ТЕХНИКАЛЫҚ ҒЫЛЫМДАР ЖӘНЕ ТЕХНОЛОГИЯЛАР

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Ensuring water quality as the main goal of preserving human health

Abstract

Main problem: The article analyzes water quality assurance as the main goal of preserving human health. The study of chemical and microbiological parameters of wastewater and drinking water was carried out using generally accepted standards. The number of deaths associated with the use of contaminated drinking water, according to WHO, tripled in 2021 and reached almost 19 thousand against 6 thousand in 2020. In addition, the number of neoplasms, diseases of the genitourinary system, digestive organs and skin increased by 2 %, to 1.486 million. The reasons for the increase in the level of harmful chemicals and microbiological pollutants in the water are outdated sewage treatment plants, old pipes and disinfection with chlorine.

Purpose: Study of the quality of wastewater and drinking water in Pavlodar, study of the quality of wastewater and drinking water in Pavlodar.

Methods: Sampling of wastewater, chemical and bacteriological analysis of wastewater and drinking water, statistical method, correlation analysis of experimentally obtained results and calculated characteristics, etc.

Results and their significance: In the field of public health risk, pollution of reservoirs that are sources of household drinking water supply and recreational water use, the continuing necessary high deterioration of water supply networks, their accident rate, as a result of low level of operation, failures in the operation of treatment facilities. Hygienic assessment of reservoirs according to complex indicators indicates the continuing high degree of water pollution in places of water use. The water quality indicators of the surface reservoirs of the region remain low in terms of sanitary and chemical (primarily organoleptic and general sanitary), as well as microbiological indicators. According to toxicological indicators, the level of water pollution in places of water use is estimated as moderate. The main pollutants of the Irtysh River in Pavlodar are industrial enterprises and housing and communal facilities that discharge untreated or insufficiently treated wastewater into reservoirs.

A complex of causes of drinking water pollution has been identified: high deterioration of water supply networks, their accident rate, because of a low level of operation, failures in the operation of treatment facilities, unfair treatment of industrial wastewater by industrial enterprises of Pavlodar, etc. Priority preventive directions for improving the quality of water as a source of life are the implementation of long-term targeted planning of measures for the modernization of water supply and sewerage networks and facilities in Pavlodar. The state of water supply necessary and measures to improve it should be constantly monitored and considered at meetings of sanitary and anti-epidemic commissions.

Keywords: drinking water, water properties, public health risk, household drinking water supply.

Introduction

The main acts and rules of management in the field of sanitary and epidemiological welfare of the population are sanitary rules, hygienic standards, rules, technical regulations and uniform sanitary-epidemiological and hygienic requirements for goods of the Eurasian Economic Union. According to the Code of the Republic of Kazakhstan «On the Health of the People and the healthcare system», measures in the field of sanitary and epidemiological welfare of the population should be inextricably linked with measures to ensure compliance with sanitary sources of rules that regulate, among other things, orders and orders regarding water sources and the safety of water bodies.

An increase in water pollution after springs can occur only in cases when there are various harmful materials at the bottom of water sources that change the water content [1] and bring harm to the surrounding nature and man. Water sources are important natural resources that people use daily for drinking and other purposes of their development. Non-hazardous drinking water is essential for public health worldwide, according to the World Health Organization (WHO), perhaps about 80 % of various possible dangerous infections and diseases are carried by water. Drinking water and wastewater around the world do not meet generally accepted standards, 3.1 % of deaths occurred due to the high level of possible chemical and possibly microbiological contamination and the disgusting quality of water sources [2].

The water that is used by a person for drinking is an indispensable element of the vital functioning of people in Pavlodar, the state and level of health of people, an indicator of sanitary, as well as epidemiological well-being, social and trusteeship stability of society on the quality of this water [3].

Materials and methods

Due to the deterioration of pipes at the treatment facilities of the city of Pavlodar and pollution of drinking and wastewater sources, previously used water purification technologies have become to people. Due to possible difficulties with economic financing, water treatment methods and technologies are being developed at a very slow pace [4].

