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Electrochemical Advanced Treatment of Laboratory Wastewater Using Ti/Ru Electrodes

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Electrochemical oxidation was adapted to advanced treatment laboratory wastewater. The removal effect of major pollutants of laboratory secondary effluent was mainly investigated and the main chemical reaction path of the removal of organic matter and nitrogen compounds by electrochemical method was discussed preliminarily. The results showed that, after dosing NaCl the best removal ratio of chemical oxygen demand, NH_3-N, total nitrogen and total phosphorus was 84.4, 100, 90.9 and 81.2 %, respectively on the condition of different electrolysis time, constant current 5A, namely the current density 7.4 mA/cm^2 and the effect was better than that without NaCl. The removal ratio of major pollutants was higher after dosing NaCl, namely they were removed faster by electrolysis in the case that other experimental conditions remained unchanged. Comprehensive consideration of power consumption suggested that the best operation condition was of definite salt concentration, constant current 5A, namely the current density 7.4 mA/cm^2 and electrolysis time 0.5 h.

Keywords: Electrochemical method, Electrolysis time, Sodium chloride solution, Chemical reaction path.

INTRODUCTION

High-tech enterprises, research institutes and universities and other scientific experiments carried out more and more common, range more widely, laboratory wastewater discharges from the lab complex composition relative to other wastewater discharge water and discharge water with uncertain , dynamic, characterized by poor reproducibility[1-3]. For laboratory wastewater treatment consists of pretreatment and consolidated. It includes pretreatment flocculation precipitation, redox and precipitation, activated carbon adsorption, organic chemicals purification, distillation, ion exchange, *etc*.[4-8]. Comprehensive treatments contain activated sludge and ozone disinfection and artificial wetlands law. However, these methods have a high cost, large area and other shortcomings unstable treatment effect[9]. The electrochemical oxidation method is a new water treatment technology recently developed, with small footprint, easy to control and no secondary pollution, *etc*. and it had been applied in many areas of water treatment[10-12].

The purpose of this experiment is to use electrochemical oxidation depth processing laboratory wastewater treatment plant effluent, wastewater treatment plant effluent coming processed through electrolysis device for in-depth treatment, according to the experience of taking the current conditions where appropriate, to identify electrochemical method to deal with such when the optimum parameters of wastewater, providing an important reference data for further engineering practice.

EXPERIMENTAL

Electrolytic system: Electrochemical test device consists of cell, the electrode plate and the DC power supply components. It was made of plexiglass cell, its specifications length × width × height 140 mm × 90 mm × 130 mm, the effective volume of about 1.6 L. Is titanium anode electrode plate to the substrate and after new electrode plates made Lr, Ru, Cs and other precious metals nano-coating process; cathode electrode plate for the plate. Each plate size length × width 130 mm × 65 mm, thickness of 1 mm, 2 pairs, four plates, plate spacing 1 cm, anode area ratio of 1:1. DC power supply: the model for the MPS702, the maximum output voltage is 36 V, maximum current of 30.7 A, the slot can be a constant voltage and constant current regulation.

Influent quality: In this study, the raw water is taken from the wastewater treatment plant laboratory secondary effluent discharge, after the wastewater treatment station hydrolysis acidification tank, biological contact oxidation pond and inclined plate sedimentation tank, the water quality of secondary effluent discharged as shown in Table-1.

In this study, the electrochemical reaction device directly was applied to raw water electrolysis. During the experiment,

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

Parameter	Unit	Concentration
pH	–	6.5-8.0
Chemical oxygen demand (COD)	mg L^{-1}	35-55
Ammonia nitrogen (NH_3-N)	mg L^{-1}	0.7-1.5
Total nitrogen (TN)	mg L^{-1}	9-20
Conductivity	ms cm^{-1}	1.5-1.8

a constant current, plate spacing of 1 cm, at the same current density, electrolysis time and whether changes in dosing electrolytes and other conditions, to understand and analyze the electrochemical device for secondary effluent treatment law.

