

PAPER • OPEN ACCESS

Preparation and characteristics of magnetic water hyacinth

To cite this article: Huiting Zeng *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **295** 032062

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the **collection** - download the first chapter of every title for free.

Preparation and characteristics of magnetic water hyacinth

Huiting Zeng, Xiaoqing WU, Honghu Zeng, Hua ZHANG^{*1}, Asfandiyar Shahab^{*2}

Guangxi Key Laboratory of Environmental Pollution Control Theory and Technology,
Guilin University of Technology, Guilin 541004, China

^{*1}Corresponding author. E-mail: zhanghua5127@163.com

^{*2}Corresponding author. E-mail: 2017022@glut.edu.cn

Abstract. The preparation process and method of magnetic water hyacinth(MBC) were conducted, and the morphological structure and surface characteristics of biochar were characterized. The optimal MBC preparation method was obtained under different carbonation temperatures, impregnation times, and mass ratio of potassium carbonate to water Gourd: carbonization temperature is 450 °C, iron nitrate concentration is 0.2 M, and the mass ratio of potassium carbonate to water hyacinth is 0.5:5.

1. Introduction

Water hyacinth is a kind of floating plant with strong vitality and reproductive ability. In the 20th century, the water hyacinth was introduced into China as a feed, but due to its strong reproduction ability, the local biodiversity was destroyed. Therefore, to turn the water hyacinth into a useful specie is one of the concerns of the low-carbon society today. [1] Therefore, considering that there are many water fields or wetlands in Guangxi province that have destroyed water hyacinth, whether it is possible to use water hyacinth to make biological charcoal to make it use. In the study of heavy metal adsorption, there are many materials used, among which biochar is a porous material that can be used as a good adsorbent-that, has the potential to adsorb pollutants, and has a promising material its unclear. [2] The preparation and characteristics of magnetic water hyacinth are discussed in this paper.

2. Preparation of materials

2.1. Material pretreatment

The hyacinth used in the experiment was collected from the Huixian Wetland in Guangxi.

The reagents required for the experiment(all analytical pure): hydrochloric acid, iron carbonate, potassium nitrate acetone, sulfuric acid, phosphoric acid, potassium dichromate, dibenzylhydrazine. In addition, the sample is cleaned with deionized water.

2.2. Preparation of biochar from magnetic modified water hyacinth

The hyacinth collected from the Huixian Wetland is washed with water, and then placed it in the oven to dry (temperature 120°C, 4 H). After drying, the hyacinth is removed to break the hyacinth into a pulverized powder, and was warped in a sealed bag and was labelled.

After soaking the pre-treated water Gourd powder with a certain concentration of iron nitrate for a period of time, add a certain concentration of potassium carbonate followed by centrifuge process to make it dry. The soaked powder is placed in Muffle furnace for carbonization. After being removed the soaked powder at room temperature, it is repeatedly cleaned with dilute hydrochloric acid and pure



water three times. The magnetic biological carbon (MBC) obtained after being put into the oven for drying is encapsulated and marked in a sealed bag.

2.3. Performance test of biochar in magnetic modified water hyacinth

Magnetic modified water hyacinth biochar performance test for Chromium content (Diphenyl carbonyl hydrazine spectrophotometry), Iodine adsorption (using Chinese standard GB/T 12496.8 - 2015 "Iodine adsorption by wood activated carbon test method is worth measuring") and methylene blue adsorption. (Chinese standard GB/T 12496.10-1999 "Wood activated carbon test method Methylene blue adsorption worthy of measurement"). [3]

2.4. Orthogonal experimental design

Based on single factor experiment, three factors: immersion time(A), concentration of potassium carbonate(B), iron nitrate and water Gourd mass ratio(C) were selected for orthogonal tests. The design is shown in Table 1.

Table 1. Orthogonal impact factors

Level	A/(min)	B/(mol/L)	C
1	40	0.1	0.5:1
2	80	0.2	1:01
3	120	0.3	1.5:1
4	160	0.4	2:01

3. Results and analysis

3.1. Orthogonal experiment

The orthogonal experimental results of magnetic modified water hyacinth are shown in table 2(carbonization temperature is a, $\text{Fe}(\text{NO}_3)_3$ concentration is b, potassium carbonate mass is c, methylene blue adsorption is d, iodine adsorption is e, Cr adsorption is f).

Table 2. Orthogonal test results

the serial number	a/(°C)	b(mol/L)	c/(g)	d/(g)	e/(g)	f/(g)
1	350	0.1	0.5	10.8	6.45	9.966
2	350	0.2	1.5	3	269.59	9.966
3	350	0.3	2.5	6.3	389.61	9.886
4	350	0.4	3.5	7.35	235.65	9.981
5	400	0.3	1.5	4.5	292.03	8.68
6	400	0.4	0.5	3.9	292.03	7.173
7	400	0.1	3.5	4.5	339.75	5.903
8	400	0.2	2.5	4.8	286.45	8.775
9	450	0.4	2.5	4.2	333.19	9.363
10	450	0.3	3.5	14.4	275.08	9.997
11	450	0.2	0.5	18.9	297.64	9.902
12	450	0.1	1.5	5.1	333.19	9.981
13	500	0.2	3.5	6	303.61	8.22
14	500	0.1	2.5	5.4	234.54	9.125
15	500	0.4	1.5	4.65	247.69	8.49

the serial number	a/(°C)	b(mol/L)	c/(g)	d/(g)	e/(g)	f/(g)
16	500	0.3	0.5	4.5	232.33	9.299