In the course of the research work, a possible comprehensive assessment of the own and statistical data of various enterprises of the city of Pavlodar was carried out.

The main indicative and possible criteria for the level of water pollution should be considered chemical and microbiological indicators of water.

According to the instructions of the regulatory documentation on water supply and sanitation in the Republic of Kazakhstan.

Mathematical analysis taking into account correlation and splitting, as well as with the calculation of reliability on an IBM PC personal computer using the program «Statistics 6.0» [5].

The measurement of the coefficient of complex pollution of water sources of the Irtysh River was carried out by us in accordance with the provisions and rules specified in the methodology.

Results

By a system of collectors, industrial and household effluents are collected in the receiving chamber. From the chamber, the drains flow into the grate room, where 3 channels are located, in which grates with mechanized garbage removal are installed. Next, the drains are fed by pumps to the distributor and the sand trap camera. After the sand traps (where the separation of mineral impurities takes place) the drains fall into the distribution. The bowls of the primary radial settling tanks and further – are distributed to the primary settling tanks (where organic impurities and fats are separated). After settling, the effluents are sent to biological treatment - aerotanks (through biologically active sludge and air, the dissolved organic pollutants are oxidized).

The discharges delayed on the grates enter the crushers. The pulp from the crushers is taken by a pump to the silt pads. Sediment from sand traps is pumped by hydraulic elevators to sand platforms. The raw sediment from the primary settling tanks is pumped by pumps to the silt pads.

After the initial settling, the effluents contain impurities in the form of a fine suspension, in a colloidal state and in a soluble form. Further cleaning involves the use of microorganisms that extract pollution from wastewater in special structures - aerotanks. The effluents clarified in the primary settling tanks are sent to the aeration tanks via pipelines. The distribution of effluents between parallel working aeration tanks is carried out using gate valves. Depending on the required degree of regeneration, the effluents are directed to the second or third corridor of the aeration tanks. Return sludge is fed into the first corridor. return sludge is fed using airlifts.

A mixture of purified effluents and activated sludge after aerotanks is collected in a collecting channel and enters the distribution channel of secondary settling tanks, where the sludge settles, and the effluents are diverted to post-treatment facilities – frame-backfill filters. Filtered purified water is fed into the chamber of the mixer brush, where chlorine water is supplied, where they are mixed and enters the contact tanks for disinfection. After that, it is sent through the discharge collectors to the Irtysh river.

Part of the sludge deposited in the secondary sedimentation tanks is returned to the aeration tanks for reuse (circulating sludge), a smaller part is removed from the treatment and disposal facilities (excess activated sludge). Excess activated sludge is piped to silt compactors, after which it is fermented in aerobic stabilizers. The stabilized sediment is sent to the silt sites for dewatering. The first stage of our research was to study the assessment of the quality of the intake water of the Irtysh River in the city of Pavlodar [6].

During the period 2020-2022, more than 250 enterprises – users of natural resources were registered in the city. Wastewater from such enterprises as «MolKom» LLP, «BestMilk» LLP, «FoodMaster» LLP and «Zhana Rosa» LLP were evaluated.

The process of wastewater treatment in the city of Pavlodar takes place at two complexes of treatment facilities.

Much attention was paid to the composition of heavy metal ions in water sources. Excessive thickening of iron and manganese in the aquatic environment, significantly exceeding the limits of the permissible norm, contributes to clogging of pipes in residential buildings of the population.

Table 1 – Composition of wastewater from dairy enterprises

Composition, mg/dm3	Companyname			MPC standards
	“MolKom” LLP	«BestMilk» LLP	«FoodMaster» LLP	
pH	6,5-8,5	6,8-7,4	6,2-7,0	4-5,5
Suspendedsubstances	350	350	600	180-240
Commonnitrogen	60	50	90	10-15
Phosphorus	8	7	16	3-5
Fats	100	100	100	100

Chlorides	150	150	200	100
BOD full	1200	1000	2400	150-600

The composition of wastewater significantly exceeds the MPC in all indicators according to GOST 31952-2012 and SanPiN 2.3.4.551-96.

