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QUALITY OF THE WATER RECEIVED FROM AIR BY MEANS OF CONDITIONERS

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Summary. For the recreational zone located in the Odessa region along the coast of the Black Sea it is expedient to use (as an additional source of water supply) the water received from air. It is shown that it is possible to receive water from air by means of conditioners which it is much placed on recreation facilities and sanatoria. As water from air may contain various dissolved substances, it is necessary to investigate its quality. It is important to know it for development of technology of water treatment. Results of research of quality of water of two types are presented. Samples are received under different service conditions of conditioners. In samples indicators of epidemic safety, and also sanitary and chemical indicators of safety and quality of the water received from air are defined.

Keywords: water, air, quality, epidemic safety, sanitary and chemical indicators.

ЯКІСТЬ ВОДИ ОТРИМАНОЇ ІЗ ПОВІТРЯ ЗА ДОПОМОГОЮ КОНДИЦІОНЕРІВ

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Анотація. Для рекреаційних зон, розташованих в Одеській області вздовж узбережжя Чорного моря, доцільним може бути використання (в якості додаткового джерела водопостачання) води, отриманої з повітря. Отримувати воду з повітряного середовища можна за допомогою побутових кондиціонерів, яких багато розміщено в санаторіях і базах відпочинку. Оскільки вода з повітря може містити різні розчинені речовини, необхідно дослідити її якість. Це важливо знати для розробки технології очищення води. В статті представлено результати дослідження якості зразків води, отриманої при різних умовах експлуатації кондиціонерів. Зокрема визначено показники епідемічної безпеки, а також санітарно-хімічні показники безпечності та якості води, отриманої з повітря.

Ключові слова: вода, повітря, якість, епідемічна безпека, санітарно-хімічні показники.

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Introduction

Deficiency of fresh water exists in many countries of the world. Therefore, search of additional sources of drinking water is actual. It is especially actual for regions where the centralized water supply is absent. In addition, quality of water is unsatisfactory in underground or superficial sources, available to use, and demands complex and expensive technology of water treatment. These include a number of districts of Odessa region of Ukraine. The recreation centre and sanatoria located lengthways coasts of the Black Sea, estuaries and lakes have deficiency of sweet water. Water supply here is carried out at the expense of bottled water (for drinking needs) and imported water in tanks (for drinking and economic domestic needs). Such situation with fresh water is the reason of growth of cost of services for vacationers.

Problem statement

One of possible ways of the partial solution of this problem is use of the water received from free air [1,2].

One cubic meter of atmospheric air, depending on temperature, contains from 4 to 25 g of water vapour. Receiving water from free air possibly by its cooling up to the temperature of "dew-point". It is economically expedient to receive water from air at its relative humidity more than 40 % and temperature above 15 °C. In particular, climatic conditions of a resort season in Odessa region conform to these requirements.

Literature review

For receiving water from atmospheric air use various devices. Wind generators of autonomous type which receive electric energy and water are known [3]. Billboards with the combined surface from hydrophilic and hydrophobic materials [4], mesh panels from the materials absorbing water [5], etc. are also known. Dehumidifiers of air use at offices for receiving water from air.

This process happens in conditioners, which widely apply, to cooling of air in premises of sanatoria and recreation centre during resort season. In the course of their work, water is formed, which is a sec-

ondary product. It, in most cases, does not gather and is not used in no way, though its volumes considerable. Each of conditioners, for example, the SenSey FTI-51MR model, generates from 10 to 15 litres of fresh water per day. If, for example, on recreation facility 70 such conditioners are operated, for a resort season (from May to October) they generate about 180 000 litres of water. This water can be used for drinking and economic domestic needs [6].

Main part

Of course, the use of the condensate from the air conditioner without treatment for drinking needs is impossible. Because the quality is dependent on many factors, in particular from contamination and humidity, structure, operating conditions and arrangement of the air conditioning space, and other factors. Therefore, the first step in work aimed at the development of water treatment technology, derived from the air, was the analysis of indicators of the quality of such water samples, depending on the conditions of its receiving.

Water samples from air were received by means of conditioners of the SenSey FTI-51MR model. These conditioners are used in a recreation centre, located on the Black Sea near Odessa. Investigated indicators of

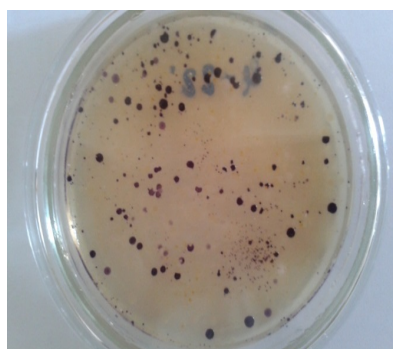
quality of samples of water of two types. The first samples are received from conditioners, which in use did not subject long time to sanitary processing. The second are received from conditioners which working surfaces regularly processed special washing solution. As the washing solution used 5 % water solution of lemon acid with a temperature (40 – 50) °C. After sanitary processing by the washing solution working surfaces rinsed with clear water and dried up. After that, the conditioner worked in the usual mode.

