Asian Journal of Chemistry; Vol. 27, No. 5 (2015), 1599-1601

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2015.17384

Electrochemical Removal of Nitrogenous Compounds in Relation to Concentration of Chloride Ions of Micro-Polluted Water

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Received: 13 February 2014; *Accepted*: 12 June 2014; *Published online*: 20 February 2015; AJC-16851

Micro-polluted water was treated by electrochemical oxidation method in this work. When the plate distance was 1 cm and electrolysis time was 10 min, NaCl solution was added to the reaction equipment, which made the ratios of concentration of NH_4^+ and Cl^- were 1:1, 1:2 and 1:3, respectively. The removal effects on nitrogenous compounds of the change of the chloride concentration in the water by electrochemical method were investigated. The results revealed that the higher the chloride concentration in the water, the higher the removal rate to nitrogenous compounds, along with the increase of cell voltage, the removal rates of nitrogenous compounds increased too. Considering the power consumption per ton wastewater and other factors, the optimal running conditions of this experiment were the cell voltage 6 V and the ratio of concentration of NH_4^+ and Cl^- were 1:3.

Keywords: Electrochemical oxidation method, Nitrogenous compounds, Chloride ions, Cell voltage.

INTRODUCTION

Electrochemical oxidation technology developed in recent years environmental pollution control technology[1]. It has a simple equipment, high efficiency, no secondary pollution, both flotation, sterilization, *etc*.[2-6]. The applied research in water quality improvement in micro-polluted waterless.

Studies have shown that the solution in the presence of chloride ions, the electrochemical oxidation reaction is more likely to occur[7]. Because the loss of chloride ions in the anode water and a series of electron reaction produces chlorine gas, hypochlorous acid or hypochlorite and other active intermediate substances[8-10]. In view of this, we have by adding sodium chloride to the water, thereby increasing the chloride ion concentration in the solution, can enhance the effect of this electrochemical oxidation, especially a nitrogen-containing compound treatment effect is obvious[11,12]. The purpose of this experiment is to use an electrochemical oxidation process for micro-polluted water under the plate spacing and experience to take appropriate conditions of electrolysis time, by changing other operating parameters, so basically reached the final effluent key indicators "Surface Water Environmental Quality Standard" (GB3838 -2002) class III-IV water standards, NH_3-N removal rate of 50 %, TN ≤ 15 mg/L, to find the best process parameters electrochemical treatment of slightly polluted water while providing important for further engineering practice data reference.

EXPERIMENTAL

Electrolytic system: The electrolytic cell is made of Plexiglas made, net internal dimensions of 200 × 100 × 150 mm, the effective volume of 3000 mL, the anode electrode plate using Ti/RuO_2-IrO_2, a cathode made of stainless steel, the size L × B × H = 200 × 50 × 1 mm, a total of four pairs, plate spacing control 1 cm. Use MPS702 DC power supply (maximum voltage 36V, maximum current 30.7A).

Influent quality: The raw wastewater was collected from Wenyu river water in Beijing. The composition of the influent used in all experiments is shown in Table-1.

TABLE-1
CHARACTERISTICS OF THE WASTEWATER SAMPLE USED IN THE EXPERIMENTS

Parameter	Unit	Concentration
pH	-	6.5-8.0
Ammonia nitrogen (NH_3-N)	mg L^{-1}	19-35
Total nitrogen	mg L^{-1}	21-38
Turbidity	NTU	4.5-5.0

RESULTS AND DISCUSSION

Ammonia nitrogen and removal of total nitrogen: As shown in Figs.1 and 2, ammonia and total nitrogen removal rate with the increase of the voltage are significantly improved as NaCl dosing, because the voltage increases, the current density increases, electron transfer speed, speed is directly oxidized at the anode surface reactions occurring on speeding up, not in the case of adding NaCl, ammonia nitrogen and total nitrogen removal rate from the cell voltage of 4.1 % 6V at 3.1 % to groove when voltage is 69.6 % 11V and 53.1 %. However, it is clear that with the increase of the molar ratio of dosing, even at the same voltage, an increase of ammonia and total nitrogen removal is equally obvious. 4.1 % when the cell voltage is 6 V, ammonia nitrogen and total nitrogen removal were never dosing when NaCl solution, 3.1 % up to vote Gamon ratio of 1:3 at 50.2 and 45.6 %. With the cell voltage increases, this increase gradually decreases when the cell voltage is 1 V, the ammonia and total nitrogen removal rate never dosing 69.6 % NaCl solution at 53.1 % to investment ratio of 1:3 Gamon 73.5 and 59.8 %. This is due to the dosing of sodium chloride,

