CHEMICAL PARAMETERS OF NATURE WATER QUALITY OF THE BELARUS.

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Abstract

Natural water is a complicated system containing different organic and inorganic combinations in dissolved and colloid states. As a rule hydro- chemists classified conventionally the substances contained in natural water in five group:

1. The main ions
2. Dissolved gases
3. Biogenic substances
4. Microelements
5. Organic substances

The ions of the following substances: calcium, sodium, magnesium, potassium are contained in water in the largest quantities as cations, most distributed anions in water in the largest hydrocarbonated, sulfates, chlorides, carbonates. The following gases dissolved in water and more often met are carbon dioxide, oxygen, nitrogen, sulphurated hydrogen and others.

Some words about the influence of hard water upon the life and health of people. Hardness of natural water is negative property. Thus, for example, if hard water is longly used in steam-boilers their walls gradually become covered with a dense layer of scale, which in its turn results in the increase of fuel competition, earlier wear-out and even failure when the layer`s thickness is 1 mm. Food products are not easily cooked in hard water and vegetables boiled in it do not taste well, also as tea loses its flavour.

When using hard water the salts deposit on walls of vessels. Calcinois or arteriosclerosis. as called before, can start. A calcified tissue becomes dense and brittle. It can also be said that calcium and magnesium salts deposited during boiling cause irritation and dryness of skin; with large amount of magnesium ions water is bitter and causes diarrheoa. Moreover, those are not all the negative consequences which can be caused by hard water.

Our research was concentrated to the study of such property or water as hardness. Hardness of natural water is defined by the content of calcium and magnesium ions which add specific properties to water. These ions appear in natural water as the result of interaction with limestone (dolomite) or gypsum dissolution.

The paper presents the results of a study water quality during the period 1985-1995. According to the results of research, hardness of water is approximately twice higher in autumn than in spring. That is, obviously, because observes of increasing of quantity of flood water from snow which thaws in spring and decreases the concentration of salts.

Introduction

Biogenic substances are the combinations which are formed in the result of activity of living organisms» Different formations of nitrogen, like ammoniac, nitrite, nitrate, phosphorus, silicon, iron, etc» compose the group. Microelements are those which are contained in water in quantities less than 10 « Microelements influencing water quality are Br_2, J_2, F_2, Cu, Co, Ni and others₀ Organic substances of natural water are represented by different kinds of vegetable and animal organisms and also their products of interaction with environments

Some words about the influence of hard water on human organism. When using hard water the salts deposit on walls of vessels. Calcinois or arteriosclerosis, as called before, can start. A calcified tissue becomes dense and brittle. It can also be said that calcium and magnesium salts deposited during boiling cause irritation and dryness of skin; with large amount of magnesium ions water is bitter and causes diarrheoa,, Moreover, those are not all the negative consequences which . can be caused by hard water.

Hard water prevents from lather formation as soluble sodium salts of stearine contained in soap transfer into the insoluble calcium salts of the same acid:

$$2C_{17}H_{35}COONa + CaSO_4 \longrightarrow (C_{17}H_{35}COO)_2Ca + Na_2SO_4$$

That is going on untill all the ions of Mg^{+2} and Ca^{+2} will be removed from the solution. So, using hard water for washing causes ineffective consumption of soap. Food products are not easily cooked in hard water and vegetables boiled in it do not taste well, also as tea looses its flavour.

The methods of removing water hardness

Let us consider some methods of water softening. Hardness can be either temporary or permanent. We shall consider them separately. Temporary hardness is made by hydrocarbonates, so it can be removed by boiling. The following reaction goes on:

$$Ca(HCO_3)_2 \xrightarrow{t} CaCO_3 + H_2O + CO_2$$

Temporary hardness can also be removed by adding definite amount of lime milk or soda:

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2\,CaCO_3 + 2\,H_2O$$

$$Ca(HCO_3)_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2\,NaHCO_3$$

Permanent hardness depends on the presence of calcium and magne sium chlorides and sulphates. It is more often removed by adding soda» The reaction is as follows:

$$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3 + Na_2SO_4$$

The method of removing water hardness by the ion exchange is widely practiced in industry. The method is based on the ability of some silica-aluminas to exchange sodium ions contained in them against calcium and magnesium ions, contained in water, i.e. to remove the latter from the solution. Such silica-aluminas are called cationites. Schematically this process can be represented by the equations:

$$Na_2R + Ca(HCO_3)_2 \longrightarrow CaR + 2NaHCO_3$$

$$Na_2R + CaSO_4 \longrightarrow CaR + Na_2SO_4$$

Where R is a complex silica-alumina anion Al_2Si_2O8 * n H_2O,
Na is a very active cation.
After the most part of sodium ions were used cationites were usually regenerated by tempering in NaCl solution where a reverse process took part:

$$CaR+2Na \longrightarrow Ha_2 R + Ca^{+2}$$

Regenerated cation can be used again for softening», To determine the hardness of water in Minsk City and Minsk Region we took water probes from water reservoirs mentioned in Table 1. The organoleptic properties of water did not meet standard requirements. For example, it was possible to see iridescent fuel oil or petroleum spots on the surface of the Svisloch River.