Table 3. Range analysis results table

indicators	factors	Type III sum of squares	df	The mean square	F
Cr adsorption	a	13.871	3	4.624	7.713
	b	1.531	3	0.51	0.851
	c	1.541	3	0.514	0.857
methylene blue adsorption	a	92.908	3	30.969	1.981
	b	22.202	3	7.401	0.473
	c	71.376	3	23.792	1.522
Iodine adsorption	a	10813.392	3	3604.464	1.003
	b	4861.344	3	1620.448	0.451
	c	1999.425	3	666.475	0.185

From table 3, it can be seen that the Cr adsorption and the methylene blue adsorption F values are the largest a values, followed by c, and the smallest is b, from which it can be seen that the carbonization temperature has the greatest effect on the preparation of magnetic water gourds; The F value of the iodine adsorption is the largest, followed by b, and the smallest is c, so the temperature effect is the greatest, followed by the $\text{Fe}(\text{NO}_3)_3$ concentration. The optimal preparation of the different adsorbents is thus derived: for Cr, a3c4b3 should be used, and for methylene blue, a3c2b1 should be used. Scheme a3b4c3 is used for the adsorption of iodine.

From table 2, it can be concluded that the best temperature for preparing MBC is 450 °C, the concentration of potassium carbonate is 0.2 mol/L, and the mass ratio of iron nitrate to water Gourd is 0.5:1.

3.2. XRD diffraction

As shown in Figure 1, the XRD diffraction charts of BC and MBC have significant changes, compared to the diffraction peaks of MBC at 30.091°, 35.527°, 38.561°, 43.195°, 57.035°, and 62.733 °. According to Zhang et al.'s study, [4] the diffraction peak generated at these diffraction angles is the characteristic peak of Fe_2O_3 .

3.3. FTIR infrared spectrum

As can be seen from the FTIR infrared spectrum, the modified biochar produces new functional groups and the displacement of functional groups occurs. Compared with BC and MBC, Fe-O function in 533cm^{-1} ; [5] The characteristic peaks at MBC and BC in 1624cm^{-1} are due to N-H telescopic vibrations.[6] MBC and BC are due to -OH at 3435cm^{-1} .

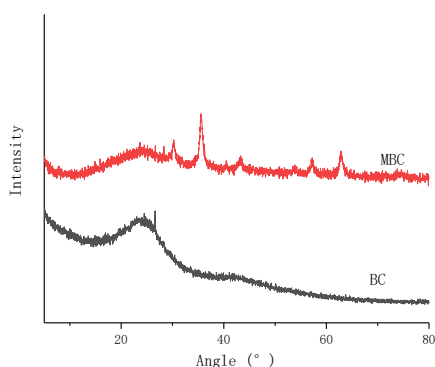


Figure 1. XRD patterns of BC and MBC

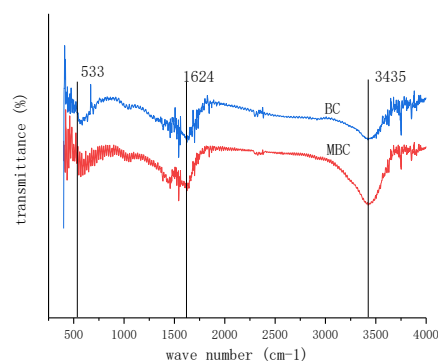


Figure 2. FTIR of BC and MBC

4. Conclusion

(1) From the orthogonal experimental results, it can be concluded that the factors affecting the adsorption of different substances are various. The best plan for preparing MBC is a carbonation temperature of 450 °C, a concentration of 0.2 mol/L of potassium carbonate, and a mass ratio of iron nitrate to water Gourd. It is 0.5:1.

(2) From the XRD diffraction and FTIR infrared spectra, it can be known that the magnetic modified water Gourd has obtained a new functional group Fe-O, resulting in a new characteristic peak.

Acknowledgments

The author is particularly grateful for the support of the National Science Foundation of China (No. 51578171), Guangxi Scientific Experiment Center of Mining, Metallurgy and Environment (No. KH2012ZD004) and the project of high level innovation team and outstanding scholar in Guangxi colleges and universities (No. 002401013001).

References

- [1] Wang H., *et al.* (2012) Study on adsorption properties of heavy metals in water hyacinth. *Environmental science and technology* 35, 33-35+121.
- [2] Bashir S., Zhu J., Fu Q. L., Hu H. Q., (2018) Comparing the adsorption mechanism of Cd by rice straw pristine and KOH-modified biochar. *Environ. Sci. Pollut. Res.* 25, 11875-11883.
- [3] Zhou Y., *et al.* (2008) Study on mechanism of grapefruit skin adsorbing the aqueous solution of methyl blue in Central Asia. *Environmental science research*, 49-54.
- [4] Zhang M., *et al.* (2013) Preparation and characterization of a novel magnetic biochar for arsenic removal. *Bioresour. Technol.* 130, 457-462.
- [5] Kong X. R., *et al.* (2017) Low-cost magnetic herbal biochar: characterization and application for antibiotic removal. *Environ. Sci. Pollut. Res.* 24, 6679-6687.
- [6] Fan Z. X., *et al.* (2018) Investigating the sorption behavior of cadmium from aqueous solution by potassium permanganate-modified biochar: quantify mechanism and evaluate the modification method. *Environ. Sci. Pollut. Res.* 25, 8330-8339.