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NOTE

Chemical Organics Removal Through Combination of Constructed Wetland and Electrolytic System

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In this study, secondary effluent of wastewater treatment plants in Tangshan area was used. Horizontal zeolite wetland was carried out treating it. Zeolite wetlands showed different behaviours for nitrogen removals. Under the optimum hydraulic loading rate, the primary pollutions were removed to a large extent. Meanwhile, electrochemical oxidation was adopted to advancedly treated secondary effluent of wastewater treatment plants. The removal effect of major pollutants of constructed wetland effluent was mainly investigated and the main chemical reaction path of the removal of organic matter by electrochemical method was discussed preliminarily. The results showed the best removal ratio of organics matter was 58.2 % after dosing NaCl on the condition of different electrolysis time and constant current 5A (namely the current density 7.4 mA/cm^2).

Key Words: Horizontal zeolite wetland, Hydraulic loading rate, Primary pollutions removal rates.

Secondary effluent of wastewater treatment plants is further treated exiguously. In most instances, the effluent is direct discharge to rivers and it will bring about river pollutions marginally. Thus, the secondary effluent of wastewater treatment plants is necessary to be treated to reduce any possible impacts on rivers.

Constructed wetlands for wastewater treatment have been extensively applied in many fields, including municipal wastewater[1], ground surface polluted water[2], farm dairy wastewater[3], oilfield drainage[4] and eutrophic aquaculture wastewater[5]. Constructed wetlands is an aquatic ecosystem mainly composed of plants, microbes and substrate. With the coordination of these components, the constructed wetlands can work smoothly and achieve optimum purification capability[6-8]. Hydraulic loading rate, a key operational condition of constructed wetlands, has a significant effect on chemical pollutant removals.

Electrochemical oxidation treatment of water is a relatively new type of water treatment technology, which gradually develops into a very promising technology. Because of easy controlling, lesser floor areas and no secondary pollution, it has been successfully applied in the purification of wastewater from many field of water treatment[9-12]. In addition, certain research experience to micro-polluted water using electrochemical method has been gained in the past several years. The experience proved that the method had great removals to organics.

Electrolytic system: A laboratory batch electrochemical oxidation reactor was designed and constructed. The electrolytic cell was made of synthetic glass, with a dimension of 140 × 90 × 130 mm and the dimensions of the electrodes were 130 mm × 65 mm × 1 mm. During electrolysis, the current density was adjusted by using a DC power supply (MPS702). The reactor consisted of an undivided cell made of synthetic glass with a cathode and anode arranged in parallel. Stainless steel plates were used as cathodes while, horizontal Ti/Ru/Cr plates acted as anodes. The electrodes were arranged in the electrochemical cell of 1 L working value.

Analytical methods: Parameters such as soluble COD and pH were monitored. Samples were collected once everyday when steady state conditions were achieved. In this experiment, intermittent flow was adapted in both the systems and they continuously run for 69 days and 3 days is one cycle, namely, the hydraulic loading rates were 0.278 m^3/(m^2·d), 0.139 m^3/(m^2·d), 0.093 m^3/(m^2·d), respectively. In addition, the optimum hydraulic loading was ensured according to the average removals of nitrogen and phosphorus under different hydraulic loading rates. The experimental constants in electrolytic contaminants degradation were interelectrode distance, current density and initial Cl^- concentration. The concentration of NaCl solution was 5 mol/L, the dosing ratio was 8 mL/h. And the removals of contaminants were changed at a time while the others were kept constant of definite salt concentration, the current density 7.4 mA/cm^2 and interelectrode distance 1 cm.

Influent quality: The raw wastewater, secondary effluent of wastewater treatment plants, was collected from wastewater treatment plant in Tangshan. The composition of the influent used in all experiments is shown in Table-1.

