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Study on Removal of Cd^{2+} /Pb^{2+} from Water by Magnesium Chloride Modified Biochar

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Abstract: Water heavy metal pollution not only leads to water quality-type water shortage and reduced use function of water bodies, but also seriously threatens people’s water safety, food safety and health, and has become a problem for people’s livelihood and heartache. Heavy metal pollution is one of the most serious pollution problems in water bodies. Heavy metal pollution will pose a threat to water safety and affect the growth and reproduction of aquatic organisms in water bodies. Moreover, heavy metals accumulate in the human body through skin contact, food chains and other ways, endangering human health. Among the many treatment methods for wastewater containing heavy metals, the adsorption method has the advantages of abundant raw material sources, low energy consumption, low cost, no secondary pollution, and easy operation. In this paper, magnesium chloride is used for modification on the basis of selecting activated carbon for adsorption, from the dosage of modified activated carbon, reaction time, initial concentration, pH value, etc. to explore the effect of magnesium chloride modified activated carbon to remove Pb^{2+} in water , and to characterize the adsorption material to explore its performance.

1. Background analysis

Heavy metal pollution of water not only leads to water shortage and reduced water use function, but also seriously threatens people's water safety, food safety and health, and has become a problem for people's livelihood and people's hearts. Heavy metal pollution is one of the most serious pollution problems in water bodies[1], such as pollution caused by cadmium, chromium, lead, arsenic, copper, and mercury[2]. Heavy metal pollutants in water mainly come from wastewater discharged from mining operations, pickling in iron and steel plants, electroplating, electrolysis, batteries, pesticides, electronics, fertilizers, medicine, tanning, paints, pigments and other industries[3]. Heavy metal pollution will pose a threat to water safety, affecting the growth and reproduction of aquatic organisms in water bodies, and heavy metals are enriched in the human body through skin contact, food chains, etc. "Minamata disease", "Minamata disease", "arsenic poisoning" and "lead poisoning" are all caused by the accumulation of heavy metals in the body[4].

For wastewater containing heavy metals, the main treatment methods include chemical precipitation, membrane separation, electrochemical, ion exchange, adsorption, etc[5]. Adsorption method is one of the common methods for treating heavy metal polluted wastewater[6]. Compared with traditional treatment methods such as chemical precipitation method, membrane separation method, electrochemical method, ion exchange method, etc., adsorption method has many advantages: the source of adsorbent raw materials Abundant, many varieties, simple adsorption treatment equipment, flexible, convenient and safe operation process, stable and efficient treatment effect, low energy consumption, low operating cost, no secondary pollution, strong practicability, and easy promotion[7]. In addition, heavy metal ions generally exist in dilute phases in wastewater. The adsorption method can effectively treat low-concentration heavy metal wastewater. The adsorption-desorption method[8] can achieve the triple purpose of treating heavy metal pollution, regenerating adsorbents and recycling adsorbate heavy metal resources. Therefore, The adsorption method has unparalleled advantages[9].

2. Significance

China is a big agricultural country, and agriculture is the foundation of the national economy. According to data from the National Bureau of Statistics, my country's total cotton output in 2018 was 6.096 million tons, an increase of 444,000 tons or 7.8% over 2017. China's cotton output ranks first in the world. In 2017, China's walnut output was about 3.8455 million tons (dried fruit), ranking first in the world, and China's walnut output also ranked first in the world. Therefore, my country's cotton stalks and walnut shell resources are extremely rich. However, non-standard treatment such as incineration makes these resources seriously waste and even pollute the environment. Biochar is a stable and highly aromatic substance, which is formed by the pyrolysis transformation of biomass under oxygen-limited or anaerobic conditions[10]. The preparation of waste biomass into biochar not only solves their disposal problems, but also can be used for environmental improvement and restoration. Biochar has great potential as an adsorbent for heavy metal pollution control. Magnesium chloride is an inexpensive and readily available inorganic salt, which can generate magnesium oxide nanoparticles on the surface of biomass at a certain temperature and improve the pore structure of biochar. Magnesium oxide nanoparticles can also undergo ion exchange with heavy metals to achieve the purpose of removing heavy metal ions in water[11] .

