Drinking water treatment with Caspian region natural sorbents

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ABSTRACT

The objectives of the research of the microbiological composition were river water samples from the basic water-supply sources in Astrakhan region. The objects of the research of the water purification efficiency were the household filter that is widely-spread in a market and the handmade experimental filter with natural sorbents.

The work employed the techniques to define total microbial count in the drinking water samples under study, and method of membrane filters to detect microbial cells of a certain size (Enterobacteriaceae) using filter pores of suitable dimension.

Application of natural sorbents on the basis of further integrated study is perspective for production of water-purification filters that are available to the public, as coquina is quarried in the region and is effective for drinking water disinfection in comparison with usual household filters.

Keywords: Caspian region, **d**rinking water, water purification systems, filters, natural sorbents, pollutants, microorganisms.

1. Introduction

Studying the role of aquatic factor in spread of some types of infections is no doubt topical, it is one of the objectives of epidemiological analysis among ecological factors of epidemic situations occurrence. So its estimation can employ different studying techniques of infectious agents spread: microbiological, empirical, sanitary, serological, medical-geographical and others [1].

At present natural reservoir carry a great anthropogenic stress. Pollution of reservoirs, water seeding with microorganisms occurs first of all because waste water both popular and industrial is damped into them. The rivers, flowing through large localities experience most anthropogenic stress. Their bacterial content sometimes comes to hundreds thousands or even millions per milliliter.

Beside anthropogenic pollutions, the reservoirs get organic substances and consequently microorganisms when they are washed out of soil, particularly in the periods of snow melting and shower rain. The maximum bacteria number in reservoirs is registered in spring and summer (May-July), the minimal one – in winter (December-January). The majority of microbes in reservoirs is concentrated in coastal areas, in superficial water layers and, especially in its silt.

The peculiarity of Astrakhan region is lack of secured water supply and canalization, the population wide using of crude river water for drinking, and vast zones of tolerance for originators of acute intestinal disease. To solve these problems scientists offer some purification methods for reservoirs and water supply sources by traditional techniques: chlorine treatment, ozonation, ultrasound, i.e. physical and chemical, as well as biological techniques (bacteriophages) [2].

There are many household filters to purify water in household conditions. Taking into consideration the above stated, we find it interesting to study the efficiency of household filters in water purification taking the examples of several filters, widely spread in the market, and to take an attempt to improve drinking water quality with a handmade filter using the natural coquina.

The aim of our research was to study modern methods and devices of drinking water purification and their efficiency in water disinfection, as well as utilization of local natural sorbents for the same purposes.

In the context of the object in view the following tasks were implemented: to give characteristic to the existing modern methods of drinking water purification and disinfection; make a comparative quality analysis of the water samples, taken from different water-supply sources; to make a comparative microbiological quality analysis of the water, purified with a household filter that is widely-spread in a market and with a handmade filter on the basis of the local natural sorbent - natural coquina.

2 Brief of previous work

In general there are more than 960 water bodies, including lakes and ilmens in Astrakhan region. The Caspian Sea basin belongs to the drainless area of the globe, for the Volga, the Terek, the Kura, the Ural that feed it, do not deliver their water to the World Ocean. Among the rivers, running into landlocked water bodies, Volga is the largest one. Astrakhan is one of the large centers in the Volga region, in accordance with the annual classification of the State committee on hydrometeorology and environmental control it is assigned to the number of polluted cities in Russia. Peculiarity of environmental pollutions of Astrakhan is directly connected with not only with the industrial, but also physiographic features of the town location. The town and its surroundings is located at the Volga underset current and represents a certain geochemical trap, accumulating all the contaminations, coming from the Volga headwater. The central water supply in the town is implemented from the surface sources, that are characterized by a raised water color index and relatively low suspended load except for freshet period, when the content of suspended substances in water are many factors of ten higher.

Hydrochemical soiling index (HSI) of water is one of the more frequent indices to estime water bodies quality. Water soiling index is generally calculated on the basis of 6-7 figures,that can be considered as hydrochemical; some of

them (dissolved oxygen concentration, hydrogen ion exponent pH, biological oxygen demand BOD 5) are obligatory. Water bodies sectors are subdivided into classes depending on the HSI rate. Then scientists compare water soiling indices of water bodies of a biogeochemical province and the ones of the similar type of one and the same water course (by the stream, time factor etc) [3].

Harmlessness of drinking water in Russia on the chemical content is determined by its correspondence to the standards of:

1. General indices of harmful chemical substances that are the most frequent in natural water bodies in Russia, and substances of anthropogenic origin and globally spread;

2. Content of harmful chemical substances, that fall into water and forming in it during its processing in the water-supply system;

3. Content of harmful chemical substances, that fall into the water-supply sources because of human activity [4].

Drinking water safety in respect of epidemiological point is determined by its correspondence to the standards of microbiological and parasitologic indices [5].

Estimation of the drinking water quality involves: definition of the bacteria total number; number of coliform bacillus in 1l.of water coli index. Quantitative accounting of microorganisms indicating the polution allows to estime more acutely the degree of bacterial contamination of water. The bacteria total number in undiluted water should not exceed 100 cells per litre, and the maximum water volume for one Echerichia coli must comprise not less than 300 ml [1].