Industrial facilities of dairy production are required to be provided with sewage systems for separate collection and purification of industrial and domestic wastewater. Wastewater from dairy industry enterprises must be subjected to mechanical, chemical (if necessary) and complete biological treatment at the treatment facilities of the settlement or at their own treatment facilities before being released [7].

Industrial effluents and fresh sample waters have a white or yellowish color. Their reaction may well be alkaline. Due to the fact that the most of the wastewater contains protein substances, carbohydrates and fats in its structural composition, they are instantly subjected to rotting and souring. This process often leads to the process of fermentation of milk sugar into lactic acid, which in the future is likely to cause precipitation of casein and many other protein substances. The process of spoiling the latter is accompanied by the release of a very unpleasant odor. The pH of wastewater is reduced to 4.5. The most dangerous for water sources are wastewater, which is discharged during the production of casein, hard cheeses and cottage cheese.

Industrial wastewater from dairy plants contains chemical compounds that can be used by the population to wash containers, equipment and floors.

Table 2 – Composition of wastewater from breweries (“Zhana Rosa” LLP)

Indicators	Onaverage	Minimum	Maximum
pH	7,3	5,1	Выше 9,0
BOD_5, mg/l	611,3	1,0	8830
Permanganateconsumption, mg/l	380	21,6	4480
Suspendedsolids, mg/l	303,6	0	5885
Dryresidue, mg/l	913,7	280	13020

Wastewater from brewing industries has a large amount of biogenic elements: nitrogen, phosphorus and potassium. It is important to take this into account in the agricultural use of wastewater and in their biological treatment. Indicators characterizing wastewater pollution - oxidizability, BPK5 and suspended solids content – are on average twice as high as in domestic wastewater.

The volume and quality of drinking water consumed, as well as wastewater at breweries, has its dependence on various production factors of the enterprise.

Table 3 – Indicators of the quality of domestic wastewater entering the Irtysh river

Indicator	Processingstage		MPC, standard (SanPiN 2.1.5.980-00)
	Aftertreatment	Aftercleaning	
Transparency, cm	6, 1	9, 1	< 10
Smell, score	6	3	> 2
Colour	Gray (9 см)	Gray (10 см)	Should not be detected in a column of 10 cm
Temperature,˚C	30	19	18, 000 – 24, 000
pH	8, 8	6, 98	7, 500 – 9, 400
Suspendedsolids, mg/dm^3	36, 8	22, 08	11, 460
Settlingsubstances, mg/dm^3	25, 9	15, 02	7, 870
Ammoniumnitrogen, mg/dm^3	0, 6	0, 38	0, 500
Nitrites, mg/dm^3	0, 2	0, 18	0, 070
Nitrates, mg/dm^3	16, 5	10, 72	30, 000
Sulfates, mg/dm^3	182, 2	153, 1	400, 000
Chlorides, mg/dm^3	138, 4	103, 88	200, 0
Phosphates (by phosphorus), mg/dm^3	2, 14	1, 48	0, 100
BOD total mg O2/dm^3	22, 9	14, 01	5, 000
Totaliron, mg/dm^3	0, 23	0, 21	0, 200
Nickel, mg/dm^3	0, 017	0, 014	0, 020
Chromium, mg/dm^3	0, 084	0, 075	0, 080

In the course of our research, insufficient functioning of water purification equipment at the enterprises of the dairy and brewing industry was revealed, which is why there is an increase in wastewater pollution in the territory of the city of Pavlodar. This carries with it the danger of further increase in the volume of pollution, a threat to the environment and the population.