In samples of water defined sanitary and chemical indicators and indicators of epidemic safety. For this purpose used the standardized techniques and the modern equipment. Values of indicators of quality of the water received from air compared to requirements of the State health regulations and norms of drinking water [7,8].

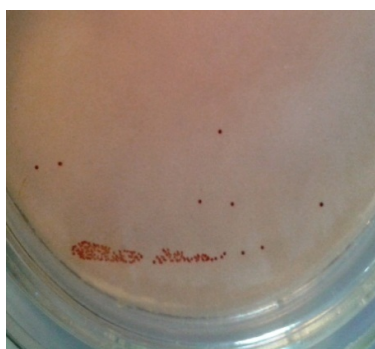
The analysis of results of pilot study of indicators of quality of samples of water from conditioners, which for a long time not been subjected to sanitary treatment allows to draw the following conclusions: quality of water on indicators of epidemic safety is low. It does not conform to normative requirements for the following microbiological indicators: colony count, Coliform bacteria, Escherichia coli (Table 1, Fig. 1).

Table 1 – Indicators of epidemic safety of samples of water from air

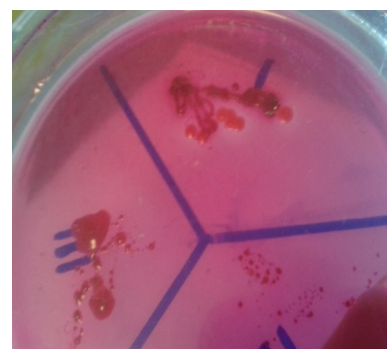
Indicator of quality of water, unit of measure	Value of an indicator	
	Water from air	Standard
Colony count, CFU/ cm ³ : 22 °C; 37 °C.	> 1000 > 1000	not defined ≤ 100
Coliform bacteria, CFU/ 100 cm ³	present	absent
Escherichia coli, CFU/ 100 cm ³	present	absent



a) Colony count (growth on agar culture medium, 22°C)



b) enterococci (growth on culture medium of Slanetz and Bartley)



c) growth of bacteria of Escherichia coli group on Endo's medium

Fig. 1. Growth of the microorganisms, which are present at water from air on culture mediums

Found that in samples of water are present saprophytic kind Micrococcus, Staphylococcus. Also found pathogenic and pathogenic flora families Enterobacteriaceae (41,7%), Pseudomonadaceae (36,1%) and Micrococcaceae (Staphylococcus aureus, 13,9%). In addition, the presence and proportion of fungi: Penicillium (19,4%), Cladosporium (11,1%)

and Aspergillus (8,4%), as well as their association (19,4%) is found. Specifically found that fungi of the genus Cladosporium and Penicillium were dominant in associations.

Sanitary and chemical indicators of safety and quality of water from air are presented in Table 2

Table 2 – Sanitary and chemical indicators of safety and quality of water from air

Indicator of quality of water, unit of measure	Value of an indicator	
	Water from air	Standart
Organoleptic		
Odour: 20 ⁰ C, score;	3	2
60 ⁰ C, score.	3	2
Flavour assessment, 20 ⁰ C, score	0	2
Colour, score	126.1	20
Turbidity, mg/dm ³	22.0	1.0
Physical and chemical		
pH, pH units	6.38	6,5-8,5
Total alkalinity, mmol/dm ³	5.84	not defined
Total hardness, mmol/dm ³	0.3	7,0
Total dissolved solids, mg/dm ³	39.0	1000
Calcium, mg/dm ³	4.0	not defined
Magnesium, mg/dm ³	1.2	not defined
Total iron, mg/dm ³	0.35	0.2
Manganese, mg/dm ³	0.013	0.05
Zinc, mg/dm ³	0.0264	1.0
Copper, mg/dm ³	0.0218	1.0
Chloride, mg/dm ³	10.6	250
Sulfate, mg/dm ³	7.0	250
Phenols, mg/dm ³	< 0.001	0.001
Iodine, µg/dm ³	<0.127	not defined
Brome, mg/dm ³	<0.080	not defined
Polyphosphates, mg/dm ³	<0.01	3.5
Petroleum products, mg/dm ³	0.014	0.1
Sanitary and toxicological		
Sodium and Potassium, mg/dm ³	—	200
Nitrate, mg/dm ³	< 0.34	50
Nitrite, mg/dm ³	2.02	0.5
Ammonium, mg/dm ³	42.54	0.5
Cadmium, mg/dm ³	0.00005	0.001
Mercury, mg/dm ³	<0.0005	0.0005
Selenium, mg/dm ³	<0.0001	0.01
Lead, mg/dm ³	0.0004	0.01
Vanadium, mg/dm ³	0.0388	not defined
Chromium, mg/dm ³	0.0011	0.05
Arsenic, mg/dm ³	0.0062	0.01
Nickel, mg/dm ³	0.0013	0.02
Fluoride, mg/dm ³	0.06	1.5
Strontium, mg/dm ³	0.34	7.0
Silicon, mg/dm ³	1.26	10
Boron, mg/dm ³	0.95	0.5
Aluminium, mg/dm ³	0.0366	0.2
Integral		
Oxidisability, mg/dm ³	4.24	5.0
Total organic carbon, mg/dm ³	7.4	8.0
Radiation		
Total activity of natural mix of isotopes of uranium, Bq/dm ³	0.002	<1

