Fabrication of New Porous Degradable Materials and Study on Purification Effect of Sewage

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Abstract: *In order to improve the effect of biomass aerogels on water purification, this study which based on microcapsule and biomass aerogels explores new porous ecological filler. The research finding is that this porous ecological filler have significant removal efficiency on the concentration of TP, NH3-N, and COD. The removal effect on NH3-N is especially ideal. During the ten- days water purification effect test, we find that the maximum removal rate of TP, NH3-N, and COD reached 45 percent, 59 percent and 20 percent, providing scientific theoretical support on the preparation of biomass aerogels and the application of water purification.*

Keywords: *Biomass aerogels, microcapsule, Sewage evolution, degradable*

1. Introduction

With the development of the economy and the progress of society, some colorful commodities such as aluminum alloys, decorative materials, clothing, etc. appear more frequently. These commodities lead to large production of dyes and wastewater, which affects the safety of the human living environment. The need to deal with them is increasingly urgent[1] Among the existing sewage treatment methods, the adsorption method has received extensive attention due to its simple operation, low operating cost, and less secondary pollution. At present, a variety of adsorbents have been developed to improve water pollution, such as activated carbon, Prussian blue, activated alumina, etc., but there are problems such as high preparation cost, low adsorption capacity, poor regeneration capacity, or narrow application range [2]. Therefore, the emergence of carbon aerogels solves this problem. Carbon aerogels (cA) which belonged to the branch of aerogels are generally a new type of nanoporous carbon material obtained by pyrolyzing organic aerogels as precursors at high temperatures in an inert gas atmosphere. It is a new type of porous and lightweight functional aerogel with a unique three-dimensional network structure, developed porosity (80%-99%), high specific surface area (1 500-2 500 m 2 g) -1), low density, excellent heat resistance, high electrical conductivity and mechanical stability [3]. However, the vast majority of carbon aerogels are made of expensive chemicals, carbon fibers, graphene and carbon nanotubes, etc., and the production process is complicated, which will also pollute the environment and limit the use of carbon aerogels[4]. Therefore, the search for low-cost raw materials, efficient drying technology, and mature process parameters has become the focus of carbon aerogel research.

Biomass raw materials coming from a wide range of sources are cost-efficient and abundant. Using biomass raw materials to prepare environmentally friendly porous carbon-dimensional aerogels is an economical and sustainable method. It plays a key role in exploring the high-value utilization of raw biomass materials [5] However, many methods for studying material aerogel use the process of sol, gel, freeze-drying, and carbonization. However, those methods are only suitable for the research of small samples in the laboratory. The final output cannot meet the need of the industrial scale. The reason is that freeze-drying is costly. The price of a freeze dryer is about 200,000 yuan, so how to develop a new technology to replace the freeze-drying technology has become a technical problem for the industrialization of carbon aerogels.

In order to solve the problem of current severe freeze-drying conditions, this research uses peanut shells as raw materials. We invented the repeated freezing and extraction technology to prepare porous and efficient carbon aerogels and studied the sewage purification effect of this material. Those preparations provide a scientific theoretical reference for the preparation of carbon aerogels.

2. Material and Methods

Put the peanut shells into a pulverizer and pass them through a 100-mesh sieve. Dissolve 2 grams of peanut shell powder in 100 ml of 90% sodium hydroxide solution. After 2 hours in a 90 ℃ water bath, cool the solution to room temperature, and adjust the pH with acetic acid. Adjust the value to neutral to form a sol. Next, we should dissolve 10g of sodium alginate in the above solution, stirring and dissolving at a temperature of 5 to 10 degrees to form a colloid. Then we prepare an additional 5% concentration of calcium chloride where the colloid is cured in it for 30 minutes and finally forn a gel.

We should add1g of a bacterial strain to 25ml of deionized water, placing it in an incubator for 24-72 hours. Then we heat another 5g of sodium alginate to dissolve it in 200ml of deionized water, and cool it for later use; The next step is taking 4ml of EM bacterial solution and adding it to 200ml sodium alginate colloidal solution, stirring evenly, and pouring this mixed solution into a dry spray bottle. we spray this mixed solution into a 5% calcium chloride solution for curing reaction to form microcapsules. The porous degradable material was soaked in the microcapsule solution for 12 hours so that the microcapsules were fully adsorbed in the porous degradable material to form a new type of filler.

