STUDY ON WATER INTENDED FOR THE SANITARY DECONTAMINATION

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Abstract: *The object of the paper is the solid water. The water is a model pollution with calcium dichloride. We used complexonometric method to determine the hardness. We have analysed the amount of softener influencing the hardness of the water, which is used to decontaminate humans.*

Keywords: decontamination, *hardness*

1. Introduction.

The one of the basic parameter is a water hardness. The water hardness must be less than 12 mg-eq/l according to [1]. In the Bulgarian army for sanitary decontamination we are use DDA-3 and Sanijet C. 921 [3]. Hardness is most commonly expressed as milligrams of calcium carbonate equivalent per liter. Water containing calcium carbonate at concentrations below 60 mg/l is generally considered as soft; 60-120 mg/l, moderately hard; 120-180 mg/l, hard; and more than 180 mg/l, very hard [4]. Although hardness is caused by cations, it may also be discussed in terms of carbonate (temporary) and non-carbonate (permanent) hardness. Limescale builds up as soon as hard water flows through a pipe. Calcium in untreated water crystallizes into a sticky structure (1). These crystals adhere to each other, adhere to surfaces and immediately produce solid scale deposits that have a very destructive effect. Scale also particularly forms in warm areas such as on heating elements. The hotter the surfaces, the more scale will develop. On Fig. 1 there are different hardness water areas in Bulgaria.

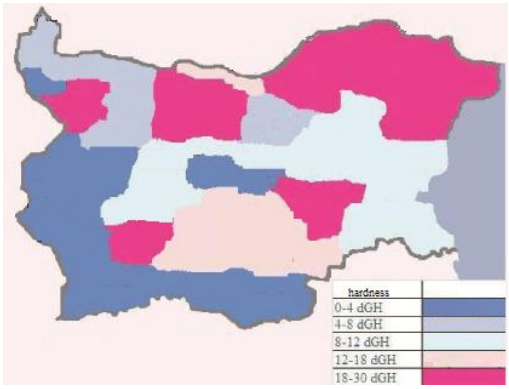

Fig. 1 *Hardness water in Republic of Bulgaria. [2]*

The water which we use for sanitary decontamination solution it enters the machines through a tank including another fluid-storing machine. Water softening is convenient to do before entering the decontamination machine, i. e. in the tank or by another machine for purification and softening.

The damaging effect that hard water can have means that it may be beneficial to soften the water. Methods for softening hard water involve the removal of calcium ions and magnesium ions from the water.

In [6-11] there are many methods for softening hard water, from which are conclusion:

- Chemical Precipitation;
- Nanofiltration (Membrane Filtration);
- Chemical Exchange;
- Electromagnetic method.

The purpose of this paper is study on quantitative impact of Na_2CO_3.

2. Measurement Methodology and Results.

Sodium carbonate, Na_2CO_3, is also known as washing soda. It can remove temporary and permanent hardness from water. Sodium carbonate is soluble but calcium carbonate and magnesium carbonate are insoluble.

The carbonate ions from sodium carbonate react with the calcium and magnesium ions in the water to produce insoluble precipitates. For example:

calcium ions + sodium carbonate → calcium carbonate + sodium ions

$Ca+(aq) + Na_2CO_3(aq) \rightarrow CaCO_3(s) + 2Na+(aq)$

The water is softened because it no longer contains dissolved calcium ions and magnesium ions. It will form lather more easily with soap.

Commercial water softeners often use ion exchange resins. These substances are usually made into beads, which are packed into cylinders called ion exchange columns. These can be built into machines, or plumbed into water systems to continuously soften the water. The resin beads have sodium ions attached to them. As the hard water passes through the column, the calcium and magnesium ions swap places with the sodium ions.

The calcium and magnesium ions are left attached to the beads, while the water leaving the column contains more sodium ions. The hard water is softened because it no longer contains calcium or magnesium ions. Some ion exchange resins use hydrogen ions instead of sodium ions.

About 11.3 million tons of Na_2CO_3 are produced annuallyand it is a cheap chemical agent. Sodium carbonate is a fairly strong, non-volatile base which is used in the manufacture of glass (55%), paper (5%), soap, and many other chemicals (25%). Sodium carbonate is also called soda ash and washing soda. Sodium carbonate is used in laundry detergents as a softening agent. The carbonate ions from dissolved sodium carbonate precipitate magnesium and calcium ions from hard water.

