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Application and Development of Activated Carbon Adsorption in Wastewater

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Abstract: With the continuous progress of modern science and technology and the rapid development of economy, with the continuous development of society, the treatment of industrial and domestic sewage has become a hot concern. Toxic substances and non-degradable pollutants in wastewater also have a great impact on the environment. This paper mainly expounds the current environmental situation and the adsorption mechanism of activated carbon. And the application and development of activated carbon adsorption in wastewater.

Key Words: wastewater; Activatedcarbon; Adsorbent; Application Development

1. Introduction

With the development of society and the great improvement of people's living standard, a large amount of sewage has been produced in industry, agriculture and life. Because of the improvement of people's living quality, there are higher requirements for the necessities of life, which directly results in a series of toxic substances and non-degradable pollutants in the wastewater, causing certain harm to the environment. As the composition of pollutants is more and more complex. Nowadays, adsorption is one of the most important methods for wastewater treatment. Activated carbon has developed pore structure and huge specific surface area characteristics, which has strong adsorption capacity for dissolved organic matter in water and good removal effect for some difficult to remove organic matter. Therefore, activated carbon adsorption technology has been widely used in water treatment.

2.Basic Introduction of Activated Carbon

2.1 Characteristic and Function of Activated Carbon

Activated carbon is a porous adsorbent prepared by carbonization and activation of carbon-based materials such as charcoal, sawdust, fruit shell, coal and petroleum coke. Activated carbon has the characteristics of porous, large pore surface area and strong selective adsorption capacity. Under normal temperature and pressure, the solute in the liquid can be adsorbed, removed and purified, and the wastewater can be purified [1-2].

2.2 Classification of Activated Carbon

Activated carbon can be divided into different types according to its appearance, raw materials, functions and manufacturing methods. It can be divided into activated carbon fibers, powdered activated carbon and granular activated carbon according to its appearance; from raw materials, it can be divided into wood, coal, petroleum coke and resin activated carbon; according to different functions, it can also be divided into gas adsorption, catalytic performance, liquid adsorption and so on; from manufacturing methods, it can be divided into physical chemical method, chemical method and physical method[3-4].

2.3 Factors Influencing the Adsorption Property of Activated Carbon

The main factors of activated carbon adsorption are the amount of activated carbon added, temperature, time, acidity and alkalinity, and the way of use. Added amount and time are generally proportional to the adsorption

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effect, and the adsorption time is usually 10-60 minutes[5]. Activated carbon adsorption process is exothermic reaction, generally the lower the temperature, the better. But in actual production, because the adsorption effect is different at different temperatures, it depends on the specific water quality. Activated carbon generally has higher adsorption rate in acidic solution than in alkaline solution. PH value will affect the state and solubility of adsorbate in water, thus affecting the adsorption effect[6-7].

3.Application of activated carbon adsorption in wastewater treatment

3.1 Application of Activated Carbon Adsorption in Wastewater Containing Mercury

In 1953, one of the ten most serious hazards shocked the world was Minamata Bay in Japan. The cause was eating fish and shellfish from rivers polluted by methylmercury. The detection report was generated by the algorithm of Wanfang Data Document Similarity Detection System. The results were only responsible for the results of the tests within the range you selected. The results were only for reference of diseases with central nervous system disorders. The mercury-containing wastewater in a factory was precipitated by sodium sulfide, adjusted pH by lime and treated with ferrous sulfate as coagulant[8]. The mercury content was 1-3 mg/L, which was much higher than the allowable discharge standard of 0.05 mg/L. If activated carbon is used to treat the wastewater of the adsorption tank, two 40 m long static batch adsorption pools with 1 m thick activated carbon are used to exchange the work, so that the wastewater of the adsorption pool is nearly full, and stirred with compressed air for 0.5 hours, then it is stationary for 2 hours. The daily wastewater volume of the plant is about 10-20 m long, and the mercury content of the effluent treated by activated carbon meets the discharge standard[9].