We took 4ml of Hoagland's nutrient solution and added it to 2L of deionized water. We poured the prepared sewage into a 1L beaker with a volume of 30% porous degradable material, set up three repetitions, and then put it into an incubator with a temperature of 30 ℃ for intermittent aeration. Finally, we collected water samples on 2d, 4d, 6d, 8d, and 10d to detect ammonia nitrogen, total phosphorus, and COD.

3. Result and discussion

3.1 Change of sewage concentration

Through the monitoring of total phosphorus concentration in sewage for 10 days, it is found that the porous composite material has a significant effect on the total phosphorus concentration in water.

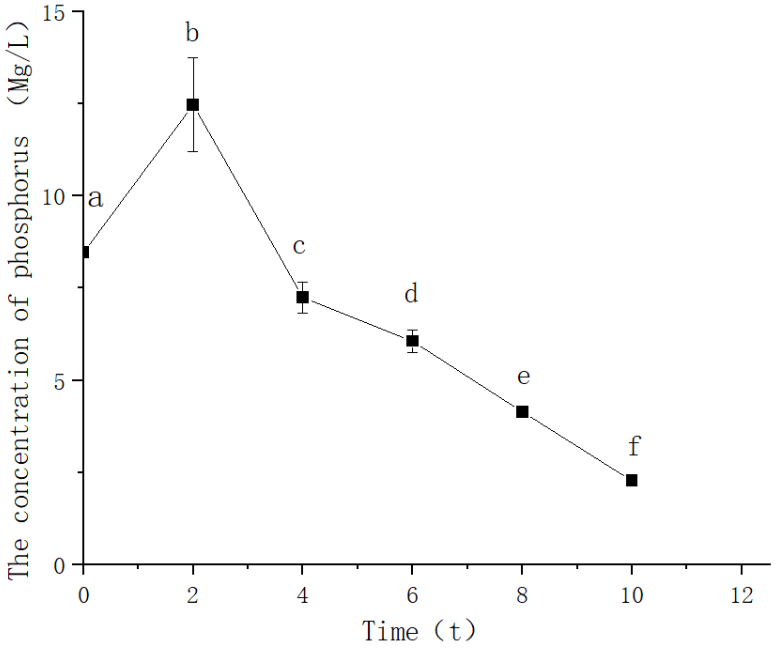

Figure 1: Changes in total phosphorus concentration

As shown in Figure 1, the change in total phosphorus concentration showed a unimodal curve. The concentration reached the maximum on the second day, which was 12.47 mg/L, and was significantly higher ($p<0.05$) than the concentration at other times. From the second day, the total phosphorus concentration showed a downward trend. The decrease in significance level ($p<0.05$) reached the lowest point on the 10th day. The significance level($p<0.05$) was also lower than the concentration of the previous 8 days. The increase in the concentration of total phosphorus on the second day may be due to the fact that peanut shells and the microbial culture solution contain phosphorus.[6]. Porous materials have a large number of pores and have adsorption properties, which can adsorb total phosphorus. At the same time, phosphorus is the main inorganic salt element required for the growth process of EM bacteria, which is absorbed and assimilated, resulting in a later decrease in the concentration of total phosphorus.