In our experiment we used a chemical method, because it will be practical convenient in sanitary decontamination. The softening water to mix we can use a circulating pump on another chemical machine, for example ARS-14. The chemical method for water softening with Na_2CO_3 we called regenerative method. The chemical process on water softening we show on the next paragraph:

$Ca(HCO_3) + Na_2CO_3 \rightarrow Ca\ CO_3 + 2\ NaHCO_3$

$Mg\ (HCO_3) + Na_2CO_3 \rightarrow Mg\ CO_3 + 2\ NaHCO_3$

$CaCl_2 + Na_2\ CO_3 \rightarrow CaCO_3 + NaCl$

$MgCl_2 + Na_2 CO_3 \rightarrow MgCO_3 + NaCl$

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The water softening in ARS-14 or another tank must be mix. When the solution is dissolved you have to wait a few hours to settle the particles on the bottom. The water hardness may use a different devices [12-15] as convenience hydro-chemical device from Bulgarian army.

The object of our study is "model system" in which are 2.5 % $CaCl_2$. The softening chemical is Na_2CO_3, in 0,5÷3 % concentrating range. The experiment was done in laboratory conditions.

Determination of the hardness of water before and after softening was performed by a complexometric method.

The analyzed water put on place 50 ml of in a flask. The 5 ml of ammonia buffer is added containing ammonium chloride and ammonia. We are add an epochrometer-T indicator to a purple color. After addition of the indicator, mixture is stirred vigorously. Titrate the sample with complex III to equivalent point (transition of color from violet to clear blue). The volume of the spent 0.1 n solution of the complex is read. Before the complexometric determination of hardness samples are filtered.

The water hardness (mg-eq/l) is calculated by (1):

(1) $$T=a.0,1.1000/V,$$

Where is: a - the amount of spent complex -III, ml; V is amount of solution, ml.

The results are showed on Fig 2.

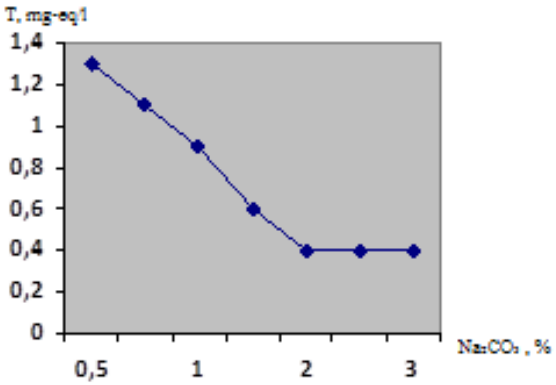

Fig. 2 *Dependence of hardness on quantity Na_2CO_3*

3. Conclusion

1) The optimal amount of Na_2CO_3 for water hardness in sanitary decontamination is concentrate range 0,5-25%.

2) The Na_2CO_3 better than 2% is not appropriate as it does not affect the further reduction of hardness.

3) The experimental data can be processed by software, a regression equation can be obtained that can be used to calculate the amount of Na_2CO_3 to soften water.

4. Bibliography

1. http://www.bds-bg.org/bg/bg/standard/?natstandard_document_id=12636.

2. https://omekotenavoda.alle.bg.

3. Sanijet C. 921. Service manual and operators' guide. 2002.

4. McGowan W. Water processing: residential, commercial, light-industrial, 3rd ed. Lisle, IL, Water Quality Association. 2000.

5. L. G. Knowlton. A new method for determination of water hardness. School science mathematics.Volume52, Issue6. 1952. pp 445-448

6. CONNORS, J.J.. Advances in chemical and colorimetric methods. J. Amer. Water Works Assoc. 1950. pp. 42:33..

7. Diehl, H., C.A. Goetz & C.C. Hach. The versenate titration for total hardness. J. Amer. Water Works Assoc. 1950. pp42:40.

8. Betz, J.D. & C.A. Noll. Total hardness determination by direct colorimetric titration. J. Amer. Water Works Assoc. 1950. pp 42:49.

9. Goetz, C.A., T.C. Loomis & H. Diehl. Total hardness in water: The stability of standard disodium dihydrogen ethylenediamine-tetraacetate solutions. Anal. Chem. 1950. pp 22:798.

10. Barnard, A.J., Jr., W.C. Broad & H. Flaschka. The EDTA titration. Chemist Analyst. 1957. pp 45:86 & 46:46.

11. Goetz, C.A. & R.C. Smith. Evaluation of various methods and reagents for total hardness and calcium hardness in water. Iowa State J. Sci. 1959. pp. 34:81.

12.http://inspectapedia.com/plumbing/Hard_Water_Measurement.php

13. https://www.hach.com/hardnessguide

14.http://www.ibcwater.com.au/zone_files/PDF/as0922mp-cl.pdf

15.https://www.unitedutilities.com/globalassets/documents/pdf/waterhardnessfactsheet_acc16.pdf