ON THE USE OF NATURAL SORBENTS FOR REMOVAL OF MICROBIAL CONTAMINANTS FROM WATER SOLUTIONS

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ABSTRACT

Microorganisms with treated sewage are discharged into surface waters, compromising their sanitary state and causing need for special extensive water treatment prior to use for domestic and industrial needs. The aim of research was to explore the process of water treatment by adsorption method. Adsorption method has advantages over other methods – high treatment efficiency and high levels of disinfection. Moreover, this treatment does not remove useful minerals and salts from water.

In this investigation several kinds of sorbents were used: bentonite, zeolite and glauconite. These sorbents are characterized by sufficiently high adsorption capacity, selectivity and cation-exchange properties. Use of natural sorbents in water treatment technologies does not require their regeneration. Used sorbents can be used in chemical and construction industries or applied in agriculture. Therefore, water treatment using sorbents is a promising and relatively inexpensive method. In experiments, water, contaminated by monocultures of *Bacillus* sp. was used. Samples were analyzed for microbial number (MN) before and after application of treatment method. The results indicate high capacity of sorbents to adsorb microorganisms.

This method allows removal of pathogenic microorganisms from water solutions to the required level.

Keywords natural sorbents, adsorption

INTRODUCTION

The current state of the water bodies and the constantly growing need for clean water that meets all hygiene requirements, require intensive action aimed at finding new technologies of water treatment.

The main source of bacterial pollution are domestic sewage, sewage from hospitals, baths, laundry and certain types of food industry and wastewater from livestock complexes.

Adsorption from solutions on solid surface is the basis for many physico-chemical processes. Along with the activated charcoal recently as the adsorbents natural dispersed minerals are widely used. Thanks to highly developed porous structure and surface mineral sorbents are able to selectively remove from aqueous solutions of various substances, and their nontoxicity allows to use these reagents for the needs of different sectors of the food industry. Natural dispersed minerals exhibit high adsorption, ion exchange and catalytic properties. The economic feasibility of using these reagents in various manufacturing processes is due to the existence and effective methods of control of their geometric structure and chemical nature of the surface, the presence in Ukraine of large industrial deposits and low cost clay minerals. (Goncharuk V.V. et al 2008, Petrushka I.M.et al 2003)

Natural and synthetic sorbents are increasingly used for treatment of water due to its high sorption capacity, selectivity, low cost and high availability. The most common natural minerals with good sorption properties are zeolites and clay materials. (U. G. Distanov et al 1990)

For water clearing with the help of adsorption non-carbonic sorbents of natural and artificial origin are increasingly used. The appliance of these sorbents due to their sufficiently high adsorption capacity, selectivity, cation properties of some of them, has comparatively low cost and availability. The most important representatives of the natural mineral sorbents are zeolites and clay materials. They are quite common and possess different variety of properties and applications. (Tarasevych J.I. et al 1975, S.P. Zhdanov et al 1968)

Among the mineral adsorbents most prevailing are:

- zeolites;
- bentonites;
- glauconites.

Usage of natural sorbents in water treatment technologies does not require their regeneration, and polluter modified sorbents can be used in other chemical and construction industry or applied in agriculture. Therefore the wastewater treatment using sorbents is a promising and relatively inexpensive method. (Grim R.E. 1967, Tsitsishvili G.V. et al 1985)

Natural zeolites – are framed aluminum silicate, internal crystalline space of which contains exchange cations of alkali and alkaline earth metals and water molecules. Unique adsorption and ion exchange properties – namely, chemical and mechanical stability, high acid resistance provide wide area of application of zeolites in industry, agriculture, protection of the environment. (Breck D. 1976, N.F. Chelischev et al 1987)

Bentonites are viscous, greasy mineral of different colors - from white to black; together with water they form a gel, during drying of which the crust is formed on the surface of particle.

Bentonite fine have developed specific surface, together with ion exchange, the of processes physical and molecular adsorption are possible. Bentonite is used usually in activated form as natural sorbent, catalyst, inhibitor, various industries. (Avidon V. P. 1968)

Glauconite – is mineral that belongs to a class of silicates. It has layer structure. It is presented as fine-crystalline or sometimes as a soil-formed unit. The color is green of various shades. It has a high cation exchange properties. It is formed during diagenesis sludge in soils and weathering crust. It is one of the main minerals used for age determination of sedimentary rocks. Glauconite is used for remediation of pollution soil and for wastewater treatment.

Mineral sorbent glauconite in the degree of impact on the human body belongs to the 4th class of danger. It shows no local effect on intact skin. Glauconite does not form toxic compounds in the air, does not burn, and is not explosive. (O. Yushmanov et al 1985)

Great number of wastewater contains various types of microbiological contaminants that are hazardous to the environment.

Microorganisms with treated sewage are discharged into surface waters, compromising their sanitary state and causing need for special extensive water treatment prior to use for domestic and industrial needs. Selection and identification of specific pathogens (disease-causing) microorganisms in the water is complicated and expensive task. For almost every type of bacteria that lives in water, are applied own methods of identification, usually of long term character. But because of the large diversity of microorganisms in water, specific tests for specific pathogens are

not applicable for routine microbiological analysis of water quality for which is desirable quick, simple and, when it's possible, single test. From the practical point of view, it is more important often and quickly to conduct a general test than rare, but a series of specific tests for specific organisms. (Slyusarenko T.P. 1984)

One of microorganism types, that is commonly present in treated wastewater and can cause human deseases are bacteria of genus Bacillus.