RESULTS AND DISCUSSION

Removal of chemical oxygen demand: In this experiment, under the first constant current of 5A, *i.e.*, when the current density of 7.4 mA/cm^2, direct electrolysis using the electrode plate. Under the same conditions, adding a certain amount of NaCl solution at different sampling time of electrolysis, water treatment regarding the removal of chemical oxygen demand was measured (Fig. 1).

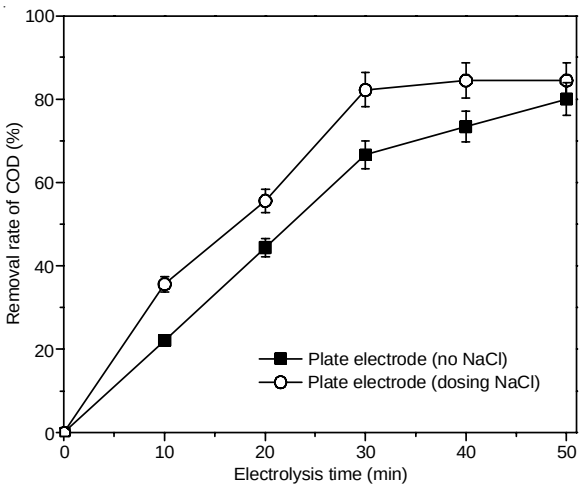

Fig. 1. Removal of chemical oxygen demand when the electric current was constant with prolong electrolysis time

As is shown in Fig. 1, when a constant current of 5A, *i.e.*, a current density of 7.4 mA/cm^2, the plate electrode, the electrode plate cast after removal of the salt significantly chemical oxygen demand, wherein the electrolysis of water directly to the plate electrode chemical oxygen demand removal of up to 80 %, while the salt flat electrode vote after removal of chemical oxygen demand up to 84.4 %; and chemical oxygen demand removal of the plate electrodes are with the extension of the electrolysis time increases. In this experiment, when the electrolysis time is less than 0.5 h, flat electrode chemical oxygen demand removal of wastewater is increasing rapidly and when more than 0.5 h after electrolysis, increases slowly chemical oxygen demand removal. Can be drawn from the above results, the flat electrode chemical oxygen demand removal in wastewater significantly, this may be due to the electrode plates inspired by the electrolysis with strong oxidizing activity $^{\bullet}OH$, H_2O_2, (O), O_3 and other organic pollutants in wastewater compounds into simple oxides reached after removal purposes; may have some organic matter is directly oxidized at the anode; Further , the cell may also be due to the reduction of dissolved oxygen to produce H_2O_2 oxidation of organic matter. As the electrolysis time after 0.5 h, the ability to produce strong oxidizing electrode material to reach the relative limit, reducing the strong oxidizing substances, prompting the oxidation of organic matter significantly slower. Further, the high efficiency of the electrolysis electrode plate after the plate electrode salt unsalted significantly higher than that in the electrolysis time 0.5 h the plate electrode after removal of the salt substantially reached the chemical oxygen demand maximum value of plate electrodes without salt chemical oxygen demand removal rate is still slow increase in after 0.5 h, indicating that the addition of a quantity of salt solution to the waste water to be treated. The conductivity of the electrolyte increases, the electrode catalytic activity is rapidly stimulated plate, making it the degradation of organic matter in wastewater speed obviously improved, so that not only protects the removal, but also saves energy.

Removal of nitrogenous compounds: At this stage, it remains constant current of 5A and when the current density of 7.4 mA/cm^2, direct electrolysis using the electrode plate and under the same conditions, adding a certain concentration of NaCl solution and the electrolysis time in different samples, the effect of the treatment water was measured and the removal of NH_3-N and total nitrogen is shown in Fig. 2.

