

Effect of polyols P-5003-AC, P-373-2-20, P-294-2-35 on the sanitary regime of water reservoirs and organoleptic properties of water in connection with the water reservoirs protection

Zhukov V.¹, Zaytseva O.², Rezunenکو Y. K.¹, Telegin V.¹, Bondarenko M.², Knigavko V.²

¹Department of Biochemistry, Kharkiv National Medical University, Kharkiv, Ukraine

²Department of Medical and Biological Physics, Kharkiv National Medical University, Kharkiv, Ukraine

Email address:

gramatyuk@ukr.net(Zhukov V.)

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Abstract: Xenobiotics effects on the organoleptic properties of water and sanitary regime of water reservoirs had been studied by estimation of their stability and transformation in aqueous medium. Limiting indicators was revealed for substantiation of threshold concentration for the purpose of development of hygiene regulations.

Keywords: Surface-Active Substances, Limiting Indicators, Stability, Transformation

1. Introduction

Chemical compounds entering the water reservoirs from industry sewage more or less can give a negative effect on organoleptic properties of water and process of natural water self-cleaning. The deterioration of the water aesthetic parameters is the most common cause of population abstinence from water use; it always leads to water use limitation. Polyoxypropylenepolyols P-5003-AC, P-373-2-20, P-294-2-35 are widely used in many sectors of the economy as intermediate and final products. In industrial production of these compounds a large amount of sewage is produced (50 m³ / ton of finished product); this water inevitably enter the water reservoirs creating serious difficulties in population supply with good quality water [1-4].

Discovering of xenobiotics influence on the water reservoirs is closely connected with the development of environmental protection measures and with optimization of water use conditions. It is known that sometimes substances in an aqueous medium under the influence of various physical, chemical and biological factors can be subjected to changes and transformations with the formation of more toxic and dangerous compounds than original products contaminating water sources [5-7].

The possibility of transformation and the transformation

of each individual substance to a certain extent depends on the stability of its forms in an aqueous medium and is defined both by properties of the xenobiotic and by the aquatic environment [8-13]. The leading and reliable preventive measure limiting the entry of xenobiotics in the environment, and particularly in water sources is their hygienic regulation and substantiation of the forecast of the potential hazard for warm-blooded animals, and water reservoirs.

The aim of this research was to examine the effect of polyoxypropylenepolyols P-5003-AC, P-373-2-20, P-294-2-35 on the organoleptic properties of water, sanitary regime of water reservoirs, and to substantiate the threshold concentrations which do not violate mentioned indicators.

2. Material and Research Methods

As objects of investigation were: polyoxy propylene polyols M.M 5000 (P-5003-AC) and M.M 370 (P-373-2-20), as well as oxy propylene amine M.M 290 (P-294-2-35). These substances are viscous liquids with regulated physical and chemical properties, well-soluble in water and organic solvents.

The ability of xenobiotics transformation and their stability was investigated with help of direct method (gas-liquid chromatography) and indirect methods (changes in the observation dynamics of organoleptic and common sanitary

indices). The substances effect on water organoleptic properties was investigated in compliance with the Ukrainian National Standards.

Odor and taste were determined by a team-based approach in a well ventilated room. Spring water devoid of odor and flavor was used as diluent water. Different concentrations were prepared by repeated dilution of the initial solution. Odor provoking under solution chlorination was done by doses of active chlorine 0.1, 1.0, 2.0 mg / l. Investigations were performed at aqueous solutions temperature 20 and 60 ° C. Compounds effect on the color and transparency was determined in flat-bottomed cylinders made of colorless glass: the color of water - by comparing the solutions on a white background with the original water, and transparency – by mean of reading Snellen's font through a column of water solution. Foaming properties were researched according to the Ukrainian National Standards; the threshold concentration for foaming was determined by shaking. The influence of substances on the sanitary regime of water reservoirs was studied by the following indices: biochemical consumption of oxygen (BCO_5 , BCO_{20}), dissolved oxygen content (O_2), pH of model reservoir water in dynamics of observation; quantification of ammonia NH_3 , nitrites (NO_2), nitrates (NO_3), development and reproduction of *Daphnia*, saprophytic and conditionally pathogenic microorganisms, viruses, and algae. Standard methods underlie determination of the xenobiotics effect on the sanitary regime of water reservoirs.

3. Results of Researches and Their Discussion

Studies of the xenobiotics effect on the organoleptic properties of water and its sanitary regime was started with evaluation of their stability and transformation in the aquatic environment. During research it was discovered that substances can be unchanged for a long time in aqueous solutions. In exposure of solutions with initial concentration of substances 4 g / l on the 6th month of monitoring the xenobiotics content exceeded 80% in all cases. The half-life of substances under exposure of aqueous solutions during a

year was not established with help of direct method of gas-liquid chromatography. Rate of hydrolytic degradation of xenobiotics depended on their initial concentration. Thus, when the initial concentration of the compounds was 10 mg / l the content of xenobiotics in the solutions on the 30th day was 50-65%, whereas at 1000 mg / l it was more than 95%. The high stability of the xenobiotics was confirmed by indirect methods: evaluation of taste, odor, foaming, and biological tests on *Daphnia*. For interpretation of the results we used the following grading of estimate for substances stability:

Short-stable: original flavor (odor) at 2 points disappears on 1st day, and at 5 points - not later than on 6th days;

Relatively stable: the original flavor (odor) vanishes on 2-3rd day, at 5 points – on 6-7th day;

highly stable: the original flavor (smell) at 2 points cannot be detected on the 4-5th day, at 5 points - more than on 10th days, and if the original flavor (odor) is not reduced during 7 days and more.

