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The Method of Electroplating Wastewater Treatment and the Comparison of Adsorption Materials

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Abstract: *In this study, the chemical method was used to treat electroplating wastewater by chemical method and biological method, and the hydrogen-catalytic oxidation method was used for pretreatment of cyanide wastewater. For the selection of adsorbent materials containing lead wastewater pretreatment, the method of using a single factor experiment exploits the amount of investment, initial concentration, adsorption time on the adsorption amount and the adsorption rate, and the results showed that when the dosage was 0.5 g L^{-1}, the adsorption rate of platycladus orientalis bark to Pb^{2+} was 88.41%,which was the highest compared with other adsorption materials; when the initial concentration is large, the lateral cerridge maintains a high adsorption amount and reaches 51.39 mg g^{-1}. This value is significantly higher than other materials that have been reported, such as constituents, walnuts, etc. The adsorption time reaches the adsorption balance after 30 min. The platycladus orientalis bark exhibits the best adsorption in the end.*

Keywords: *Electroplating wastewater, Sewage treatment, Adsorption, Single-factor experiment*

1. Introduction

The wastewater produced by electroplating plant usually contains chromium, copper, nickel, lead and other heavy metal ions, which have the characteristics of complex pollution components, great harm and difficult to control [1]. If it is not properly disposed of, it will pose a serious threat to the ecological environment and human existence.

Electroplating wastewater can be divided into pretreatment wastewater, cyanide wastewater, chromium wastewater and nickel wastewater according to the difference of its nature. At present, a variety of mature and widely used technologies have been developed for electroplating wastewater treatment. Zhou Rongzhong[2] et al. designed an combined process technology model of acid-base neutralization precipitation to membrane separation to oxygen membrane bioreactor to reverse osmosis for the wastewater from a company containing copper acid, cyanide, nickel, silver and comprehensive electroplating in Jiangxi province. Chen Jianhao [3] took electroplating wastewater in the workshop of a sanitary company in Guangdong as the object, and designed the physical and chemical pretreatment system - biochemical system - membrane concentration system - evaporation system as the main process technology to achieve zero discharge of electroplating wastewater. Since the large fluctuation of electroplating wastewater quality and the complexity of its composition, a variety of processes are usually combined to achieve the effluent standard. In general, the current electroplating wastewater treatment process has a good effect, but its treatment cost is high, so its cost performance needs to be improved.

The common treatment methods of electroplating wastewater include electrolysis method, chemical method, membrane separation method, ion exchange method and biological method [2].

Electrolysis refers to the electrochemical reaction of wastewater under the action of external current, so as to remove pollutants and purify wastewater [4]. It has high removal efficiency, simple operation and does not produce secondary pollution [5], but it has large investment, high cost of electrolysis equipment and large amount of electric energy consumed by equipment operation. Similarly, although the membrane separation method has high removal efficiency and strong stability, the production cost of the membrane is usually high and the application range is limited. Chemical method refers to the chemical reaction between the target pollutant of wastewater and the substance through the addition of some chemical substances, so as to change the chemical properties of the target substance, and finally remove the substance through precipitation or convert it into non-toxic and harmless substances [7]. It has high removal efficiency, wide application range and good selectivity, low investment cost and simple management and maintenance process [8]. Biological method means that organisms use their own

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chemical structure and composition characteristics to adsorb heavy metal ions, or flocculate and precipitate pollutants under the action of organisms or their metabolites. Microorganisms and plants are usually non-toxic, convenient and safe. They produce less sludge and generally do not cause secondary pollution to the environment. The cost is very low and there is no need to add chemicals or conditions such as high temperature and high pressure [9].

The influent quality of electroplating wastewater selected in this study has the characteristics of large fluctuation of water volume, high concentration of heavy metals and high organic load. Considering the engineering cost and application site, as well as the problems of economy and treatment effect, the target wastewater is treated by the combination of chemical method and biological method.