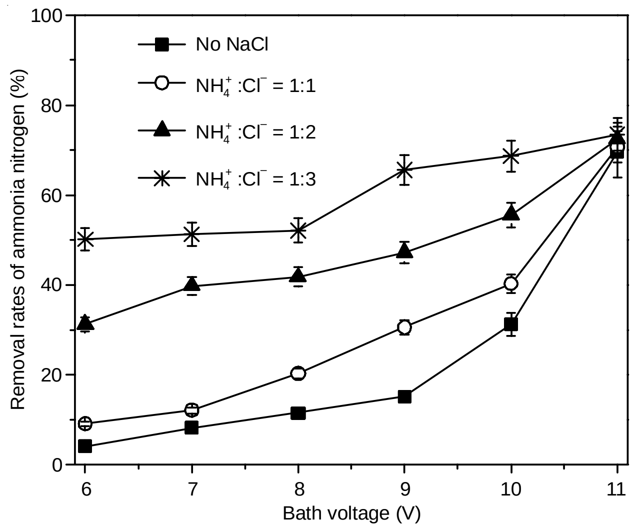

Fig. 1. Influence of ammonia nitrogen removal by dosing under different voltage

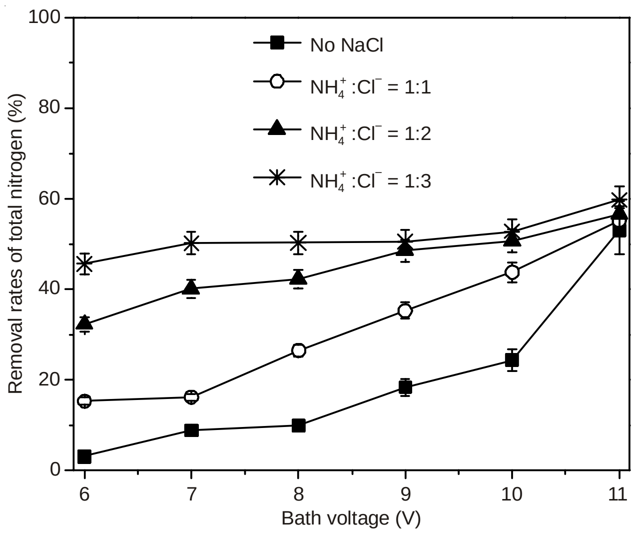

Fig. 2. Influence of total nitrogen removal by dosing under different voltage

so that the chloride ion concentration in the solution increased, chloride ions are oxidized to chlorine gas at the anode, such as hypochlorous acid or hypochlorite intermediate active substances that have strong oxidation resistance, thereby speeding up the rate of oxidation of the anode indirectly.

Nitrite nitrogen removal: As is shown in Fig. 3, when no NaCl dosing, as the voltage is increased nitrite significantly improved removal, from 6 to 11 V at 6.8 at 82.6 %, with the molar ratio increased dosing large, nitrite nitrogen removal is also significantly improved, as the voltage is 6V, dosing ratio of 1:1, nitrite nitrogen removal rate of 7.1 %, when the dosing ratio of 1:2, nitrite removal rate increased to 18.5 %, when dosing ratio of 1:3, nitrite nitrogen removal rate of 29.1 %; when the voltage increases to 11 V, the dosing ratio of 1:1, nitrite nitrogen removal rate was 82.8 %, when the dosing ratio of 1:2, nitrite nitrogen removal rate increased to 83.3 %, when dosing ratio of 1:3, nitrite nitrogen removal rate of 86.8 %. At lower voltages with increasing dosage ratio increased nitrite removal, when the voltage is increased to a large, nitrite removal general increasing trend, but relatively slow and the water match ammonia nitrogen, total nitrogen removal rate trends. It can be inferred during the electrolysis, the chloride ions can be added to produce a strong oxidizing agent such OCl^- water on the anode to indirect oxidation of nitrite into other forms of nitrogen, such that water is obtained representing nitrite completely removed.