In 10 days of aqueous solutions exposure the presence of bitter-viscous taste, oil products odor, and foaming properties at the level of practical threshold were revealed; it confirmed the high stability of xenobiotics and the need of effective degree of purification of sewage containing these compounds. Among the products of the hydrolytic oxidation of xenobiotics hydrocarbons, aldehydes, ketones, alcohols, ethers, were revealed by gas-liquid chromatography; it confirmed the free radical mechanism underlying the polyoxypropylenpolyols transformation. Metabolites of the hydrolytic oxidation are much more toxic and dangerous for warm-blooded animals. They have a polytropic action.

During research we discovered that compounds at concentrations greater than 50 mg / l are able to give a bitter-viscous taste, oil products odor, and foaming properties to aqueous solutions. Induction of smells and tastes under the chlorination of aqueous solutions at the threshold doses (2 points) was not observed. Limiting organoleptic indicator of hazard is foaming. The threshold concentrations for this indicator are determined at levels of 1.0, 5.0, and 1.0 mg / l respectively for the P-5003-AC, P-294-2-35, and P-373-2-20 (Table 1)

Table 1. Effect of polyoxypropylenpolyols on organoleptic properties of water

Organoleptic properties of water	Threshold concentrations, mg / l		
	P-5003-AC	P-373-2-20	P-294-2-35
<u>Taste:</u>			
1 point	44,30±3,20	45,60±2,70	40,60±4,35
2 points	59,60±3,40	63,70±4,35	56,20±2,80
<u>Odor:</u>			
1 point	39,60±2,50	43,40±3,40	47,60±4,20
2 points	56,30±2,80	62,80±3,50	65,40±3,60
Foaming	1,0	5,0	1,0
Transparency		No effect up to 100 mg / l	
Color		No effect up to 100 mg / l	

Table 2. Effect of polyoxypropylenpolyols on sanitary regime of water reservoirs

Indicator	Threshold concentration, mg / l		
	P-5003-AC	P-373-2-20	P-294-2-35
BCO ₅	20,0	40,0	40,0
O ₂	20,0	40,0	40,0
NH ₃	20,0	40,0	40,0
NO ₂	20,0	40,0	40,0
NO ₃	20,0	40,0	40,0
pH	No effect up to 100 mg / l		
<i>Pedinomonas tenuis</i>	15,0	20,0	20,0
<i>Dunaliellasalina</i>	10,0	15,0	15,0
<i>Daphniamagna</i>	5,0	10,0	10,0

Among the large variety of negative effects of hazardous substances and of industrial sewage on water reservoirs a special attention was given to the study of their influence on the sanitary regime of water reservoirs and water-use conditions. During researching of the self-purification processes in the model water reservoirs we revealed that xenobiotics at concentrations more than 20.0 mg / l increase the biochemical consumption of oxygen (BCO₅, BCO₂₀), decrease the dissolved O₂ concentration in water, inhibit accumulation of NH₃, nitrites (NO₂), nitrates (NO₃); all these indicate the inhibition of organic substances mineralization, the toxic effect on growth and reproduction of aquatic organisms - *Daphnia*, saprophytic and conditionally pathogenic microorganisms, viruses, and unicellular algae (Table 2). Xenobiotics at concentrations up to 100 mg / l do not cause violations of the pH limits (6.5 - 8.5) regulated by the Rules of surface waters protection from pollutions. Limiting common sanitary indicator of hazard was determined according to polyoxypropylenpolyols effect on *Daphnia* growth and reproduction.

4. Conclusions

1. Polyoxypropylenpolyols P-294-2-35, P-373-2-20, and P-5003-AC are highly stable compounds which can be undergone to hydrolytic oxidation with difficulty. In the process of their transformation in the aquatic environment they can form aldehydes, ketones, alcohols, ethers which are more toxic and dangerous to warm blooded animals; they have a polytropic mechanism of action, can damage all organs, systems, and functions of the warm-blooded animal organism.

2. Xenobiotics in concentration more than 50.0 mg / l are able to give a bitter- viscous taste, oil products odor, and foaming properties to aqueous solutions. At concentrations up to 100.0 mg / l these substances do not effect on the color, transparency, and turbidity of water. Limiting organoleptic indicator of hazard is foaming. Threshold concentrations are determined at levels 1.0, 5.0, and 1.0 mg / l respectively for the P-5003-AC, P-294-2-35, and P-373-2-20.

3. Polyoxypropylenpolyols P-294-2-35, P-373-2-20 and P-5003-AC at concentrations more than 20.0 mg / l increase the biochemical consumption of oxygen (BCO₅, BCO₂₀), decrease the dissolved O₂ concentration in water, and inhibit accumulation of NH₃, nitrites (NO₂), nitrates

(NO₃), make the toxic effect on growth and reproduction of aquatic organisms - *Daphnia*, saprophytic and conditionally pathogenic microorganisms, viruses, and unicellular algae; all these indicate unfavorable influence of this group of compounds on the processes of natural self-purification of water. Limiting common sanitary indicator of hazard was determined according to xenobiotics effect on *Daphnia*. Threshold concentrations for this test are determined at levels 5.0, 10.0, and 10.0 mg / l respectively for P-294-2-35, P-5003-AC, P-373-2-20.

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