Preparation of Activated Carbon by Agricultural Straw and Study on its Performance

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Abstract. The activated carbon is a kind of adsorbents which has ample internal pore structure and high specific surface area, widely applying on chemical industry, pharmaceuticals, metallurgy industry, agriculture and environmental protection. The effects of operation parameters such as impregnation ratio, activation temperature and time on the adsorption properties of activated carbons,and burning time were measured and analysed in order to optimize these operation conditions. We can make such conclusions: The optimum technological conditions of preparation by chemical activation were: KOH / ZnCl2 was the better activator, activator ZnCl2 5mol/L, solid/liquid 1:1g/mL, soaking time 1.0h, soaking temperature 20℃, pyrolysis temperature 550℃,the optimum washing temperature 90℃.

Introduction

With the improvement of people's linving standard in our country, environmental problems also rise sharply. Adsorption method is widely used, as a kind of waste water and gas pretreatment method [1].In numerous adsorbents, activated carbon [2] is a good choice. China is an agricultural country, so its crop straw resource is very rich in it. There are plenty of rest straw biomass except for return to the field [3].In recent years, crop straw burning phenomenon becomes more and more serious, and it has caused to great harm for environment. Using maize straw preparation of activated carbon [4], not only can solve the problem of a large number of corn straw comprehensive utilization, but also improve the resource utilization. This experiment used straw as its raw material [5], the adsorption value of methylene blue solution and the activated carbon yield as its measurement index. First screening of activator, then explore effective activator by changing solid-liquid ratio, activation time, activation temperature, pyrolysis time and other factors[6],perfect the preparation technological parameters of chemical activation method. This article also discusses the adsorption performance of straw activated carbon, provides the technically feasible reference.

Materials and methods

Materials

Corn stover

Instrument: Multi-parameter electrochemical analyser (DR 5000 type), electronic balance (AUY220 type), oven oscillator (CHA-S type), temperature controller (KSW-4D-11 type), electrothermal constant temperature water bathpot (DK-S24 type), ultrasonic cleaner (KQ-250DB type).

Reagent: 37% hydrochloric acid solution, 98% sulfuric acid solution, methylene blue(A.R), potassium hydroxide(A.R), sodium hydroxide(A.R), phosphoric acid(A.R), zinc chloride(C.P) .

Experimental method

Dipping and activating the corn straw by adding activator such as inorganic salt (eg. H_2SO_4、$ZnCl_2$、H_3PO_4), then carbide it in a certain temperature. Activated carbon could be got by cativating finally. Because the influencing factors are different, such as the carbonization time,

activation temperature [7], activation time and activator concentration, it could be get activated carbon of different pore-size ranges. Put the corn straw into the stoving chest after grinding it (105 ℃,24h), weight 1g straw and adding some activator. Put it into the high temperature tubular resistance furnace [8], control the condition: heating rate 20℃/min, pyrolysis temperature 450-700℃, pyrolysis time 0.5-2.0h.

Protect the experimental process by controlling the N2 [9] flow rate at 0.1m3/h. The production has been cleaning in turn by 3mol/L hydrochloric acid solution, 70 ℃ distilled water till pH is 6-7, ultrasonic cleaner(50W,10min).Put the sample into dying oven at 120℃ for 5 hours, grinding and get the final production through 200 mesh sieve.

Results and Discussion

Effect of Activation temperature

Put the corn straw into the oven after grinding it, and the experimental condition is: activation time 1.0h, ZnCl2 5mol/L,KOH 5mol/L,ZnCl2/KOH=1/1,adsorption time 0.5h.Then it could be get the effect of activation temperature from graph 1.As a result, temperature effect on the performance of the activated product is obviously, and the best activation temperature is 20℃.

Table 1 Effect of activation temperature

Activation temperature(℃)	Yield (%)	Methylene blue adsorption value(mg/g)
15	35.47	37.42
20	30.83	38.04
30	30.11	32.18
35	28.45	31.33