The efficiency of adsorption of mercury-containing wastewater by activated carbon is affected by pH and additives in solution. When activated carbon adsorbs mercury-containing wastewater, the amount of mercury removal increases nearly twice when the pH decreases from 9 to 6. Adding tannic acid or ethylenediaminetetraacetic acid chelating agent 0.02 mg/L can increase the amount of mercury adsorbed from 10% to 30%; adding calcium ion to 200 mg/L can increase the amount of mercury adsorbed by about 15%; adding calcium ion and tannic acid at the same time can double the amount of mercury removed.

3.2 Application of Activated Carbon Adsorption in Phenolic Wastewater

Phenolic wastewater mainly comes from petroleum cracking industries such as plastic factories, coking factories, insulating materials factories, synthetic fiber factories and petrochemical factories. At present, the main methods to treat phenolic wastewater are adsorption, extraction, oxidation and biotechnology. Three columns in series were used to treat high concentration wastewater with phenol concentration of 1950 mg/L. After treatment, the concentration of phenol in purified water was less than 0.1 mg/L, but the adsorption column would be penetrated by phenol wastewater soon.

Therefore, activated carbon is more suitable for treating low concentration phenol-containing wastewater. When the concentration of phenol in wastewater is between 0.12mg/L and 44mg/L, the adsorption rate of phenol in wastewater can reach 99%, and the concentration of phenol in purified water after treatment is less than 0.1mg/L. The experimental results show that the concentration of phenolic wastewater with 487 mg/L can be reduced to less than 0.5 mg/L by aeration for 2 hours with 40 g/L of powdered activated carbon, which meets the discharge standard[10].

3.3 Application of Activated Carbon Adsorption in Pesticide Wastewater

Pesticides are generally divided into two categories: chlorinated benzene with benzene as raw material and methylene chloride without benzene as raw material. Among them, chlorinated benzene includes 223, 666, lindane and benzene hexachloride. Among methylene chloride, dieldrin, endrin, aldrin, isoaldrin, chlordane, toxaphene, indene heptachloride, carbon filter, etc. These pesticide wastewater can be removed by activated carbon. The treated water is proved to be non-toxic to fish by experiments. Experiments show that the adsorptive capacity of activated carbon to isodieldrin, toxaphene, aldrin, dieldrin and DDT is 100mg/g, 42mg/g, 30mg/g, 15mg/g and 11mg/g, respectively. When the concentration of bactericide o-phenylphenol is 100mg/L, the amount of activated carbon is 2.5g/L, which can achieve 99.6% removal rate. Activated carbon can also adsorb 2,4-dichlorophenol and less contained in herbicide wastewater. quantity of 3,4-dichlorophenol, 2,5-dichlorophenol and 2,6-dichlorophenol[11].

3.4 Application of Activated Carbon Adsorption in Printing and Dyeing Wastewater

The environmental problems of printing and dyeing wastewater are becoming more and more obvious. Its wastewater has large amount of water, high content of organic matter (COD 103-106 mg/L), deep color (500-500,000 times), and great change in water quality. The unreasonable discharge of such wastewater will result in excessive surface water chroma, excessive organic matter, excessive heavy metal content and excessive COD, which will eventually lead to a large number of biological deaths in the water and seriously destroy the ecological balance. Bai Xiaolong et al. treated two kinds of simulated printing and dyeing wastewater, methyl orange and methylene blue. The adsorption rate of activated carbon soaked in 8% hydrochloric acid solution was 95.60% and 93.46%, respectively. Chenzhen et al. treated methylene blue simulated printing and dyeing wastewater. After adsorption by modified activated carbon, the adsorption and decolorization effect was increased to more than four times, and the decolorization rate was close to that 100%. Zhang Xiaoxuan et al. used activated carbon to treat acidic fuchsin, basic fuchsin and active black B-133 at 70 C. The decolorization rates were 99.48%, 99.22% and 70.95% respectively[12]. Therefore, activated carbon had good decolorization effect on printing and dyeing wastewater. The types of activated carbon have an effect on the adsorption effect of printing and dyeing wastewater. Fruit shell charcoal, raw coal and mixed charcoal all have adsorption capacity for printing and dyeing wastewater, but fruit shell charcoal has the best effect on the treatment of printing and dyeing wastewater, with the largest adsorption capacity and COD removal rate.