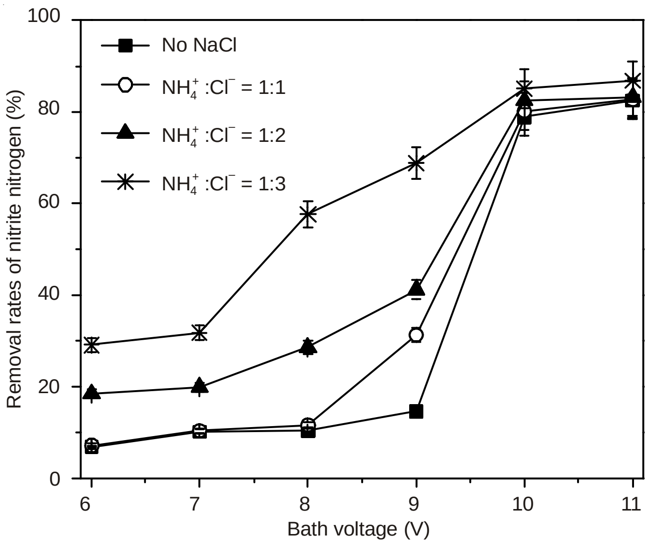

Fig. 3. Influence of nitrite nitrogen removal by voltage under different additive amount

Nitrate nitrogen removal: As is shown in Fig. 4, when no NaCl dosing, voltage increases as the concentration of nitrate nitrogen has significantly increased from the time of 6 V 1.1 mg/L to 11 V at 5.89 mg/L, with the molar ratio of dosing increases, the concentration of nitrate in the overall downward trend, such as the voltage of 6 V, dosing ratio of 1:1, the nitrate concentration of 1.33 mg/L, when the dosing ratio of 1:2, the concentration of nitrate nitrogen was 1.04 mg/L, when the dosing ratio of 1:3, the concentration of nitrate is 1.1 mg/L; when the voltage increases to 11 V when, l dosing ratio of 1:1, the concentration of nitrate is 5.07 mg/L, when the dosing ratio of 1:2, the concentration of nitrate decreased

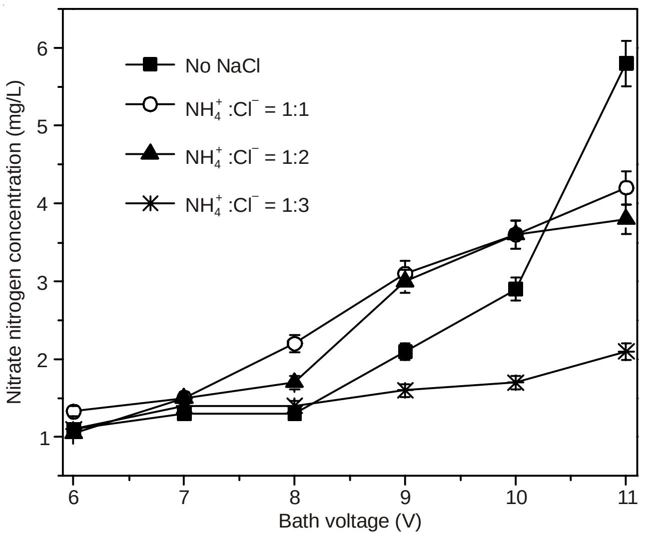

Fig. 4. Influence of nitrate nitrogen concentration by voltage under different additive amount

to 4.46 mg/L, when the dosing ratio of 1:3, the concentration of nitrate reduced to 3.03 mg/L; can be seen in the voltage lower, compared with the increase of dosing, the change is not obvious nitrate concentration.

Conclusion

In electrochemical oxidation process, NaCl solutions of different concentrations have a greater impact on the removal of major nitrogenous compounds. In the case of maintaining a certain voltage, NH_4^+ and Cl^- molar ratio of 1:3, Wenyu river water pollution index for each removal are better. When NH_4^+ and Cl^- molar ratio of 1:3, with increasing voltage, ammonia nitrogen and total nitrogen removal is also increasing, to determine the best value of the electrolysis voltage 6 V, under the process conditions, the ammonia removal efficiency of 50.2 % total nitrogen removal rate was 45.6 %, turbidity removal efficiency of 39.1 %.

ACKNOWLEDGEMENTS

The financial support of this research by Hebei Province Science and Technology Project (13273608), The Open Fund Project of State Key Laboratory of Coastal and Offshore Engineering (LP1209) and Hebei Construction Science and Technology Research Program (2013-143) are gratefully acknowledged.

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