In conclusion, in this study, cotton stalks and walnut shells were used to prepare biochar, and magnesium chloride was used as modifier to prepare magnesium chloride-modified biochar to remove heavy metals Pb and Cd in water. By optimizing the preparation temperature and time of biochar, biochar With the ratio of magnesium chloride, one or two kinds of cost-effective heavy metal adsorbents are prepared to provide an effective solution for the removal of heavy metals in water.

3. Pre-test

3.1 Preparation of modified activated carbon

The modified biochar was prepared by using a muffle furnace at 600 ℃ for 3 h. The biomass and magnesium chloride were mixed and impregnated in different proportions, then dried at 80 ℃, and then heated at 200 ℃ for 1 hour and 450 ℃ for 3 hours. , then washed until neutral, dried at 80 ℃ to constant weight for use

3.2 Material morphology and structure characterization

The modified activated carbon was measured with a Z-potentiometer and weighed - respectively. 12 g of magnesium chloride and magnesium nitrate modified activated carbon were placed in five

50 mL conical flasks, and the pH of the mixed solution was adjusted to 2.0, 3.0, 4.0, 5.0, and 6.0 with 0.1 M HCl and NaOH solutions, respectively, until the pH was stable, and then ZETA potential was used. The meter measures the potential of the activated carbon in the conical flask in turn, and the curve of the potential changes with pH:

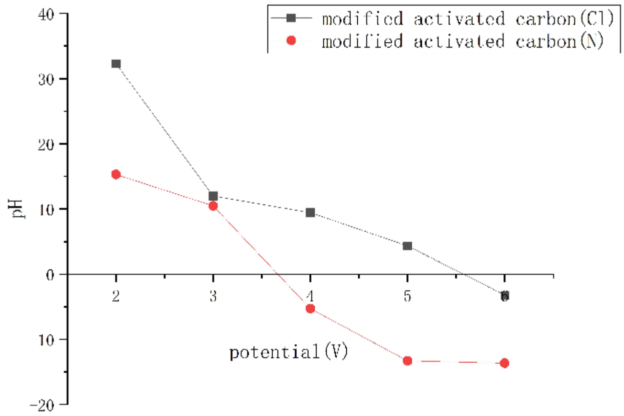

Figure 1 Plot of Potential vs. pH

4. Formal experiments

4.1 The effect of activated carbon dosage on the adsorption of Pb $^{2+}$

Weigh adsorbents of different masses (80, 100, 120, 140, 160, 180, 200 mg) were added to containing 75mL, 500 mg/L Pb $^{2+}$ solution in the Erlenmeyer flask, put it into the shaker to fully react for 24 hours, take samples to measure the concentration of Pb 2+ in the solution, and record the detailed experimental data. The experimental results show that under normal temperature conditions, with 60, 80, 100, 120, 140, 160, 180, 200 mg activated carbon fully reacted 24 The Pb $^{2+}$ concentrations after h were 31.673, 18.411, 9.722, 4.920, not detected, not detected, not detected (unit: mg/L). It can be found that the adsorption effect of activated carbon on Pb $^{2+}$ varies with the dosage The increase is basically an increasing trend.

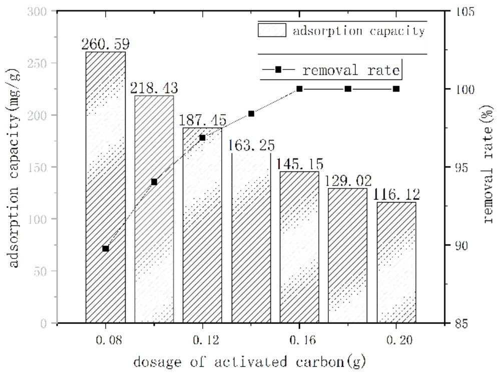

Figure 2 The relationship between the dosage of activated carbon and the removal rate and adsorption capacity