Bacillus are one-celled, non-photosynthetic, aerobic, rod-like cells that form typical endospore. They are related to heterotrophic organisms. They multiply by divioliny cells by half. Transverse size of cells varies within 0,4-2 microns. Vegetative cells are more direct or barely bent rods with parallel sides and rounded ends, which in some cases are sharply truncated. There are species that form mobile colonies on the surface of solid surface.

The aim of research work was to study the effectiveness of natural disperse sorbents application for the treatment of aqueous solutions of contaminated with microorganisms.

METHODOLOGY

Experimental conditions: water that was studied - model water infected with bacteria genus Bacillus, type of sorbent - bentonite, zeolite, glauconite, duration of the process - 1 hour under constant stirring.

Sampling was carried out before the experiment, after the use of natural sorbents.

Sanitary and epidemiological assessment of water quality is determined by microbial number – the total number of bacteria in 1 ml.

The method is based determining the total number of microorganisms that can grow on beef-extract agar at 37 $\pm$ 0,5 ^{o}C for 24 $\pm$ 2 h in 1 ml of water with further account of the colonies that grew on this medium. (Slyusarenko T. P. 1984)

RESULTS AND DISCUSSIONS

Samples were analyzed for microbial number (MN) (Tables 1-3, Figures 1-2).

Table 1. Changes MN for Bentonite

C g/l	MN0 cfu/cm^3	MN after sorption cfu/cm^3
1	111000	59300
5	111000	30550
10	111000	7650
20	111000	3300
30	111000	900
35	111000	200

Table 2. Changes MN for Zeolite

C g/l	MN0 cfu/cm^3	MN after sorption cfu/cm^3
1	111000	85100
5	111000	41350
10	111000	8300
20	111000	6000
30	111000	4150
35	111000	2600

Table 3. Changes MN for Glauconite

C g/l	MN_0 cfu/cm^3	MN after sorption cfu/cm^3
1	111000	90550
5	111000	50800
10	111000	29450
20	111000	25900
30	111000	22400
35	111000	18750

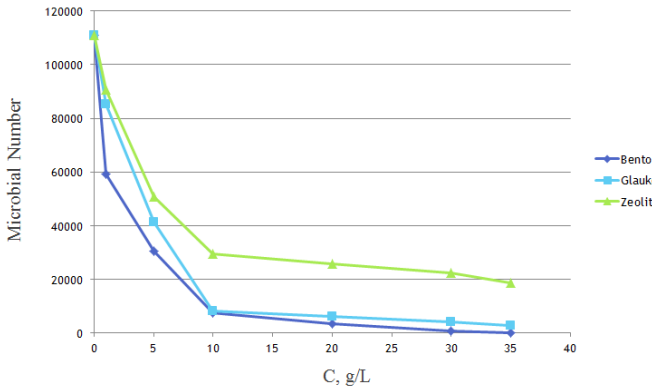

Figure 1. Dependence of microbial number from the concentration of sorbent.

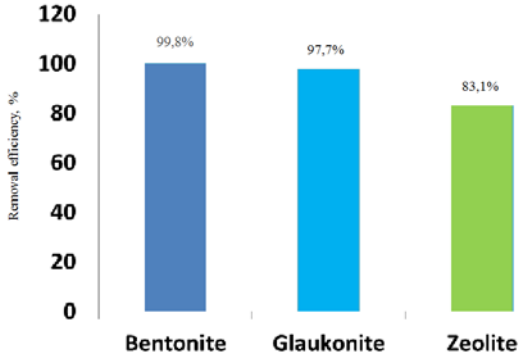

Figure 2. Efficiency of microorganisms removal.

With higher concentration of sorbent higher treatment efficiency can be reached. The best results are obtained for bentonite.

Efficiency of microorganisms remove in cose of bentonite was 99,8%, in cose of glaukonite – 97,7%, and 83,1% when zeolite was used.

CONCLUSIONS

The results indicate high microorganisms adsorption ability of all the materials and especially bentonite. Based on obtained results use of sorbents is very promising and that will enable removal of pathogenic microorganisms.

Sorption method has advantages over other methods: a very high degree of treatment, high levels of disinfection. In contrast to application of membranes, after sorption process useful minerals – salts – remain in the water.

Usege of natural sorbents in water treatment technologies does not require their regeneration, and polluter modified sorbents can be used in chemical and construction industry or applied in agriculture. Therefore the wastewater treatment sorbents usage is promising and relatively inexpensive method. Thus, sorption on sorbents such as bentonite, can be seen as competitive method of disinfection of water, due to its high sorption capacity.

Treatment of water with use of dispersed adsorbents meets many requirements of environmentally friendly and energy-efficient production, based on the no-waste principle. Reach geological

reserves, cheap material, simple preparation for transportation and usage, the possibility of used sorbents application in other technologies, consequently eliminating the need for costly regeneration – these are the main benefits of using natural minerals.

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