TABLE-1
CHARACTERISTICS OF THE TWO SYSTEM INFFLUENT

	Parameter	Unit	Concentration
Constructed wetland influent	pH	-	6.5-8.0
	Chemical Oxygen Demand(COD)	mgL^{-1}	92-155
Electrolytic system influent	pH	-	7.2
	Chemical Oxygen Demand, COD	mgL^{-1}	21.90

COD removal: As shown in Fig. 1, under different hydraulic loading rate, the removals to COD in horizontal zeolite wetland system were obvious, but also have certain regularity, that gradually decreased as the hydraulic load, the system gradually increased the removal rate of COD. When the hydraulic loading of 0.278 m/d, the wetland system effluent of COD the removal rate was maintained at the range 21.1 to 79.4 %, seen that the more volatile; and when hydraulic loading reduced to 0.093 m/d when wetlands of the water concentration range of COD decreased to 9.26 to 30.96 mg/L, the removal rate range is increased to 53.7 to 85.3 %.

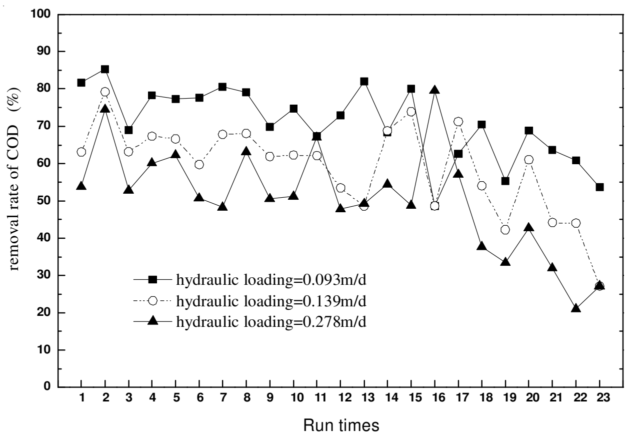

Fig. 1. Removal effect on COD in horizontal zeolite wetland under various hydraulic loading

Advanced removals of COD with electrochemical method: As shown in Fig. 2, when current density was 7.4 mA/cm^2 and the interelectrode distance was 1 cm, the COD was removed remarkably. Among other things, the removals of COD with direct electrolysis were lower than the dosing NaCl solution. And the minimum concentration of COD was 9.16 mg/L, which could satisfy the environmental quality standards for surface water to full advantage. In addition, the removals of the electrolytic oxidation of COD increase generally with the retention time. Fig. 1 also showed the oxidizing ability of electrodes attained the relative limit when the electrolysis time was 0.5 h. At that time, the reduced oxidizability substances made the oxidation rate slacken remarkably, so the removals of COD increased tardily. The results indicated that conductivity could increase after dosing NaCl solution in solution and catalytic activity of electrodes was stimulated quickly, which made the removals of COD increased remarkably. The processes not only ensured the removal effects, but also saved the energy consumption.

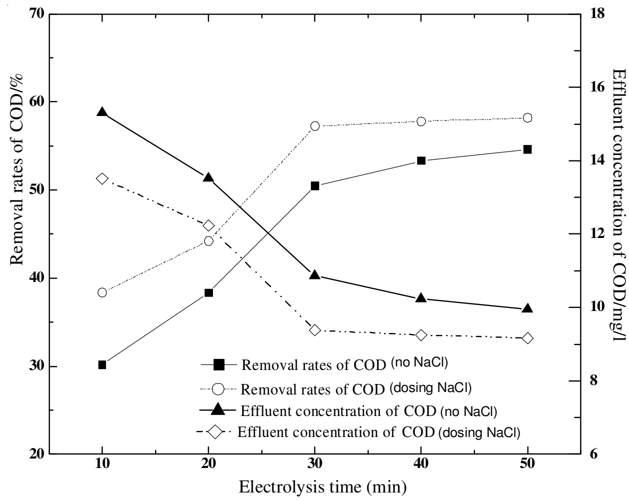

Fig. 2. Removal effect of COD was showed when the electric current was constant with the electrolysis time

In summary, zeolite wetlands showed different behaviours for organics, nitrogen and phosphorus removals. Under the optimum hydraulic loading rate of 0.093 m^3/(m^2·d), the primary pollutions were removed to a large extent. The experimental results indicated that the best operating condition was of some salt solution, the current density 7.4 mA/cm^2 and electrolysis time 30 min. In addition, the removals of contaminants with direct electrolysis were lower than the dosing NaCl solution.

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