4.2 Preparation of standard curve

Accurately pipette 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, and 1.4 mL of the lead standard solution into six 25 mL colorimetric tubes with stoppers, and add 3.0 mL, 0.2 M hydrochloric acid solution, 1.0 mL diluent to each tube respectively. Nitrogen chloride phosphorus III solution and 1.0 mL chloroacetic acid solution, then add deionized water to the mark, mix well, place for 10 min, use a 1 cm cuvette at 616 nm on the spectrophotometer, and measure with the reagent blank as a reference For each absorbance[12], fit a curve of absorbance versus concentration:

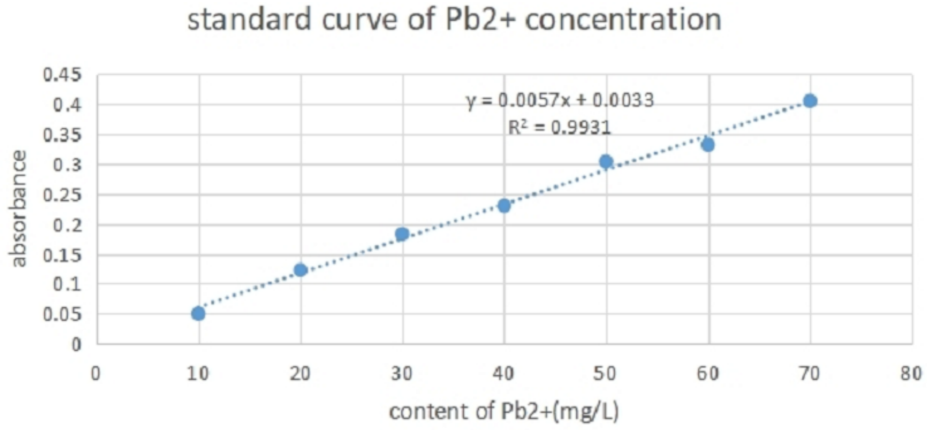

Figure 3 Pb $^{2+}$ concentration standard curve

4.3 Influence of reaction time on adsorption effect

Under normal temperature and neutral conditions, configure 500 mL of Pb $^{2+}$ solution with a concentration of 500 mg/L, respectively take 200 mL of Pb $^{2+}$ solution and place it in two 250 mL conical flasks, and then add 0.43 g of magnesium chloride to modify it. Activated carbon and magnesium nitrate modified activated carbon were put into a shaker, and the Pb $^{2+}$ concentration was measured by spectrophotometry after 0.5, 1, 2, 3, 6, 12, and 24 hours, respectively . (Note: When using the spectrophotometric method to measure the concentration of Pb $^{2+}$, dilute the concentration to 50 mg/L for determination, which is the same for subsequent experiments.) The experimental results show that when the dosage of activated carbon is constant, with the increase of reaction time, the two The adsorption capacity of modified activated carbon increased with time.

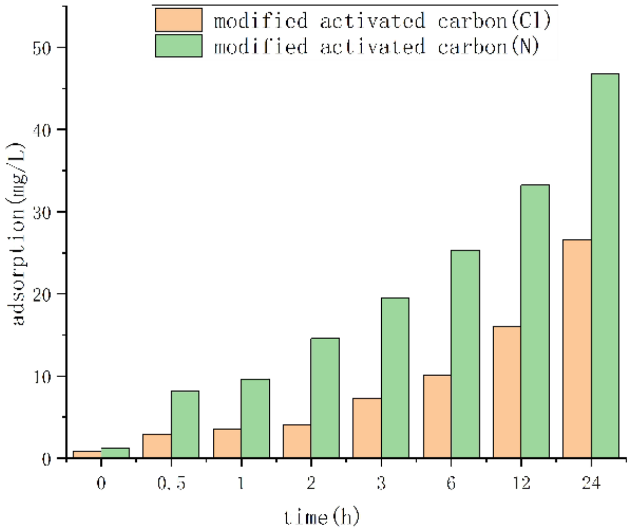

Fig. 4 The relationship between the adsorption amount of activated carbon and the reaction time