In order to determine water hardness three substances are used:

* the solution of trilon B having the concentration 0.5N;
* the buffer ammonia solution with pH= 9.5 + 10;
* the chromogen dark-blue indicator preliminary grinded to powder with KaCl in the proportion 10:100.

The analysis was made by titrimetric method based on measuring the solution's volume of the reagent with known concentration used, for the reaction with the given quantity of the substance to be determined.

100 ml of water under analysis was put into the conical Erlenmeyer flask, then 5 ml of buffer solution and 0.1g of the chromogen dark-blue indicator were added. The colouring of the solution obtained was crimson. Then slowly, drop by drop, the solution of trilon B was added by a burette untill the colouring was changed from crimson to blue. The quantity of trilon E used for the titration was determined, and also water hardness was determined from the equation:

$$X = \frac{W*0.05K*1000}{V}$$

where X— is water hardness 'in mg-equivalents

V -is the volume of the water sample taken for the analysis

K—is the coefficient, equalling 1.

W - is the volume of the trilon B

0.05 – is the concentration of the solition trilon B

The buffer solution keeps constant the value of hydrogen index pH=9.5-10 with the medium changing , the reaction going on more fully.

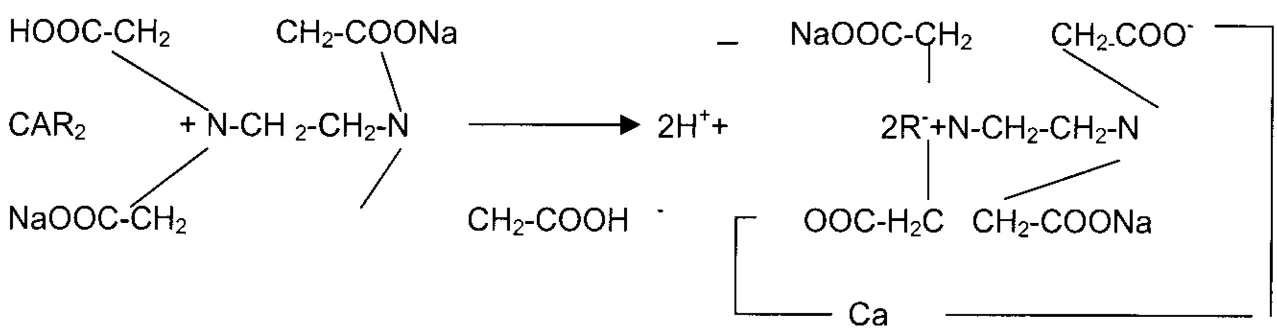
The structure of the dark-blue chromogen is very complicated, that is why it was presented as a complex combination H^+R^-. When dissolved in water this combination dissociated according to the equation:

$$H^+R^+ \rightarrow H^+ + R^-$$

In this case the anion R^- gives the solution blue colouring, but if water contains ions of calcium or magnesium then a complex combination CaR_2 of red wine colour is formed in the result of the following reaction:

$$Ca^{+2} + 2R^- \longrightarrow CAR_2 \text{ -wiiny-red}$$

However, this combination is not stable$_e$ During titration trilon B displaces the anion of chromogen dark-blue from the complex combination, thus forming more stable complex combination calcium ethelenediaminte-traacetic:



ethelenediamintetraacetic calcium

In the result of the reaction the anion *R"* moves into the solution in a free state, that is why the colouring is changed from winy-red to blue. The results of the research are presented in Table 1

Table1. The Research of change of water hardness depending on the season

№	The name of water reserviores	Hardness, mg-eq/ l	
		Spring	Autumn
1.	Komsomolskoye Lake	-	3.02
2.	Drozdy (water reservoir)	3.72	2.66

3.	Minsk Sea	4.22	3.77
4.	Ptich (water reservoir)	4.65	-3.45
5.	Svisloch River	5.32	3.37
6.	Tsnianka (water reservoir)	4.32	2.82
7.	Water supply of Minsk City	4.66	3.27

According to the chart, hardness of water is approximately twice higher in autumn than in spring* That is, obviously, because of flood water, which decreases the concentration of salts» On the other hand, the further from Minsk the smoother the curve falls, i«e» water hardness is decreasing. It can be explained by the fact that concentration of industrial plants throwing out the wastes, like calcium and magnesium salts, decreases. At a distance of 10 km from the Central Post-Office the hardness increases to a great extent: these are the districts of the Minsk Sea and Ptich River. As far as Ptich is concerned, it is because the place from where we took the probes is situated near the Keating Electric Station (Malinovka Region).

The Minsk Sea is the largest reservoir among the examined ones. Naturally, the flood water bring salts from the fields. On the other hand, the Svisloch River is the only biggest river which falls into the Sea at a very slow flow, resulting in accumulation of salts.

The Research of water hardness in the rivers of Belarus during 1985-1995 is submitted in the Table 2

Table 2. The average-annual concentration of water hardness in river waters of Pripyat and Dnieper.

Year	Pripyat		Dnieper	
	Spring	Autumn	Spring	Autumn
1985	415	371	505	424
1990	4.1	368	446	342
1991	481	359	4.2	385
1993	464	344	412	370
1995	458	338	401	300

It is known from literature that water is soft if its hardness is less than 4 mg-eq/1, so, although there are differences in hardness values both in time and space, but still water in Minsk reservoires and Minsk Region is soft.

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