Water purification is usually a multistage process using different purification techniques, particularly, biological, mechanical, chemical. Sorption water treatment is used to decontaminate not only for sewage, it is also applicated in household filters. Sorption sewage treatment employs absorbent coal and other porous materials. The principle of sorption purification is the basis for low-rate filters, where the water is strained either under gravity or by a forced run bottom-upwards. Sorbents structure and surface determine their physical and chemical features, mechanisms of interaction with substances, forming cleanser conglomerates for special purposes. Mechanisms of interaction identify selectiveness or non-selectiveness of sorption of various substances. Nowadays non-selective sorbents are used more often, for they are multifunctional due to the broad range activity.

The main requirements to the cleansers of environment:

- nontoxicity, chemical inertness towards objectives to be purified;
- absence of the toxic substances in the content of the sorbent that could penetrate into water and other objects;
- absence or limited content of radionuclides in the sorbent;
- absence or limited content of organic substances of general toxic, cancerigenic or mutagenic effect in the sorbent;
- absence in the sorbent of such organic compounds as lignin and derivatives of crude materials for fat-and-oil industry;
- absence of pathogenic microorganisms in the sorbent, as well as substances encouraging microflorula development in water and other objects.

The principle requirement for water purification, if the above mentioned limits are kept, is their high sorption capacity. The most important characteristic of sorbents is their specific area and porousity.

The experiments are carried out in the laboratory of Astrakhan State University (ASU) (Astrakhan region) in 2004-2007. The objectives of the research of the microbiological composition were water samples from the basic water-supply sources: in Astrakhan and Nachalo village. The objects of the research of the water purification efficiency were the household filter that is widely-spread in a market and the handmade experimental filter with natural coquina. The objectives of the research were: drinking water source in Astrakhan town, drinking water source in Nachalo village (Astrakhan region). The estimation of the microbiological water content was carried out with the help of the techniques to define total microbial count (TMC), and method of membrane filters: control before purification, after filtering with the control filter, after filtering with natural coquina.

Water samples for microbiological study were taken in May-June, i.e. in the high-water season, with observance of aseptics in sterile glass-ware with ground-in or cotton-gauze plugs. Before taking samples from faucet the water was flushed during 5-10 minutes, and tap brims were burned with flame [6].

Method of membrane filters was also applied to detect microbial cells of a certain size (Enterobacteriaceae) using filter pores of suitable dimension [7].

A widely-spread household filter and a handmade filter with natural coquina were exposed to the study of the water purification efficiency. The control filter is intended for advanced treatment of the tape water, it is completed with a clip-on cassette consisting of a combination of high quality absorbent coals to sorb harmful contaminants and exchange materials to remove toxiferous metal ions from water.

Coquina belongs to organogenetic carbonaceous sedimentary strata-limestone. In consists of calcite mineral ($CaCO_{3)}$ and is formed when carbonate cements calcite skeletons of died away organisms [8]. Carbonate rock occurrence is in Akhtubinskiy region, 5.5 km to the East of lake Baskunchak. The useful section is presented by limestones, hard, porous, of white, yellow and light-grey with the average width of 7.8 m (2.5-12 m). The field contains $CaCO_3$ – 93.5-96.0%, $MgCO_3$ – 1.0-2.5%. Limestones specific weight is 2.08 g/sm^3; gravity-2.7-2.93 g/sm^3 [9].

3. Results

The research proved that the control filter fails to reduce the microbial count in the water samples under study. The

Clean Technology 2008, www.ct-si.org, ISBN 978-1-4200-8502-0

handmade filter with natural coquina decreases the microbial count in the water samples under review without changing the general microbial composition.

The method of membrane filters to detect microbial cells of a certain size (Enterobacteriaceae) using filter pores of suitable dimension showed the presence in the drinking water samples of the following microorganisms: colibacilli group (CBG), actinomycetes, clostridi, bacilli, micrococci as well as bacteria forms, that are not typixcal for Endo medium.

In this work researches estimated microbial content of the drinking water samples from several water supply sources on the basis of general empiric results and on the data, with the purpose to determine the initial microbe content in the control water samples, and then studied in laboratory conditions the water disinfection efficiency of a widely-spread filter and the filter using natural coquina.

On the basis of study of microbial content of the drinking water samples, purified with the control filter and the filter using natural coquina, one may judge on their water disinfection efficiency.

The control household filter fails to reduce the microbial count, what is proved by the experiment.

The filter on the basis of the natural coquina reduces the the microbial count.

Both the filters do not change the microbial content in the samples under study. Researches found out with the method of membrane filters colibacilli group (CBG), actinomycetes, clostridi, bacilli, micrococci as well as bacteria forms, that are not typical for Endo medium both in the control samples and in the samples purified with the control filters and the filter using natural coquina.

4. Conclusion

The comparative microbiological analysis of the water, purified with a spread household filter proved that the filter fails to reduce the total microbial count, that witnesses about its inefficiency in water purification from microflora.

Comparative microbiological analysis of the water, purified with the handmade filter using natural coquina, proved that the filter reduces the total microbial count in the drinking water samples averagely by 1,5 times, that suggests the efficiency of that filter in water purification.

Application of drinking water purification method on the basis of natural sorbents is perspective, for the experiment proved the filter is efficient in water disinfection. Besides coquina is widely-spread, consequently its potential usage to produce simple accessible water purification filters can be economically profitable.

Application of natural coquina is perspective for production of water-purification filters that can be widely available, as coquina is quarried in the region and is effective for improvement of the microbiological parameters of drinking water quality as well as because of low costs of finished goods necessary for people both in urban and particularly poorly developed rural areas where water treatment is for various reasons not available.

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