4.4 Effect of initial pH value on adsorption effect

Weigh 0.12 g of magnesium chloride and magnesium nitrate modified adsorbents and 50 mL of 500 mg/L Pb^{2+} solution into 5 conical flasks, respectively, and use 0.1 M HCl and NaOH solutions to adjust the pH of the mixed solution to 2.0, 3.0, 4.0, 5.0, 6.0. After 24 h of reaction, the concentrations of Pb^{2+} and Cd^{2+} in the solution were determined by spectrophotometry . The experimental results show that the adsorption amount of Pb^{2+} on the two modified activated carbons varies with pH value when the dosage and reaction time are determined, and the optimum adsorption pH value of chlorine modified activated carbon is, The optimum adsorption pH of nitrogen-modified activated carbon was 5.

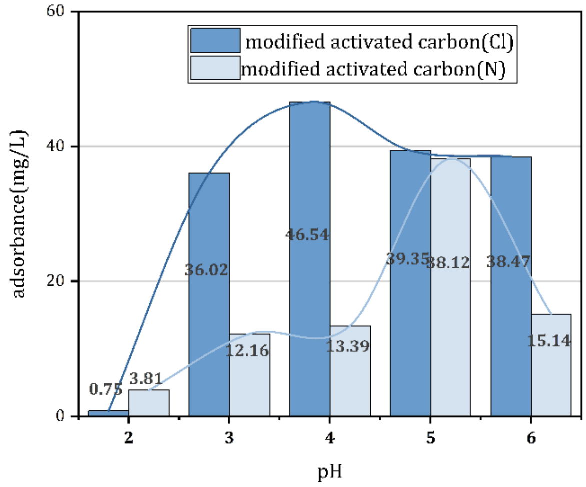

Fig. 5 Variation of adsorption capacity with pH value

4.5 Influence of initial concentration on adsorption effect

Weigh 0.12 g of magnesium chloride and magnesium nitrate modified adsorbent and 50 g respectively. Add 500 mg/L P b $^{2+}$ solution to 5 conical flasks, dilute to 100, 200, 300, 400, 500 mg/L, add activated carbon, put it on a shaker, take it out after 24 hours to measure the remaining concentration .

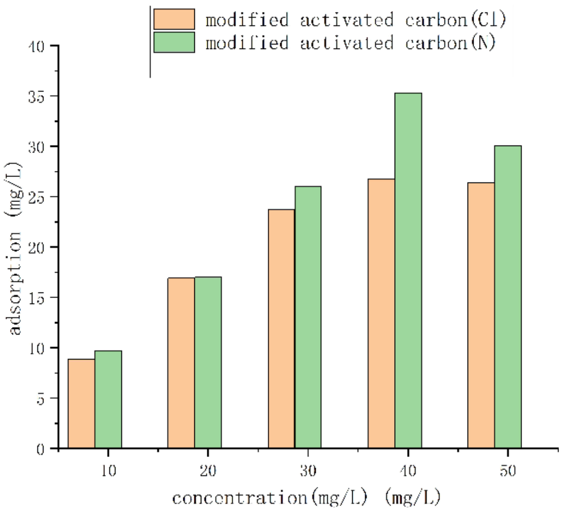

Figure 6 Variation of adsorption amount with initial concentration

5. Innovations

Using waste cotton stalks and walnut shells to prepare biochar, and using low-cost magnesium chloride as modifier to prepare magnesium chloride-modified bio-char material, which effectively reduces the cost of adsorbents; for the first time, magnesium chloride-modified bio-char is used as adsorbent to remove water Pb^{2+} and Cd^{2+}, and their adsorption mechanism was discussed. In conclusion, in this study, cotton stalks and walnut shells were used as raw materials to prepare biochar, and magnesium chloride was used as modifier to prepare magnesium chloride-modified biochar to remove heavy metals Pb and Cd in water, providing an effective solution for the removal of heavy metals in water. It is also expected to alleviate the environmental problems caused by the improper disposal of straw, and have better environmental benefits.

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