Table 4 – Work with regulatory documentation in the field of protection and safety of water sources

Name of the product (object)	Designation of regulatory legal acts, regulatory documents for products(object)	Designation of regulatory documents for test methods for determining characteristics (indicators)
1	3	5
Source of centralized drinking water supply (Irtysh river)	Water sources, places of water intake for household and drinking purposes, household and drinking water supply and places of cultural and domestic water use and safety of water bodies» Order of the Minister of National Economy of the Republic of Kazakhstan 16.03.2015 No. 209	ST RK GOST R 51592-2003 GOST 3351-74 GOST 31868-2012 GOST 26449.1-85 GOST 4151-72 GOST 4245-72 GOST 26449.2-85 GOST 33045-2014 GOST 4011-72 GOST 4974-2014 GOST 4388-72 GOST 4386-89 GOST 18293-72 GOST 18309-2014 GOST 18164-72 GOST 4152-89 ST RK ISO 5815-2-2010 GOST 18165-2014 GOST 18308-72 GOST 18309-2014 Methodical instruction No. 4.2.2314-08
Drinking water	Water sources, places of water intake for household and drinking purposes, household and drinking water supply and places of cultural and domestic water use and safety of water bodies» Order of the Minister of National Economy of the Republic of Kazakhstan 16.03.2015 No. 209 ST RK 51232-03 Drinking water. General requirements for the organization and methods of quality control Technical regulations «Requirements for the safety of drinking water for the population» Decree of the Government of the Republic of Kazakhstan 13.05.2008	ST RK GOST R 51593-2003 GOST 3351-74 GOST 31868-2012 GOST 26449.1-85 GOST 18190-72 GOST 26449.2-85 GOST 4151-72 GOST 4245-72 GOST 18165-2014 GOST 19355-85 GOST 33045-2014 GOST 4011-72 GOST 4974-2014 GOST 4388-72
Wastewater	Permission to release into the environment. No. KZ33VCZ00093984 dated 08.07.2016 Rules for the use of water supply and sanitation systems of settlements. Order of the Ministry of National Economy of the Republic of Kazakhstan dated 28.02.2015 No. 163 Rules for the reception of wastewater in the drainage system of settlements. Order of the Ministry of National Economy of the Republic of Kazakhstan dated 20.07.2015 No. 546 RD Methodological guidelines for sampling industrial wastewater before dumping it into the wastewater disposal systems of settlements	ST RK GOST R 51592-2003 GOST 26449.1-85 ST RK 1322-2005 ST RK ISO 5815-2-2010 ST RK 2012-2010 GOST 18165-2014 GOST 33045-2014 GOST 18190-72 Instructions for disinfection of drinking water and treated wastewater No. 539 dated 12/29/2011

In the course of the study, we analyzed the regulatory documentation. Work was carried out on the classification of documents characterizing the MPC for wastewater and for drinking water. All the requirements that apply to water at different stages and levels of its purification have been carefully studied. Priority preventive directions for improving water quality are the regular analysis of regulatory documentation, the procedure for updating regulatory documents.

Table 5 - Microbiological contamination of drinking water in Pavlodar (Irtysh river)

Indicator	StandardSanPiN 2.1.5.980-00	Indicators
Commoncoliformbacteria	No more than 500 CFU in 100 ml	550 CFU in 100 ml
Thermotolerantcoliformbacteria	No more than 100 CFU in 100 ml	200 CFU in 100 ml
Coliphages	No more than 100 BOE in 100 ml	150 BOE in 100 ml
Pathogens of intestinal infections (analysis of bacteria from the family. EnterobacteriaceaeofthegenusSalmonella)	Water should not contain pathogens of intestinal infections (complete absence in 1000 ml)	1-3 in 1000 ml

Bacteriological analysis of water is a procedure similar to microbiological testing. However, many research laboratories distinguish between these methods, defining microbiological studies as a general analysis, and bacteriological studies as a determination of the amount of:

– Helminthes

– Pseudomonas aeruginosa,

– other types of microflora harmful to humans.

There is no fundamental difference in the research methods, you separate the test points. Special methods are required for studying. As a rule, sowing is done in a test tube with a nutrient medium, after some time the number of species and the number of colonies of microorganisms are determined.