After determining the treatment method, pretreatment needs to be considered. For the pretreatment of cyanide containing wastewater, alkaline chlorination is a commonly used treatment process. Under alkaline conditions, chlorine oxides are used to oxidize cyanide into less toxic cyanate (CNO^-), which is then decomposed into non-toxic carbon dioxide and nitrogen. Ozone oxidation method uses the oxidation property of ozone to oxidize cyanide into cyanate, and then further oxidize into bicarbonate ion and nitrogen. Hydrogen peroxide catalytic oxidation method is also widely used. Under the catalysis of copper ion, hydrogen peroxide oxidizes free cyanide and its complex into nitrite and carbonate ions. It has no pollution to the environment, less sludge output and low operation cost. Considering the advantages and disadvantages of the three processes, hydrogen peroxide catalytic oxidation method is selected for the pretreatment of cyanide containing wastewater.

For the pretreatment of lead containing wastewater, adsorption method, as an efficient method to remove heavy metals from polluted water, has the advantages of low cost, simple operation and large treatment capacity [11]. Inorganic adsorption materials and polymers containing Pb2+ are commonly used in wastewater treatment [12].

Because biomass material has the advantages of low cost, easy access and green, it has become an adsorption material with broad prospects [13]. Bark is rich in lignin, tannin, cellulose and other substances as well as hydroxyl, carboxyl and other functional groups [14]. Previous studies have shown that cedar bark has a certain adsorption efficiency for Cu2+ [15], so bark may be a potential and effective heavy metal ion adsorption material.

In this study, bark was selected as the material for shock adsorption of Pb^{2+} in simulated electroplating wastewater. By single factor experiments on dosage, initial concentration and adsorption time, the best adsorption material was obtained, which aims at selecting better adsorption materials for the pretreatment of lead containing wastewater in electroplating wastewater and achieve better treatment effect.

2. Materials and method

2.1. Main experimental materials

The bark of Platycladus orientalis, Broussonetia Papyrifera, Juglans regia and Ailanthus altissima were selected from four self-studied bark materials. Lead chloride (analytical pure) was purchased from Shanghai Macklin Biochemical Co., Ltd.

2.2. Main instruments and equipment

Electronic analytical balance (Shanghai Jingkong Science Co., Ltd.); Thermostatic oscillator (Harbin Donglian Electronic Technology Co., Ltd.); Atomic absorption spectrophotometer (Shimadzu company of Japan); Precision pH meter (Shanghai Precision Scientific Instrument).

2.3. Experimental method

1) Influence of dosage on adsorption effect

Take 50 mg/L Pb^{2+} solution into conical flasks, and add 4 kinds of bark adsorption materials 0.5 g $Ł^{-1}$, 1.0 g $Ł^{-1}$, 2.0 g $Ł^{-1}$, 4.0 g $Ł^{-1}$, 8.0 g $Ł^{-1}$ respectively, then shock adsorption under the same conditions in a shaking table for 1 h, after filtration, determine the concentration of Pb^{2+}. The adsorption capacity and adsorption rate of Pb^{2+} were obtained.

2) Influence of initial concentration on adsorption effect

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Take Pb^{2+} solutions with initial concentrations of 30 mg L^{-1}, 40 mg L^{-1},50 mg L^{-1}, 80 mg L^{-1} and 100 mg L^{-1} respectively into the conical flasks, add the same amount of four kinds of bark adsorption materials into the conical flasks, shake and adsorb in a shaking table under the same conditions for 1 h, and measure the concentration of Pb^{2+} after filtration to obtain the adsorption capacity and adsorption rate of Pb^{2+} under different initial concentrations.

3) Influence of adsorption time on adsorption effect

Take 100 mg L^{-1} Pb^{2+} solution into a conical flasks, add the same amount of four kinds of bark adsorption materials, shake and adsorb for 0.5 h, 1.0 h and 2.0 h respectively under the same conditions in a shaking table, and measure the concentration of Pb^{2+} after filtration to obtain the adsorption capacity and adsorption rate of Pb^{2+} under different adsorption times.

3. results and discussion

3.1. Influence of different dosage on adsorption effect

The amount of Pb^{2+} adsorbed by the four tree bark adsorbents decreased significantly with the increase of dosage (Fig. 1a). When the dosage was 0.5 g L^{-1}, the Pb^{2+} adsorption capacity of Platycladus orientalis bark was 79.61 mg g^{-1}, which was significantly higher than that of the other three kinds of bark ($P < 0.05$); The adsorption capacity of Ailanthus altissima bark was the lowest, only 58.34 mg g^{-1}. When the dosage increased to 8.0g L^{-1}, there was no significant difference in their adsorption capacity of Pb^{2+} ($P > 0.05$), which fluctuated around 5mg g^{-1}. The adsorption rate of Pb^{2+} by the four tree bark adsorbents showed the same trend, that is, it increased with the increase of dosage (Fig. 1b). When the dosage was 0.5 g L^{-1}, Platycladus orientalis bark (88.41%) had a higher adsorption rate of Pb^{2+}, which was significantly higher than that of other bark adsorption materials ($P < 0.05$); The adsorption rates of walnut and Broussonetia papyrifera were similar, both about 70% ($P > 0.05$); Ailanthus altissima bark was the lowest, only 45.40%.