3.5 Application of Activated Carbon Adsorption in Pharmaceutical Wastewater

Pharmaceutical wastewater has the characteristics of many kinds of organic species, high salinity, high organic content and strong toxicity, but this kind of wastewater still has very high recycling value. Some salts and organic compounds can be recovered by physical and chemical methods to achieve the unity of economic benefits and environmental benefits. Therefore, this kind of wastewater needs to be treated and discharged, otherwise it will cause land salinization, water eutrophication, water biological poisoning and death, and so on.

Jiang Junqing[13] and other activated carbon fibers were used to adsorb phenol wastewater. The results showed that activated carbon fibers had large adsorption capacity and fast adsorption speed. The saturated activated carbon fibers were regenerated with 10% sodium hydroxide solution. The recovery rate of pheno lwas 69.5%. Tang Dengyong and others used activated carbon fibers to adsorbp-nitrophenol wastewater. The results showed that activated carbon could effectively remove toxic and harmful substances from pharmaceutical wastewater. After treatment, p-nitropheno lcould be recovered from the treated activated carbon. Wang Maoyu studied the degradation of pharmaceutical wastewater by catalytic ozonation with activated carbon. The results showed that activated carbon and ozone had synergistic catalytic effect on the degradation ofpharmaceutical wastewater. Compared with ozonation only, the removal rate of COD increased from 33.1% to 72.57%. The biodegradability of pharmaceutical wastewater was significantly improved, which was conducive to further biochemical treatment.

4.Development of Activated Carbon Adsorption in Wastewater Treatment

4.1 Ozone-Activated Carbon Hybrid Technology

In the process of using chlorine to oxidize, people have found trace by-products such as trichloromethane and chloroform, which are carcinogenic and seriously endanger human health. At present, some Waterworks in China have begun to use the combined process of ozone oxidation and biological activated carbon. The technology has the following advantages: the consumption of ozone is lower than that of ozone alone; adding ozone before adsorption of activated carbon can oxidize some macromolecules into small molecules easily adsorbed by activated carbon, and at the same time, it can eliminate bacteria and viruses[14].

Donai Waterworks in Munich, Germany, collects surface water from the lower Rhine River. For many years, chlorine oxidation technology has been used. As a result, the content of chloroform and trichloromethane in the effluent water is relatively high, reaching 200 and 25 ug/L at the highest time, respectively[11]. In 1978, Donai Waterworks adopted ozone-activated carbon process. The results show that the organic macromolecule content in water is reduced by half than before, and the content of chloroform and trichloromethane in water is 0 due to the replacement of chlorine oxidation process, which shows that this process is feasible.

4.2 Activated carbon fiber technology

Activated carbon fibers are the third generation of activated carbon products after powdered activated carbon granular activated carbon. The product has the general characteristics of activated carbon and is smaller than ordinary activated carbon in volume, which can greatly reduce the volume of treatment equipment[15]. Contrastive experiments show that under the same effluent water quality, the adsorption capacity of activated carbon fibers is 15-75 times that of ordinary activated carbon, and in dynamic adsorption. Activated carbon fibers (ACFs) do not leak and absorb, and the water permeability ratio (384L/kg) is 17 times that of activated carbon (22.5L/kg). The chroma of the effluent of dye wastewater treated by adsorption is close to 0. Activated carbon fibers (ACFs) have strong plasticity. They can be made into paper, cloth, fiber bundles and other forms according to need. They have better application prospects in wastewater treatment.

5.Epilogue

Activated carbon has the characteristics of simple use, low cost, excellent adsorption effect and reusability. Activated carbon has been widely used in water treatment. Nowadays, the components of wastewater need to be treated are more complex and the harm is more serious. People need to develop new technologies of chemical separation, membrane separation, sensor technology, biological separation and activated carbon adsorption. These technologies provide a new application space and application platform for activated carbon.

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