Discussion

Industrial facilities of dairy production are required to be provided with sewage systems for separate collection and purification of industrial and domestic wastewater. Wastewater from dairy industry enterprises must be subjected to mechanical, chemical (if necessary) and complete biological treatment at the treatment facilities of the settlement or at their own treatment facilities before being released. The process is quite painstaking, the result largely depends on the level of training of laboratory assistants, as a result of this research, it is recommended to choose specialized organizations. Microbiological contamination of drinking water indicates its low quality and a threat to Pavlodar. Non-compliance with the norms of the SanPiN can lead to an outbreak of various infectious diseases and exacerbation of chronic diseases. Exceeding the permissible microbiological indicators carries a different threat to the population of the city of Pavlodar, depending on the time of year. So, in autumn and spring, exceeding the MPC by 5-10 % is an acceptable norm, while in winter it is unacceptable to exceed even one hundredth of a percent.

Proposed measures to improve water quality in Pavlodar

– Timely purging of the mixer, reaction chamber and settling tanks;

– High-quality filter flushing and control flushing with determination of: flushing intensity, filtration rate, load level measurement;

– Analysis of the filter material;

– Determination of the correctness of the dose setting by trial coagulation;

– Monthly monitoring of the water of the Irtysh River according to the determined chemical and bacteriological indicators;

– Daily quality control of drinking water according to chemical and bacteriological indicators.

Conclusion

A comparative analysis of regulatory requirements for the quality of wastewater and drinking water and the results of water sampling tests in Pavlodar was carried out, a complex of causes of drinking water pollution was identified: high deterioration of water supply networks, their accident rate, as a result of low level of operation, failures in the operation of treatment facilities, etc. Priority preventive directions for improving the quality of water as a source of life are: the implementation of long-term targeted planning of measures to modernize water and sewer networks and structures in the region, compliance with the requirements of regulatory documentation (GOST R 51232-98, GOST 18963-73, SanPiN 2.1.4.1074-01, ST RK GOST R 51232-2003). Improving the methods of wastewater and drinking water purification, compliance with regulatory and legal acts, methodological guidelines will be an important step on the way to a healthy environment in our republic, since water is a source of energy, strength, as well as the basis for the correct functioning of the human body.

The drinking water supply system is complex in its structure and is associated with many risk factors that can have a negative impact on human health. Despite the measures applied by the state, culture of water use of the population, so compliance with hygiene standards is impossible without the participation of citizens.

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Адам денсаулығын сақтаудың басты мақсаты ретінде судың сапасын қамтамасыз ету

Сапасыз ластанған ауыз суды пайдалануға байланысты өлім мен аурулардың саны тез өсуде. Судағы химиялық және микробиологиялық ластану деңгейінің жоғарылау себептері ескірген тазарту қондырғылары, ескі құбырлар және хлормен зарарсыздандыру болып табылады. Мақалада адам денсаулығын сақтаудың басты мақсаты ретінде судың сапасын қамтамасыз ету талданады. Павлодар қаласының ауыз суының ластану деңгейіне статистикалық талдау жүргізілді. Ағынды сулар мен ауыз судың химиялық және микробиологиялық көрсеткіштерін зерттеу жалпы қабылданған стандарттарды қолдану арқылы жүргізілді.

Мақаланың мақсаты - Павлодар қаласының ағынды және ауыз суының сапасын зерттеу.

Зерттеу әдістері сарқынды сулардың сынамаларын іріктеу, сарқынды және ауыз суға химиялық және бактериологиялық талдау жүргізу, статистикалық әдіс, эксперименттік алынған нәтижелер мен есептік сипаттамалардың корреляциялық талдауы және т. б. болды.