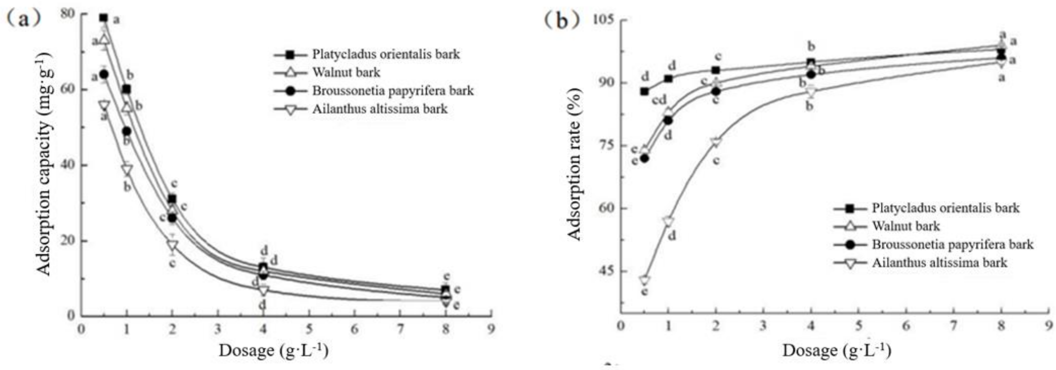

Figure 1: Effect of adsorbent dosages on the adsorption efficiencies of Pb^{2+}

3.2. Influence of different initial concentration on adsorption effect

The adsorption capacity of Pb^{2+} by the four kinds of bark increased with the increase of the initial concentration of simulated wastewater (Fig. 2a). When the initial concentration of simulated wastewater is low ($C_{Pb}{}^{2+} < 50$ mg L^{-1}), there is no significant difference in the adsorption capacity of various bark to Pb^{2+}($P > 0.05$). The residual Pb^{2+} concentration in the adsorbed wastewater is very low, and the lowest is only 0.0785 mg L^{-1}, indicating that they have relatively complete adsorption of low concentration Pb^{2+}. When the initial concentration of simulated wastewater was large ($C_{Pb}{}^{2+} = 100$ mg L^{-1}), the adsorption capacity of Pb^{2+} by various bark was significantly different ($P < 0.05$), and the adsorption capacity of Platycladus orientalis bark remained high, up to 51.39 mg L^{-1}.

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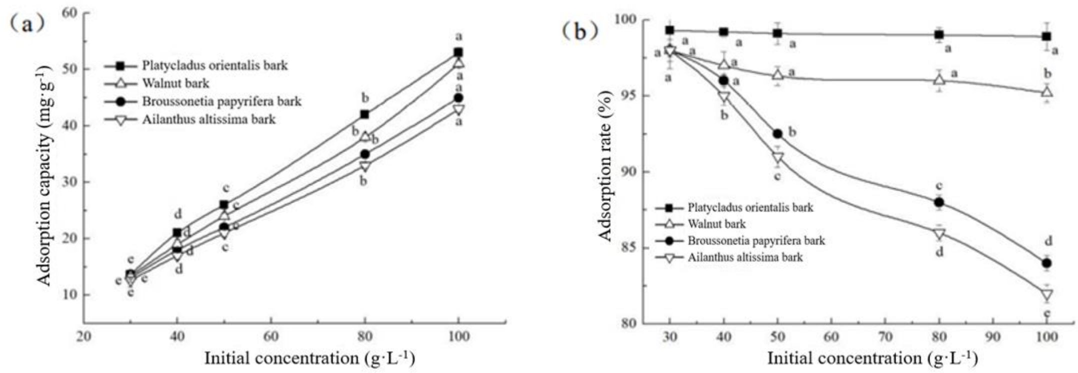