The high content of ammonium in water samples from air can be caused by the high content of nitrogen oxides in atmospheric air of the Odessa region. The reason of it, perhaps, is uncontrollable emissions of pollution in the atmosphere of the powerful enterprise for production and transportation of the ammonia located in the region. Exhaust gases of cars also promote pollution of atmospheric air nitrogen oxides. Their quantity significantly increases during a resort season.

The raised content of nitrites, most likely, is caused by that in the absence of sanitary processing of working surfaces of the conditioner which directly contact to air and water, favorable conditions for biological processes are created. As a result, under the influence of autotrophic microorganisms there is an oxidation of ammonium in nitrites.

Excess of standards for microbiological indicators testifies to intensity of biological processes in the conditioner. In our opinion, waste products of microorganisms are also the reason of a bad smell, considerable colouring and a turbidity of samples of water of the first type.

The raised content of boron in water from air can be connected with that it is present at sea water. As water from air was received on the seashore, perhaps, there was movement of boron together with couples of seawater in the conditioner.

The analysis of results of pilot study of indicators of quality of the water received from conditioners which sanitary processing constantly was carried out has shown that its quality is better, both on sanitary and chemical indicators, and on indicators of epidemic safety. At the same time, the content of ammonium still significantly exceeds norm (Table 3) and there are deviations on some microbiological indicators.

It is also necessary to note, very low content of salts of calcium, magnesium, sodium and potassium, and also iodine and fluorides in both types of samples of water. That is, from the point of view of physiological usefulness of mineral composition of water it needs in additional conditioning before using it for drinking (Table 4).

Table 3 – Influence of sanitary processing of the conditioner on quality of water from air

Indicator of quality of water, unit of measure	Value of an indicator		
	Water from air, sanitary processing of working surfaces of the conditioner is absent	Water from air, sanitary processing of working surfaces of the conditioner is present	Standard
Ammonium, mg/dm ³	42,54	30,84	0,5
Nitrite, mg/dm ³	2,02	0,058	0,5

Table 4 -Comparison of quality of water from air with requirements to physiologically full-fledged drinking water

Indicator of quality of water, unit of measure	Value of an indicator	
	Water from air	Standard for full-fledged drinking water physiologically
Calcium, mg/dm ³	4,0	25 - 75
Magnesium, mg/dm ³	1,2	10 - 50
Sodium, mg/dm ³	-	2 - 20
Potassium, mg/dm ³	-	2 - 20
Iodine, µg/dm ³	0,127	20 - 30
Fluoride, mg/dm ³	0,06	0,7 - 1,2
Total alkalinity, mmol/dm ³	5,84	0,5 - 6,5
Total hardness, mmol/dm ³	0,3	1,5 - 7,0
Total dissolved solids, mg/dm ³	39,0	200 - 500

Conclusion

Thus, the executed pilot studies of quality of samples of the water received by means of conditioners from free air have shown that it does not conform to the existing requirements of drinking water.

To use the received condensate as drinking water, it is necessary to develop technology of improvement of its quality. This is the next task of our research.

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КАЧЕСТВО ВОДЫ ПОЛУЧЕННОЙ ИЗ ВОЗДУХА С ПОМОЩЬЮ КОНДИЦИОНЕРА

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Аннотация. Для рекреационных зон, расположенных в Одесской области вдоль побережья Черного моря, целесообразным может быть использование (в качестве дополнительного источника водоснабжения) воды, полученной из воздуха. Получать воду из воздуха можно с помощью бытовых кондиционеров, которых много размещено в санаториях и базах отдыха. Поскольку вода из воздуха может содержать различные растворенные вещества, необходимо исследовать ее качество. Это важно знать для разработки технологии очистки воды. В статье представлены результаты исследования качества образцов воды, полученной при различных условиях эксплуатации кондиционеров. В частности, определены показатели эпидемической безопасности, а также санитарно-химические показатели безопасности и качества воды, полученной из воздуха.

Ключевые слова: вода, воздух, качество, эпидемическая безопасность, санитарно-химические показатели

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