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一种太阳能驱动处理赤泥污水的绿色节能装置

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Summary. *Alumina production will produce a large amount of red mud wastewater every year, which will cause great harm to the surrounding environment. In this study, a solar evaporator using biochar as photothermal material for red mud wastewater treatment was designed. Driven by sunlight, the device can recover water from red mud wastewater and absorb harmful substances in wastewater. This study provides a new idea for green and energy saving treatment of red mud wastewater.*

About 1.5 tons of red mud tailings are discharged for every ton of alumina produced. The treatment of red mud tailings has always been a difficult problem [1]. Most of the red mud tailings can only be stored for disposal. As the demand for alumina increases, the storage problem of red mud tailings will become more serious. In the rainy season, the long-term watering of rainwater will lead to the overflow of red mud wastewater, causing serious pollution to the surrounding lakes and farmland. At the same time, the overflowing red mud wastewater will change the composition and structure of the soil, and then affect the planting or animal husbandry. The treatment and utilization of water sources polluted by red mud has become an urgent problem to be solved [2].

In this study, three kinds of biomass carbon materials were prepared from wastes with high carbon content. After material characterization and comprehensive analysis of performance, the biomass carbon prepared with straw residue as raw material was finally selected.We used this material in a self-designed solar evaporator, and found through experiments that the device has excellent ability to treat red mud wastewater.

Firstly, we used sugarcane rod and coffee grounds to prepare biochar, and carried out SEM, BET and FTIR tests on the two materials after carbonization. It was found that the two biomaterials have the following characteristics after carbonization: although the carbonized sugarcane rod retains the original good pore structure.Its adsorption ability to the pollutants in red mud wastewater is low, and it is not very ideal photothermal material. The carbonized coffee grounds are ellipsoid and cannot absorb red mud sewage evenly. Besides, the BET specific surface area of the carbonized coffee grounds is far less than that of the biochar made from sugarcane rod in front. Therefore, biochar prepared from coffee grounds is not a good experimental material.

After that, we used common agricultural waste straw to make biochar, and conducted SEM, BET and FTIR tests on the carbonized straw material. Biochar material can be well formed, and can keep the shape floating on the water surface and has a certain hydrophobicity. The forming condition, pore size, specific surface area and hydrophobicity of the material are well maintained. Finally, the straw residue mixture was determined as the raw material for biochar preparation.The experimental samples are shown in fig.1 below.

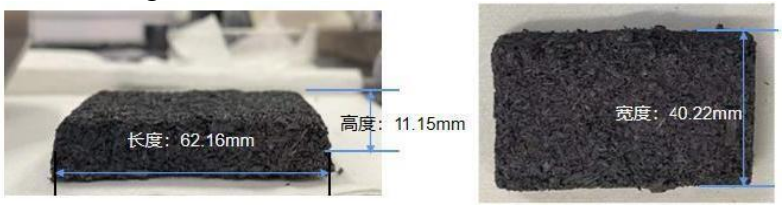

Figure 1 – Biomass carbon sample

The surface temperature of the photothermal layer reaches an equilibrium of about 39.5 ºC after 10 min of irradiation under the same sunlight,and reaches the highest temperature of 64.5 ºC after 30 min of irradiation. However, when there is no biochar floating on the water surface, the

temperature increases slowly and the highest temperature of the red mud can only reach about 31.2 ℃. The evaporation rate of red mud is about 1.0294 $kg \cdot m^{-2} \cdot h^{-1}$ when biochar is not used as the interface. After the use of solar biomass charcoal evaporator, the evaporation rate is about four times than the original.

Compared with the changes of the red mud solution before and after evaporation, the color of the red mud solution before evaporation is darker, and the color of the red mud wastewater after evaporation is obviously lighter, and the water level drops somewhat. The collection efficiency is up to 55.5 %.

The red mud solution before evaporation was tested by a high-precision pH tester and its pH value was 11.06. The shallow red mud solution after evaporation was also tested and the pH value was 9.76. The evaporator also weakened the alkalinity of the red mud. The surface of the biochar showed a change of red color, which proved that the substances in the red mud were successfully adsorbed to the surface of the biochar after evaporation. After XRD test, it was confirmed that biomass carbon adsorbed harmful substances in wastewater.

Based on the solar evaporator model designed by previous researchers, we carried out the following innovative design and transformation: we used xenon lamp light source with AM1.5G filter (keeping the light intensity at about 1 kW/m^2) to simulate sunlight, and designed the biochar based solar evaporation device as shown in fig. 2.The right picture shows the evaporation condensation and collection device. *A* is a condensing collection device, which is composed of a ramp structure and a condensing tank. The evaporated water vapor will condense upward and stay in the groove with the wall surface. In order to collect the condensed water in time, we open holes in the groove to facilitate the discharge of condensed water from the groove into the collection beaker. *B* is the insulation device and biochar, *c* is the red mud wastewater storage tank.

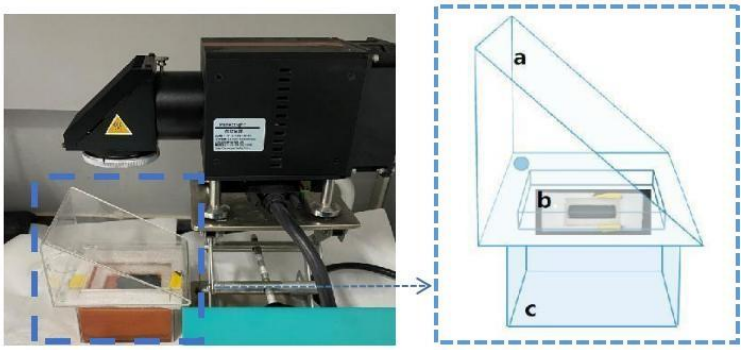

Figure 2 – Solar evaporation condensing device

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