WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 7, Issue 1, January- 2026

INFLUENCE OF THE INSTALLATION'S TIGHTNESS AND THE POSITION OF THE ELECTRODES ON THE ELECTROLYSIS OF SODIUM CHLORIDE SOLUTION

B. Sh. Usmonov
A. G. Khamidov
A. A. Nabiev
I. T. Bozarov
Tashkent Institute of Chemical-Technology
E-mail: abdusamatxamidov1960@gmail.com .

Abstract

This article examines the impact of system tightness during the batch electrolysis of sodium chloride solution. The influence of parameters (temperature, duration, tightness) on the process of producing sodium hypochlorite in diaphragmless electrolysis of table salt solution is examined.

Keywords: Water disinfection, electrolysis, current density, active chlorine, hydrogen, sodium hypochlorite, tightness, cathode, anode, temperature, continuous, periodic.

Introduction

The most widely used method of water disinfection worldwide, using gaseous chlorine [1, 2], while being reliable (with a prolonged effect) and relatively inexpensive, raises concerns among experts and consumers regarding the environmental safety of its use [1–5]. The toxicity of chlorine, aggravated by the high concentration of the reagent, as well as the need to transport containers of chlorine through densely populated urban areas and subsequently store it at stations, usually located near residential areas, determine the high risks of its use.

Sodium hypochlorite (SHC) is a generally recognized alternative to gaseous chlorine as a disinfectant. It is a safe-to-handle, low-toxic, and easy-to-use reagent containing active chlorine.

Sodium hypochlorite can be obtained on-site by electrolysis of artificially prepared solutions of table salt or natural mineralized chloride waters.

The promise of the electrolytic method of water disinfection is due to its operational reliability, simplicity, and reasonable cost-effectiveness. To date, the principles of electrolytic disinfection of water containing bacteria and viruses have been studied in sufficient detail, electrolysis units have been designed, and their industrial production and use at water supply stations have begun. Typically, during the electrolytic decomposition of table salt, the solution environment is in the range of 10-11, which facilitates the interaction of chlorine with the alkali formed under these conditions. Electrolysis under these conditions produces chlorine forms identical in activity to the products present during the treatment of water with bleach [8].

While studying the electrolysis of table salt in a diaphragmless setup and searching for ways to produce sodium hypochlorite solution, we decided to build a sealed laboratory setup. We also wanted to study the effect of the setup's seal on the formation of highly concentrated sodium (potassium) hypochlorite in a batch mode.

Material and Methods

The determination of active (equivalent) chlorine in sodium hypochlorite solution was carried out based on the following standard method [9].

The method is based on the oxidation of potassium iodide with active chlorine to iodine, which is titrated with a specific sodium thiosulfate solution. To eliminate interfering influences (the presence of ozone, nitrites, iron oxide, etc. in the water), the solution samples are acidified with a buffer solution with a pH of 4.5.

Preparation of reagents

– 0.1 N sodium thiosulfate solution, dissolve the ampoule of fixanal in distilled water and bring the volume to 1 l;

– potassium iodide in crystals, 10 g of salt is dissolved in distilled water and the volume is brought to 100 ml;

– 0.01 N sodium thiosulfate solution, 100 ml of 0.1 N $Na_2S_2O_3$ solution are diluted with distilled water and the volume is brought to 1 l. The solution is used when the active chlorine content in the sample is more than 1 mg / l;

– 0.005 N sodium thiosulfate solution, 50 ml of 0.1 N $Na_2S_2O_3$ solution, brought to 1 l with distilled water, used when the active chlorine content in the sample is less than 1 mg/l;

– 0.5% starch solution, 0.5 g of soluble starch is mixed with 15-20 ml of distilled water, poured into 100 ml of boiling distilled water and boiled for 1-2 minutes;

– a buffer solution with pH 4.5, 102 ml of 1 M acetic acid (60 g of glacial acetic acid in 1 l of water) and 98 ml of 1 M sodium acetate solution ($CH_3COONa\ 3H_2O$ in 1 l of water).

Experimental part

The electrolysis of a table salt solution can be carried out in continuous (flow-through) or batch modes. Creating a laboratory setup for a continuous process requires complex, expensive equipment, so we decided to conduct the experiments in a batch setup. A 1-liter glass jar with a metal screw-on lid was selected for this purpose. After opening two holes in the lid, we passed electrical wires through, sealing them with silicone auto-sealant manufactured according to TU 20.17.10-016-58646534-2014, article number 11225-060. Two electrodes, measuring 3 x 7 cm with an area of 0.2 dm^2, were made from dense graphite and assembled into a block with an interelectrode distance of 5 mm. The exposed parts of the fasteners and wires were sealed with the same silicone sealant, and the block was immersed in a 25% sodium chloride solution. The electrodes in the cell were installed horizontally, and the lower electrode was connected to the positive pole (where molecular chlorine gas is formed and where maximum dissolution occurs in cool water (11-14 °C)). The electrolysis cell was placed in a 10-liter plastic bath with running water (10-11 °C) to maintain the required process temperature.