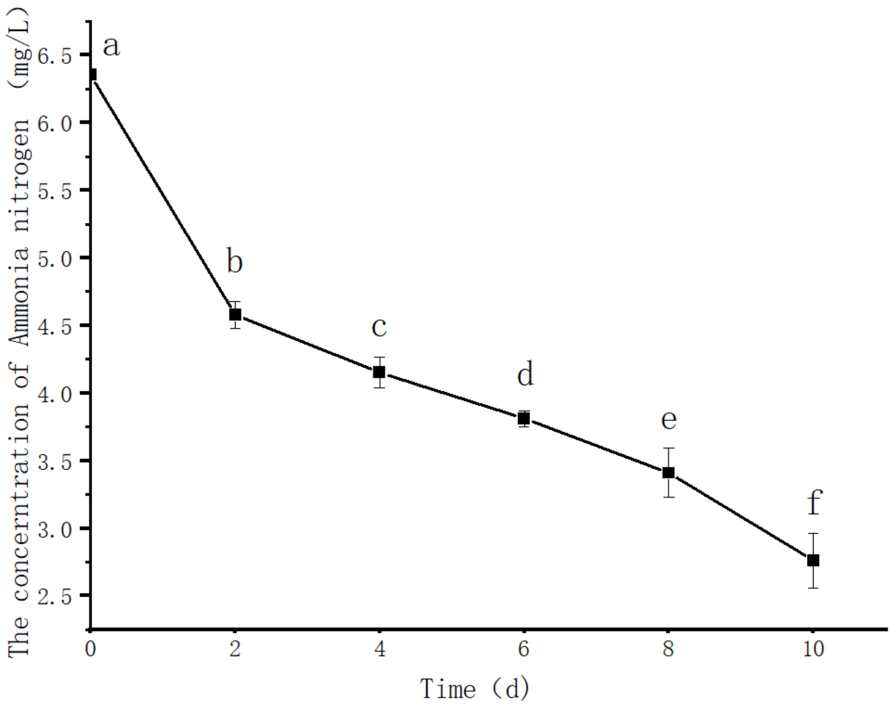

Figure 2: Changes in ammonia nitrogen concentration

It can be seen from the figure that the concentration of ammonia nitrogen kept decreasing within 0-10 days, and reached the lowest value of 2.76 Mg/L on the tenth day, and the rate of change of ammonia nitrogen concentration was the fastest within 0-2h. Between 10 hours, the ammonia nitrogen concentration in the water decreased slightly. The main reason for the analysis may be that the ammonia nitrogen content in the water body has been greatly reduced in the first 2 hours after the microcapsules are put into the water, so the subsequent changes in ammonia nitrogen concentration decrease.

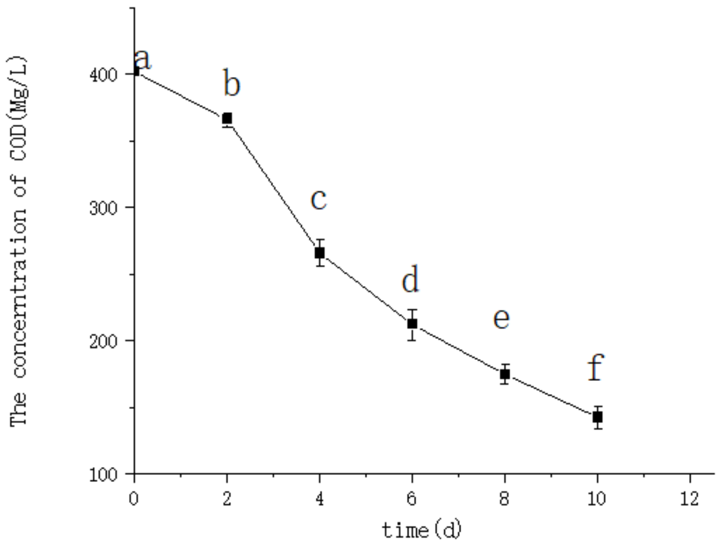

Figure 3: Changes in COD concentration

It can be seen from Figure 3 that the concentration of COD showed a significant downward trend within 10 days, and reached the lowest value of 142.25 Mg/L on the tenth day, which was significantly lower than the previous eight days.