Халықтың денсаулығына қауіп төндіретін аймақ ауыз сумен жабдықтау көзі болып табылатын су объектілерінің ластануымен байланысты. Ертіс өзенінің су қоймасын гигиеналық бағалау, кешенді көрсеткіштер бойынша, суды пайдалану орындарында судың ластануының жоғары деңгейін көрсетеді. Санитарлық-химиялық, органолептикалық және жалпы санитарлық талаптар, сондай-ақ микробиологиялық көрсеткіштер бойынша облыстың жер үсті су қоймаларындағы су сапасының көрсеткіштері төмен болып табылады. Павлодар қаласындағы Ертіс өзенінің негізгі ластаушылары су қоймаларына тазартылмаған немесе жеткіліксіз тазартылған сарқынды суларды ағызатын өнеркәсіптік кәсіпорындар мен тұрғын үй-коммуналдық объектілер болып табылады

Ауыз суды ластау себептерінің жиынтығы: сумен жабдықтау желілерінің жоғары тозуы, олардың жұмыс деңгейінің төмендігі нәтижесінде олардың апаттылығы, тазарту құрылыстарының жұмысындағы ақаулар, өнеркәсіптік кәсіпорындардың өндірістік сарқынды суларды адал емес тазартуы анықталды. Павлодар және т.б. өмір көзі ретінде судың сапасын жақсартудың басымды профилактикалық бағыттары: Павлодар қаласының сумен жабдықтау және су бұру желілері мен құрылыстарын жаңғырту жөніндегі іс-шараларды ұзақ мерзімді мақсатты жоспарлауды жүзеге асыру. Халықты сапалы ауыз сумен қамтамасыз ету, сумен қамтамасыз етудің жай-күйі және оны жақсарту

шаралары тұрақты бақылауда болуы және санитарлық-эпидемияға қарсы комиссиялардың отырыстарында қаралуы тиіс.

Түйін сөздер: ауыз су, судың қасиеттері, халықтың денсаулығына қауіп, шаруашылық-ауыз сумен жабдықтау.

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Обеспечение качества воды как главная цель сохранения здоровья человека

Количество смертей и заболеваний, связанных с употреблением некачественной загрязненной питьевой воды стремительно растет. Причины увеличения уровня химических и микробиологических загрязнений в воде - устаревшие очистные сооружения, старые трубы и обеззараживание хлором. В статье анализируется обеспечение качества воды как главная цель сохранения здоровья человека. Произведен статистический анализ уровня загрязнения питьевой воды г. Павлодара. Исследование химических и микробиологических показателей сточной и питьевой воды проходило с применением общепринятых стандартов.

Цель статьи – изучение качества сточной и питьевой воды г. Павлодара.

Методами исследования стали отбор проб сточных вод, проведение химического и бактериологического анализа сточной и питьевой воды, статистический метод, корреляционный анализ экспериментально полученных результатов и расчетных характеристик и др.

Область риска для здоровья населения связана с загрязнением водоемов, которые являются источниками питьевого водоснабжения. Гигиеническая оценка водоема р.Иртыш, по комплексным показателям, свидетельствует о высокой степени загрязнения воды в местах водопользования. Показатели качества воды поверхностных водоемов области по санитарно-химическим в первую очередь, органолептическим и общесанитарным требованиям, а также микробиологическим показателям являются низкими. Основными загрязнителями р. Иртыш в г. Павлодар являются промышленные предприятия и жилищно-коммунальные объекты, сбрасывающие в водоемы неочищенные или недостаточно очищенные сточные воды

Выявлен комплекс причин загрязнения питьевой воды: высокая изношенность водопроводных сетей, их аварийность в результате низкого уровня эксплуатации, сбои в работе очистных сооружений, недобросовестная очистка промышленных сточных вод промышленными предприятиями г.Павлодар и др. Приоритетными профилактическими направлениями улучшения качества воды являются: реализация долгосрочного целевого планирования мероприятий по модернизации водопроводных и канализационных сетей и сооружений в г. Павлодар, а также проведение регулярного анализа нормативной документации в сфере водоснабжения и водоотведения, проведение процедуры актуализации нормативных документов. Вопросы обеспечения населения доброкачественной питьевой водой, состояния водоснабжения, мерах по его улучшению должны постоянно находиться на контроле и рассматриваться на заседаниях санитарно-противоэпидемических комиссий.

Ключевые слова: питьевая вода, свойства воды, риск здоровью населения, хозяйственно-питьевое водоснабжение.

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