://kvanta.ru/analiz-vody/pribory-dlya-proverki-kachestva-vody
11. Educational experimental research in electrical engineering and electronics, Mayer R.V., Koshcheev G.V., 2010.
12. Ivanov I.I., Soloviev G.I., Frolov V.Ya. Electrical Engineering and Fundamentals of Electronics - Ed. "Doe", 2017
13. 13. Atabekov G. I. Theoretical foundations of electrical engineering. Linear electrical circuits - Ed. "Doe", 2021

Appendix




ҚАЗАҚСТАН РЕСПУБЛИКАСЫ

РЕСПУБЛИКА КАЗАХСТАН

АВТОРЛЫҚ ҚҰҚЫҚПЕН ҚОРҒАЛАТЫН ОБЪЕКТІЛЕРГЕ ҚҰҚЫҚТАРДЫҢ МЕМЛЕКЕТТІК ТІЗІЛІМГЕ МӘЛІМЕТТЕРДІ ЕНГІЗУ ТУРАЛЫ

КУӘЛІК

2022 жылғы «18» қаңтар № 22904

Автордың (лардың) тегі, аты, әкесінің аты (егер ол жеке басын куәландыратын құжатта көрсетілсе):
АСИЛБЕКОВА САБИНА АНВАРБЕКОВНА, Матимәр Дияра Сабитқызы

Авторлық құқық объектісі: **ғылыми туынды**

Объектінің атауы: **Автоматизированный комплекс по очистке и минерализации воды**

Объектіні жасаған күні: 15.08.2021

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ЭЦҚ қол қойылды

Е. Куантыров

KZ.T.16.1095 TESTING	Аттестат аккредитации зарегистрирован в реестре субъектов аккредитации №KZ.T.16.1095 от 15.04.2021г, действителен до 15.04.2026г	Нысанның БКСЖ бойынша коды Код формы по ОКУД ______ КҰЖЖ бойынша ұйым коды Код организации по ОКПО ______
ҚР ДСМ СЭБК «Ұлттық сараптама орталығы» ШЖҚ РМК Түркістан облысы бойынша филиалының Шымкент қалалық бөлімшесі индекс 160013, мекенжайы:Қазақстан, Шымкент қ, Әл-Фараби ауданы,Майлыкент көшесі,4 Тел: 87252433673, email: ukofscc@gmail.com Шымкентское городское отделение филиала РГП на ПХВ «Национальный центр экспертизы» КСЭК МЗ РК по Туркестанской области индекс:160013,адрес:Казахстан,г.Шымкент, Аль-Фарабийский район,ул.Майлыкент,4 Тел: 87252433673, email: ukofscc@gmail.com	Санитарно-гигиеническая лаборатория Отделение коммунальной гигиены	Қазақстан Республикасы Ұлттық экономика министрінің 2021 жылғы «20» тамыз № 84 бұйрығымен бекітілген № 074/у нысанды медициналық құжаттама Медицинская документация Форма № 074/у Утверждена приказом Министра здравоохранения Республики Казахстан от «20» августа 2021 года №84

Орталықтандырылған және орталықтандырылмаған сумен жабдықтау [stamp: Санитариялық-гигиеналық зертханасы]

ХАТТАМАСЫ

ПРОТОКОЛ

исследования образцов питьевой воды централизованного и нецентрализованного водоснабжения

№ 2022-105/70/РО-22-00123

(от) «03» февраля 2022 ж.(г)

1. Объектінің атауы, мекенжайы (Наименование объекта, адрес) ЧЛ Грязнов Ю.Д. г.Шымкент,Аль-Фарабийский р/н, ул.Казыбек би,29
2. Үлгі алынған орын (Место отбора образца) Вода из под крана (корпус 1)
3. Зерттеу мақсаты (Цель исследования) Физико-химические исследования (по разовому договору)
4. Іріктелген күні мен уақыты (Дата и время отбора) 28.01.2022г вр 09:00
5. Жеткізілген күні мен уақыты (Дата и время доставки) 28.01.2022г вр 09:30
6. Мөлшері (Объем) 1,0 л
7. Топтама саны (Номер партий) -
8. Өндірілген мерзімі (Дата выроботки) -
9. Зерттеу күні мен уақыты (Дата и время исследования) 28.01.2022 г-31.01.2022 г
10. Үлгі алу әдісіне НҚ (НД на метод отбора) ГОСТ 31862-2012
11. Тасымалдау жағдайы (Условия транспортировки) автотранспорт
12. Сақтау жағдайы (Условия хранения) В лабораторных условиях
13. Су үлгілерін консервациялау әдістері (Методы консервации образца воды) Не проводились
14. Зерттеу әдістеменің НҚ-ры (НД на метод испытаний)

Көрсеткіштердің атауы Наименование показателей	Анықталған концентрация Обнаруженная концентрация	Нормативтік көрсеткіштер Нормативные показатели	Қолданыстағы нормативтік құқықтық актілердің (бұдан әрі –НҚА) атауы Наименование действующих нормативных правовых актов (далее – НПА)
Иісі (запах) 20°C кезіндегі баллдары(балы при 20°C)	0,0	2,0	ГОСТ 3351-74
Иісі (запах) 60°C кезіндегі баллдары(балы при 60°C)	0,0	2,0	ГОСТ 3351-74
Дәмі (привкус)20°C кезіндегі баллдары (балы при 20°	0,0	2,0	ГОСТ 3351-74
Түстілігі (цветность) градустар (градусы)	0,0	20 (35)	ГОСТ 31868-2012
Лайлылығы(мутность) стандарттық шкала бойынша мг/дм³ (по стандартной шкале)	0,0	1,5 (2,0)	ГОСТ 3351-74
pH	7,0	6-9	ГОСТ 26449.1-85
Қалдық хлор (остаточный хлор) мг/дм³	-	0,3-0,5	ГОСТ 18190-72
Еркін хлор (Свободный хлор) мг/дм³	-	0,3-0,5	ГОСТ 18190-72
Байланыстағы хлор (Связанный хлор) мг/дм³	-	0,8-1,2	ГОСТ 18190-72
Қалдық озон (Остаточный озон) мг/дм³	-	0,3	ГОСТ 18301-72

