ADVANCED WASTEWATER TREATMENT TECHNOLOGY FOR NITRITES REMOVAL

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Abstract: The paper discusses an innovative wastewater treatment technology for nitrites removal with hypochlorite produced during electrolysis.

Keywords: advanced technology, wastewater treatment, nitrite ions, the electrochemical cell, the methods of purification, sodium hypochlorite.

1. Introduction

The main reason for high concentration of nitrite ions in water is the existence of sources of industrial and agricultural pollution. Contamination of drinking water, juices, wine and other liquids of nitrite ions as a result of improper use of nitrogen fertilizers has an adverse effect on living organism, because under the influence of enzymes nitrite ions in living organisms form high carcinogenic nitrosamines, and the interaction of nitrite ions from blood hemoglobin causes such toxicity that leads to disease cyanosis [1]. Therefore removal of nitrite ions from water has received increased attention.

One effective way of removing nitrite ions from wastewater is the oxidation of hypochlorites [2], however, this method has a serious drawback in that time working solutions of sodium hypochlorite decompose and lose their activity. These working solutions must be stored protected from light in special containers equipped with air vents for discharge of free oxygen. In addition, sodium hypochlorite can form resistant to biochemical oxidation of toxic chlorine by-products, which is a limitation to its use. An alternative process water treatment with sodium hypochlorite neutralization process of nitrite-containing wastewater is applied to nitrite-containing wastewater by hydrogen peroxide [3]. Lack of water from the purification of nitrite ions by hydrogen peroxide, the same as the method using hypochlorite. Hydrogen peroxide tends to rapid self-destruction.

These drawbacks of methods of water purification from nitrite ions with sodium hypochlorite or hydrogen peroxide are absent in the electrochemical method of water purification of nitrite ions, considered by G. Duca, and co-workers [4].

In this method, water is treated in an electrochemical cell with an insoluble anode for 3 - 10 minutes to restore the nitrite ions. After this treatment the water does not contain the reduction products of nitrite ions and the concentration of nitrite ions themselves reduced to the requirements of the MPC.

Table 1

Concentration of nitrite ions in the processing of natural water in an electrochemical cell with an insoluble anode. $C_{(NO3-)}$ = 45 mg/l; $C_{(NO2-)}$ = 41 mg/l; pH = 7,8; I = 1,2A.

№	t, min.	$C_{(NO3-)}$, mg/l	$C_{(NO2-)}$, mg/l	$\Delta C_{(NO2-)}$, mg/l	Reduction $C_{(NO2-)}$, %
Initial	0	45,0	41,0		
1	3	45,0	13,2	27,8	67,8
2	5	45,8	2,4	38,6	94,1
3	7	46,8	0,5	40,5	98,8
4	8	47,0	0,2	40,8	99,5
5	9	47,2	0,1	40,9	99,8
6	10	47,7	0	41,0	100

The disadvantage of this method is the fact that, along with an insoluble anode (carbon electrode) used soluble cathode metal (Fe, Al or Mg), which in this case is a consumable item.

2. Experimental

We offer the technology of water purification of nitrite ions consisting in the oxidation of nitrite ions with sodium hypochlorite to give him direct in containers with purified water by electrolysis of sodium chloride solution with the formation of active sodium hypochlorite

$$NaCl + H_2O = NaOCl + H_2.$$

Freshly NaOCl oxidizes immediately nitrite ions with the regeneration of sodium chloride

$$NaOCl + NaNO_2 = NaNO_3 + NaCl.$$

Thus, it is possible to remove from the wastewater nitrite ions with little or no cost of consumables (NaCl).

3. Results and discussion

Waste water from chemical plants vary considerably in contamination of nitrite ions. For example, in electroplating effluent content of nitrite ions is about 180 mg /l. In some industries acid content of nitrite ions in the effluent up to 1000 mg/l. Therefore, we prepared a wide range of model solutions of sodium nitrite containing 300 mg /l, 500 mg/l and 800 mg /l and 1000 mg/l. In the electrolysis of chloride solutions there is no separation of electrode products. This method allows to obtain sodium hypochlorite of sodium chloride solutions. In a simplified technology and, therefore, less costly equipment operation is the main advantage of the proposed method for producing sodium hypochlorite for the removal of nitrite ions. The effectiveness of the method depends on two factors: the parameters of electrolysis and the electrode material. We used graphite electrodes. Such plants do not have the shortcomings of the electrolysis using diaphragms. In the formation of sodium hypochlorite is no stage of chlorine gas and does not generate by-products (alkali), which require disposal.

Table 2

Parameters of electrolysis model solutions

Power supply frequency 50 Hz, V	220 + 22
The power consumed from the network, W	130
Constant current through the electrolytic cell, A	3+0,15 5+0,25
The voltage on the electrolytic cell at which rum provided the nominal value DC, V	
mode 5A	до 6,5
mode 3A	до 7,5
Time of the solution preparation (session)	6 min + 10 s 20 min +10 s
The nominal concentration of hypochlorite sodium, obtained in a given mode, mg / l	
3A, 6 min	350
5A, 6 min	600
3A, 20 min	870
5A, 20 min	1200

The resulting sodium hypochlorite reacts with sodium nitrite according to the equation

$$NaOCl + NaNO_2 = NaNO_3 + NaCl.$$

Based on the fact that at 69 mg $NaNO_2$ consumed 74.5 mg of NaOCl, we can conclude that the former received 350 mg /l NaOCl for 6 minutes at a current of 3A (see table) is sufficient to neutralize the nitrite ions in the first model mixture (300 mg /l). In the second case 600 mg /l NaOCl for 6 minutes at a current of 5A is sufficient to neutralize the nitrite ions of the second model mixture (500 mg /l). In the third case 870 mg /l NaOCl for 20 minutes at a current of 3A is sufficient to neutralize the nitrite ions in the third model mixture (800 mg / l). In the fourth case 1200 mg /l NaOCl for 20 minutes at a current of 5A is sufficient to neutralize the nitrite ions in the fourth model mixture (1000 mg /l). As a result, the analysis of solutions after the electrolysis of model mixtures in any of the samples was not observed the presence of nitrite ions.

4. Conclusions

Our proposed method of wastewater treatment of nitrite ions favorably with previously used methods, such as safety and cost of consumables.

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4. References

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