Research on the Treatment of Wastewater by Waste Ceramic Adsorption

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Abstract. The process of preparing porous ceramic with waste porcelain powder as aggregate was researched. The effect of assimilate time on cuprum removal efficiency in wastewater containing copper was investigated. The results show the water copper removal rate increased along with the augment of assimilate time, and the assimilate time is suitable for 35 min; XRD characterizations show the porous ceramic catalyst before and after calcination in active components of X ray diffraction peak position almost had no changes, and the diffraction intensity slightly changed with calcination and absorption, and diffraction peaks became sharper, and its crystallinity was improved. Baking leads to the growth of crystal particles, and the performance of porous ceramics is stable before and after adsorption.

1. Introduction

With the rapid social economical development and the ceramic industry, ceramic waste residue increasing, they not only cause tremendous pressure for the city environment, but also restricts the sustainable city economical development and the ceramic industrial development. Therefore, the treatment and utilization of waste residue from ceramic industry has become a common concern of ceramic manufacturers and ceramic workers [1-3]. At present, the methods of removing copper in wastewater include precipitation, adsorption and other methods. Commonly precipitation agents are lime, sulfide, sodium carbonate and so on. Lime as precipitant produces floc, precipitate difficulty, large sludge volume, high turbidity of effluent. Sulfide particles are small. Two kinds of precipitator’s solid and liquid separations are difficult. The precipitation time is slightly longer by traditional chemical precipitation method. The method of chelating and combining two valences copper ion precipitation and flocculation is the disadvantage of introducing complex organic compounds, which increase the difficulty of separating effluent from sediment. The disadvantage of biosorption in adsorption is that the number of biologically effective adsorption sites limite the adsorption efficiency. In other methods, electrochemical method has high energy consumption and low current efficiency with the decrease of sewage concentration. The physical and chemical adsorption method has less impurity, mature development, large adsorbent, large surface area and dense pore diameter. If the functional group is embedded on the adsorbent, the adsorption is selective.

Adsorption treatment of wastewater containing heavy metal ions usually uses active carbon as sorbent. The absorbing ability and removal efficiency of active carbon have advantages, but it is more expensive, the application subject to certain restrictions, and ceramic industrial waste ceramics for daily use, the original China is kaolin, which is suitably used for adsorbent in water treatment. The waste domestic ceramics is re-sintered into porous ceramics by crushing, adding pore-forming agents and adhesives. Because of its internal porosity, large specific surface area, good chemical and thermal stability, it has better adsorption properties, and the porous ceramic regenerate and reuse easily. It
shows waste ceramics in wastewater treatment has a wide range of applications and development of spaces [4-5]. Referring to reference [6-9], whose paper focuses on the treatment of wastewater containing Cu\(^{2+}\) by fired porous ceramics. Combined with previous experiments, the experiment done in the paper as follows [10-12]:

2. Experiment

2.1 experimental reagents
The experimental reagents include Cu(NO\(_3\))\(_2\), CuCl\(_2\), HCl, HNO\(_3\) and NaOH, all of which is analytically pure. The manufacturers are Guangzhou Chemical Reagent Co., ltd.. The experimental material of Sesbania powder (starch replacing) porcelain (Chaozhou porcelain clay factory), waste domestic ceramics. Experimental instruments and equipment with cyclone pulverizer, electronic analytical balance, pH meter, air bath thermostats oscillator, digital electric thermostatic drier, muffle furnace, automatic atomic absorption spectrometer.

2.2 experimental methods
We crush specimen and through mesh screen of 100. We take the concentration of 25 mg/L solution containing Cu(instead of copper containing wastewater) 100 mL into 250 mL Erlenmeyer flask, adding into the porous ceramic powder 2 g. After 90 min oscillation, it is placed to the filter. The residual Cu content was measured by partial filtrate.

2.3 methods of detection and characterization
Although the porous ceramic of water treatment can be naturally settled, for saving time, the water samples are separated by centrifugal separator for digestion and detection. The pH values of water samples are measured with a pH meter. The concentration of Cu ion in raw water and treated effluent was determined by atomic absorption spectrophotometer. The properties of raw porcelain powder and samples before and after adsorption were examined by X ray diffractometer.

3. Experimental results and discussions

3.1 Results of soak time on removal efficiency of Cu
We remove the concentration of 25 mg/L Cu solution 100 mL into 250 mL Erlenmeyer flasks, and porous ceramic and wastewater containing Cu by adding 10 g/L porous ceramic adsorbent. We only change the contact time of adsorption, and the experimental results are shown in Table 1. The affect of soak time on the concentration of Cu ion is shown in Figure 1. The affect of soak time time on the removal efficiency of Cu ion is shown in Figure 2.

| Adsorption time /min | 5      | 10     | 15     | 20     | 25     | 30     | 35     | 40     | 60     |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Cu concentration of water sample after adsorption/ mg/L | 21.8   | 19.9   | 16.6   | 12.8   | 9.88   | 7.22   | 3.58   | 3.58   | 3.58   |
| Cu removal rate of water after adsorption / % | 12.6   | 20.0   | 33.4   | 48.7   | 60.5   | 71.1   | 85.6   | 85.6   | 85.6   |
From Table 1 and Figure 1-2, porous ceramic can adsorb Cu$^{2+}$ more quickly. The removal rates of Cu are increasing with the soak time increasing. When the soak time attained to 35 min, the removal rate of Cu$^{2+}$ reached equilibrium value of 85.68%. Therefore, the oscillation adsorption time is determined as 35 min.

3.2 representations of porous ceramics by XRD

For characterizing the stability of porous ceramics, XRD characterization was performed. From Figure 3 we can see compared with the original waste China and waste ceramic before 800 °C roasting and adsorption, the diffraction intensity increased significantly, because the crystal growth of roasting. After roasting and adsorption with waste clay at 800 °C compared to waste clay before roasting and adsorption at 800 °C, and the diffraction intensity did not change obviously, which indicates the adsorption in the process of the representations of the porous ceramics is relatively stable.

4. Conclusion

(1) The removal efficiency of Cu increases with the augment of soak time of porous ceramic, and the suitable adsorption times are 35 min. (2) XRD characterization shows calcination may cause the crystal particles growing, and the properties of porous ceramics are stable before and after adsorption. (3) The X-ray diffraction peak of the active component has almost no changes before and after calcination, and the diffraction intensity changes slightly. With the catalyst calcination and absorption, the diffraction peak becomes sharper and the crystallinity may increase.

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