Results

Experiment No. 1, duration 1 hour, temperature at the beginning 15 °C, at the end 20 °C, current density 10 A/dm^2, $Na_2S_2O_3$ consumption – 2.8 ml, concentration of active chlorine $C_{A.X} = 4.96$ g/l.

Experiment No. 2 was continued for another hour at a temperature of 12 °C at the beginning and 18 °C at the end, with the consumption of $Na_2S_2O_3$ being 3.0 ml and the concentration of active chlorine $C_{A.X} = 5.31$ g/l. The setup with the sample was stored with a hermetically sealed lid in a water bath at 15-18 °C. After 24 hours, experiment No. 3 was carried out with this sample.

Experiment No. 3, duration 3 hours, temperature at the beginning 13 °C, at the end 20 °C, current density 10 A/dm^2, consumption of $Na_2S_2O_3$ - 5.3 ml, concentration of active chlorine $C_{A.X} = 9.39$ g/l. The setup with the sample was stored hermetically sealed in a water bath at 15-18 °C. After 24 hours, experiment No. 4 was carried out with this sample. In this case, the content of active chlorine was determined first, consumption of $Na_2S_2O_3$ - 5.0 ml.

No. of Experiments	Duration, hours	t_{start}, °C	t_{con}, °C	Consumption, ml $Na_2S_2O_3$	Loss of active chlorine during storage	With $_{A.H.}$, g/l	storage temperature, °C
1	1	15	20	2.8	2.8	4.96	
2	1	12	18	3.0	3.0	5.1	15-18
3	3	13	20	5.3	5.0	9.59	15-18

Discussion

1. Part of the formed chlorine, upon contact with water and sodium cations, turns into hypochlorite, and part of the chlorine gas and hydrogen gas are released onto the surface of the solution and will collect in the upper part of the unit, while chlorine gas, being heavier than hydrogen, will be located in the lower part of the mixture and will be maximally absorbed by the aqueous solution, increasing the formation of sodium hypochlorite in the solution.
2. In the upper part of the electrolysis unit, the maximum amount of gaseous hydrogen was collected above the solution and left the unit when the lid was opened to collect samples for active chlorine analysis.

Conclusion

To obtain maximum hypochlorites, the process of electrolysis of chloride solutions:

1. it is necessary to create conditions for the removal of hydrogen and for the absorption of chlorine by the reaction solution;
2. Place the electrodes horizontally, with the anode at the bottom and the cathode at the top;
3. create the maximum distance between the anode and the electrolyte surface.

References

1. Slipchenko A.V., Kulsky L.A., Matskevich E.S. Current state of water impurity oxidation methods and chlorination prospects // Water Chemistry and Technology. 1990. Vol. 12. No. 4. Pp. 326–349.
2. Tsinberg M.B., Mezhebovskaya G.P., Khamidullina F.F., Rakhal'skiy Yu.M. Modern methods of disinfection of natural waters // Gas industry. Information review. Series: Natural gas and environmental protection
Wednesday. M., 1990. 34 p.
3. Medvedev A.N. The use of chlorine – a reliable and safe basis // Water supply and sanitary engineering. 1995. No. 4. P. 30 – 32.

4. Shatalov A.A., Yagud B.Yu., Perevoshchikov V.Ya., Segal M.D.,
Koenig M. Safety when handling chlorine. Moscow, 2000. 324 p.
5. Yagud B.Yu. Experience of using chlorine, sodium hypochlorite, chlorine dioxide at foreign water treatment plants // Proceedings of the All-Russian seminar "Technique and technology for disinfecting drinking and waste water without using elemental chlorine". Moscow, 2008.
6. Fesenko L.N., Denisov V.V., Skryabin A.Yu. Water disinfectant – sodium hypochlorite: production, application, economics and ecology. Rostov n / D., 2012. 246 p.
7. Medrish G.L., Teisheva A.A., Basin D.L. Disinfection of natural and waste water using electrolysis. Moscow, 1982. 81 p.
8. Using Electrolyzed Solutions of Table Salt for Water Disinfection. D. K. Rakhimberdieva. Young Scientist. — 2017. — No. 23.2 (157.2). — P. 3-5.
9. GOST 18190-72. Drinking water. Methods for determining the content of active chlorine. Moscow, 1976. 7 p.