Тотығуы (Окисляемость) мгО$_2$/дм^3	0,72	5,0	ГОСТ 26449.1-85
Аммиак азоты (Азот аммиака) мг/дм^3	0,04	2,0	ГОСТ 33045-2014
Нитриттер азоты (Азот нитритов) мг/дм^3	0,001	3,0	ГОСТ 33045-2014
Нитраттар азоты (Азот нитратов) мг/дм^3	13,2	45,0	ГОСТ 33045-2014
Жалпы кермектік (Общая жесткость) ммоль/дм^3	3,2	7,0 (10)	ГОСТ 31954-2012
Құрғақ қалдық (Сухой остаток) мг/дм^3	216,0	1000 (1500)	ГОСТ 18164-72
Хлоридтер (Хлориды) мг/дм^3	17,7	350,0	ГОСТ 4245-72
Сульфаттар (Сульфаты) мг/дм^3	-	500,0	СТ РК 1015-2000
Темір (Железо) мг/дм^3	0,01	0,3 (1,0)	ГОСТ 4011-72
Бериллий (Be 2+) мг/дм^3	-	0,0002	ГОСТ 18294-2004
Бор (B) мг/дм^3	-	0,5	ГОСТ 31949-2012
Нефтепродукты, мг/дм^3	-	0,1	М 01- 05 - 2012
Молибден мг/дм^3	-	0,25	ГОСТ 18308-72
Фтор мг/дм^3	-	1,2-1,5	ГОСТ 4386-89
Қалдық алюминий мг/дм^3 (Остаточный алюминий)	-	0,5	ГОСТ 18165-2014
Поверхностно-активное вещества (ПАВ) анионноактивные, мг/л	-	0,5	СТ РК ГОСТ Р 51211-2003
Полифосфаттар (Полифосфаты) мг/дм^3	-	3,5	ГОСТ 18309-2014
Кальций, мг/дм^3	-	-	ГОСТ 23268.5-78
Магний, мг/дм^3	-	-	ГОСТ 23268.5-78
Гидрокарбонаты, мг/дм^3	-	-	ГОСТ 31957-2012

Үлгі (нің) НҚ-ға сәйкестігіне зерттеулер жүргізілді (Исследование проб проводилось на соответствие НД)
Қазақстан Республикасы Ұлттық экономика министрінің 2015жылғы 16 наурыздағы №209 бұйрығы
(СП утв. Приказом министра национальной экономики № 209 от 16.03.2015г)
Зертеу жүргізген маманның Т.А.Ә. (Ф.И.О., специалиста проводившего исследование)
Специалист сан.эпид службы _____ Турысбекова С.Т. Лаборант _____ Тлепова Б.Б.

Зертхана меңгерушісінің қолы, Т.А.Ә.
(Ф.И.О. подпись заведующего лабораторией) _____ Абдиева А.К.

Мөр орны
Место печати
Бөлімше бастығының орынбасары
Заместитель начальника отделения _____ Искакова Б.А.
Т.А.Ә., қолы (Ф.И.О., подпись)

Diary of work on the scientific project

Name of the project	Automated complex for purification and mineralization of water
Members of the project group (names, grade)	Assilbekova Sabina – Grade 11 B Madiomar Diyara – Grade 11 B
Scientific adviser	Physics teacher Gryaznov Yuri Petrovich
Project consultant	Head of the Department of Physics , South Kazakhstan State Pedagogical University , PhD Ualikhanova B. S.
The subject within which the project is being worked on	Physics
Academic disciplines close to the topic of the project	Chemistry, Informatics
Necessary equipment	Organic glass, plastic corners, two-component adhesive, sealant, water pump, commutation tubes, wires, buttons, connecting plugs, voltammeter, 433 MHz wireless RF switch with remote control, wireless Wi-Fi switch
Intended products of the project	Device for purification and mineralization of water
Project started **Project ended**	April 2020 September 2021

Research project schedule

Timing	Job Title
April 2020	Acquaintance with the general requirements, criteria for assessing complexity, rules for the design of scientific work. Choosing a topic, setting a problem, formulating a problem.
May 2020	Selection of the necessary material, study of the problem area. Development of the information model of the task.
August 2021	Pre-defense preparation, preparation of materials
September 2021	Pre-protection credit
September 2021	Development and debugging of the device
September 2021	Preparation and presentation of the report

Project implementation timeline (in stages)

Stages of project implementation	**Dates**
Drawing up a research plan. Coordination of the research plan with the supervisor.	15.04-20.04
Search and selection of the information sources.	20.04-20.05
Preparing the Introduction. Choice of research methods.	20.05-20.06
Writing the theoretical part. Statement of conclusions.	20.06-15.07
Recording the results of observations in the diary. Preparation of materials for practical demonstration.	15.07-20.08
Writing a practical part. Formulation of conclusions. Compilation of the Conclusion.	21.08-2.09
Project design. Typing on a computer.	3.09-15.09

Creation of a multimedia presentation to protect the project.	16.09-20.09
Preparation for the defense of the results of research activities. Self-diagnosis.	21.09-1.10