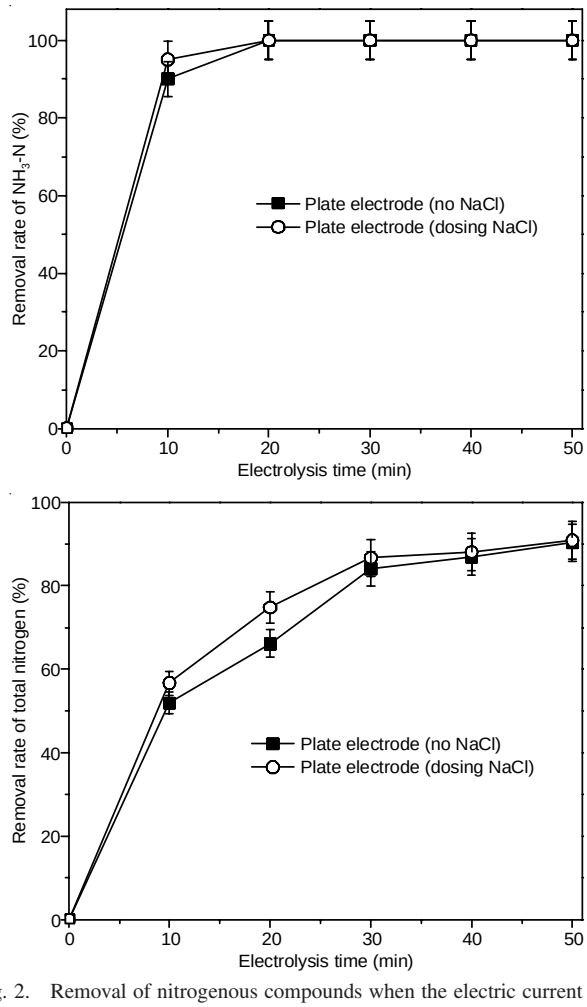

Fig. 2. Removal of nitrogenous compounds when the electric current was constant with prolong electrolysis time

As shown in Fig. 2, when a constant current of 5 A, a current density of 7.4 mA/cm^2, the plate electrode, the electrode plate cast after removal of the salts of NH_3-N and total nitrogen obvious. As the wastewater treatment plant effluent NH_3-N content is very low, in which the waste water electrolysis plate electrodes directly on the NH_3-N and cast salt flat electrode after removal of NH_3-N maximum of 100 %. In addition, flat electrode electrolysis wastewater directly highest removal efficiency of total nitrogen was 90.3 %, while the flat electrode cast after salt removal rate of total nitrogen was 90.9 %, that total nitrogen concentration of 1.16 mg/L. And flat electrode containing with the removal of nitrogen compounds is to increase the electrolysis time. In this experiment, because the ammonia content in wastewater is small, so the time was 20 min after electrolysis, NH_3-N basically been removed, but in the 10 min when comparing the treatment effect, the flat electrode is significantly higher than after salt unsalted plate electrode, which shows the cast after the salt water, wastewater electrolytic conductivity increased significantly, so to speed up the rate of $^{\bullet}$OH generating electrode plate and other strong oxidizing substances. Therefore, NH_3-N can be more after removal of fast oxidation. In addition, the electrolysis time 0.5 h, the plate electrode and cast the salt flat electrode after removal of total nitrogen basically reached the highest value and the first 0.5 h, the removal rate changed significantly, while at 0.5 h after removal only slowly increasing. This shows that in the electrolysis time 0.5 h when activated ion conductivity relative limit is reached, the treatment rate of nitrogen compounds also reached the relative limits, under constant current conditions, the electrochemical method with removal of nitrogen compounds is still relatively high.

Conclusion

According to the experimental results, the best operating conditions is determined from this experiment. NaCl solution under conditions of adding a certain amount, when constant current of 5A, *i.e.*, a current density of 7.4 mA/cm^2, the electrolysis time of 0.5 h. Experimental results show that the processing efficiency of the salt flat electrode vote on all major pollutants higher than throw salt flat electrodes.

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