3.2 Changes in wastewater removal rate

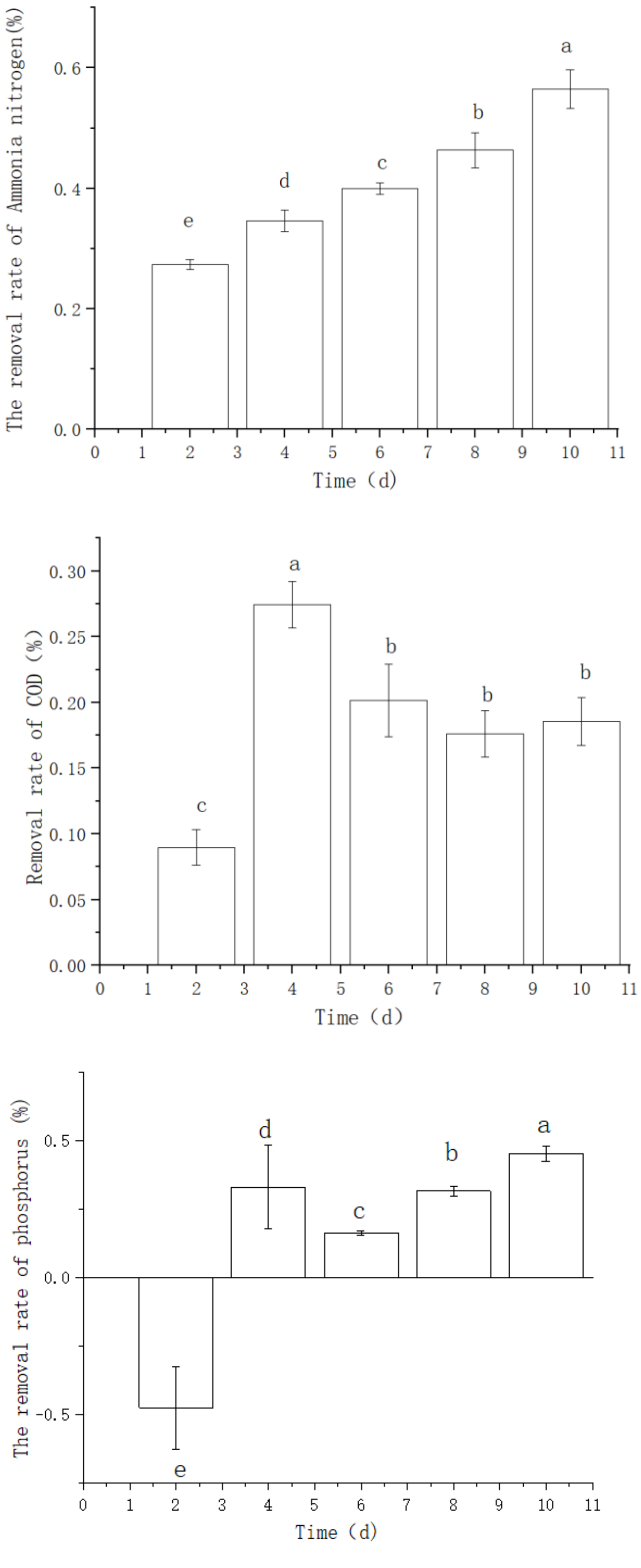

Figure 4: Changes in removal rate of three sewage indicators

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The porous composite material has a significant effect on the removal rate of ammonia nitrogen in sewage. As shown in Figure 4, the removal rate of ammonia nitrogen in wastewater showed a significant ($P<0.05$) upward trend. On the 10th day, the removal rate reached a maximum of 59%, which was significantly higher than the previous 8 days.

Porous composites have a significant effect on the removal rate of total phosphorus in wastewater. As shown in the figure, the removal rate of total phosphorus in wastewater increased significantly between two days and four days ($P<0.05$). The removal rate decreased significantly on days 4 and 6 but increased significantly on days 6 and 10, reaching a maximum of 59% on day 10, significantly higher than the previous 8 days.

Porous composites have a significant effect on the removal rate of COD in wastewater. As shown in the figure, the removal rate of COD in the sewage reached 8.9% on the second day, and increased significantly on the fourth day, reaching 27.4%. The reason may be that COD has been absorbed by organic materials in large quantities on the second day, reaching adsorption saturation, so the removal rate also decreased.

4. Conclusion

The ecological filler based on the porous degradable material made of peanut shell powder combined with the microcapsule technology has a significant sewage purification effect. Through the ten-day sewage purification effect test, it was found that the maximum removal rate of total phosphorus, ammonia nitrogen, and COD reached 45%, 59%, 20%. In this way, this study provides a scientific theoretical reference for the preparation of carbon aerogels and their application in sewage purification.

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