Figure 2: Effect of initial concentrations of simulated wastewater on the adsorption efficiencies of Pb^{2+}

In contrast to the change of adsorption capacity, the adsorption rate of Pb^{2+} by the four bark decreased with the increase of the initial concentration of simulated wastewater (Fig. 2b). When the initial concentration of simulated wastewater was low ($C_{Pb}^{2+} < 50$ mg L^{-1}), the four tree bark had high adsorption rate, and the adsorption rate of lateral cypress bark to Pb^{2+} was up to 99.7%; With the increase of Pb^{2+} concentration in the solution, the adsorption rate decreased significantly ($P < 0.05$), but Platycladus orientalis had high adsorption rate in low concentration and high concentration Pb^{2+} polluted wastewater, and the adsorption efficiency in high concentration wastewater was significantly better than that of the other three kinds of bark ($P < 0.05$).

3.3. Influence of different adsorption time on adsorption effect

In this study, the prolongation of adsorption time had no significant effect on the adsorption efficiency of bark adsorbents on Pb^{2+} ($P > 0.05$, FIG. 3a and 3b), and the adsorption capacity and adsorption rate remained at a high level. It shows that there is a rapid adsorption process of Pb^{2+} by bark adsorbents within 0~30min, and the adsorption equilibrium has been reached after 30min, and the adsorption capacity and adsorption rate will not change significantly. In conclusion, Platycladus orientalis bark adsorbent can be used as adsorbent in the pretreatment section of wastewater containing Pb^{2+}.

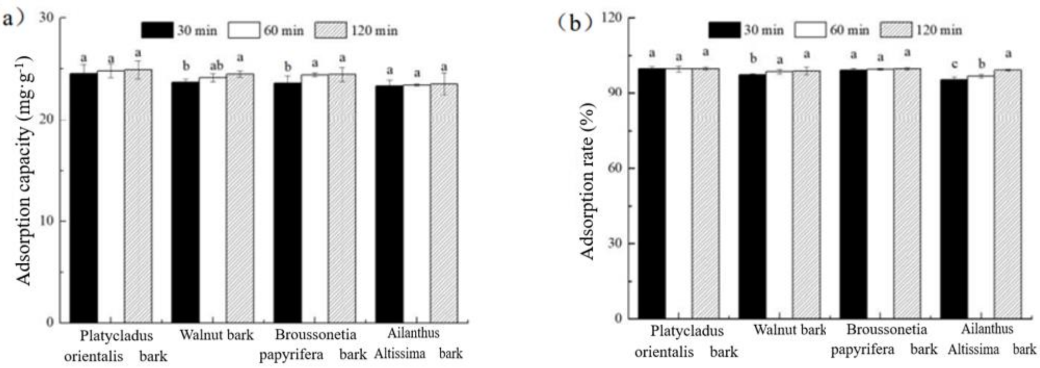

Figure 3: Effect of reaction times on the adsorption efficiencies of Pb^{2+}

Based on the above analysis and discussion, this paper conducted a single factor experiment on the pretreatment of lead containing wastewater in terms of dosage, initial concentration and adsorption time. The adsorption capacity of the four materials decreased with the increase of dosage, increased with the increase of initial concentration, the adsorption rate increased with the increase of dosage and decreased with the increase of initial concentration, and the influence of adsorption time was not significant, However, the effect of Platycladus orientalis is always better than the other three, so it is concluded that Platycladus orientalis is the best adsorption material for Pd^{2+}.

4. Conclusion

(1) In this paper, various treatment methods of electroplating wastewater and pretreatment methods of cyanide containing wastewater are compared. Finally, the combination of chemical method and biological method is selected to treat electroplating wastewater, and hydrogen peroxide catalytic

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oxidation method is selected to pretreat cyanide containing wastewater.

(2) In this paper, four kinds of bark materials studied by ourselves were compared and selected. The bark of Platycladus orientalis, Broussonetia papyrifera, Juglans regia and Ailanthus altissima were selected to explore the effects of different amount of adsorption materials, initial concentration and adsorption time on the adsorption efficiency of Pb^{2+} in simulated wastewater through shaking adsorption experiment, and then the bark adsorption materials with strong adsorption capacity and environment-friendly were selected as Platycladus orientalis adsorption materials in order to provide potential materials for the treatment of heavy metal polluted wastewater.

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