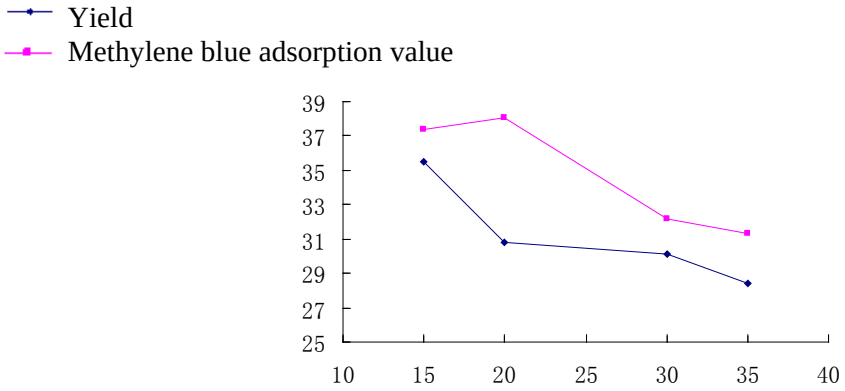

Fig. 1 Effect of Activation temperature

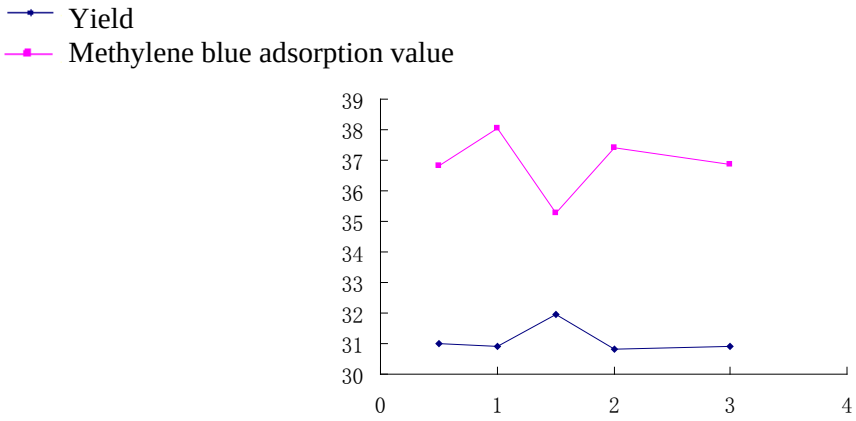

Fig. 2 Effect of Activation time

Effect of Activation time

The experimental condition is: solid-liquid ratio 1g/4mL, activation temperature 20℃,ZnCl2 5mol/L,KOH 5mol/L,ZnCl2/KOH=1/1,adsorption time 0.5h. Then it could be get the effect of activation time from graph 2.As a result, the best activation time is 1.0h.

Table 2 Effect of activation time

Activation time(h)	Yield (%)	Methylene blue adsorption value(mg/g)
0.5	31.02	36.83
1.0	30.91	38.04
1.5	31.95	35.29
2.0	30.82	37.39
3.0	30.90	36.86

Effect of solid-liquid ratio

The experimental condition is: Activation temperature 20 ℃ ,activation time 1.0h,ZnCl2 5mol/L,KOH 5mol/L,ZnCl2/KOH=3/1,adsorption time 0.5h. Then it could be get the effect of activation time from graph 3.As a result, the best solid-liquid ratio is 1g/4mL.

Table 3 Effect of solid-liquid ratio

solid-liquid ratio (g/mL)	Yield (%)	Methylene blue adsorption value(mg/g)
1/1	29.50	23.79
1/2	26.33	25.74
1/2.5	25.41	26.17
1/4	16.50	27.28
1/5	5.83	24.74

Effect of activators remixed ratio

The experimental condition is: solid-liquid ratio 1g/4mL, activation temperature 20℃, activation time 1.0h,ZnCl2 5mol/L,KOH 5mol/L,adsorption time 0.5h. Then it could be get the effect of activators remixed ratio from graph 4.As a result, the best ratio is KOH / ZnCl2=1/1.

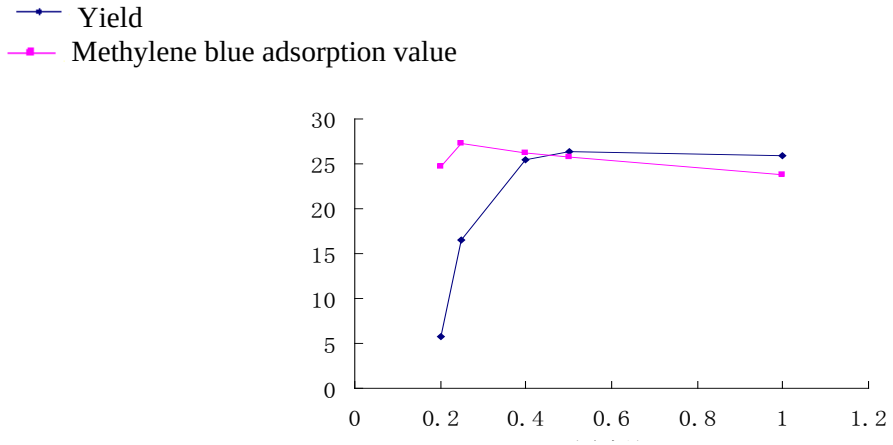

Fig.3 Effect of solid-liquid ratio

Table 4 Effect of activators remixed ratio

KOH/ZnCl2	Yield (%)	Methylene blue adsorption value(mg/g)
3/1	30.88	12.83
2/1	45.42	16.07
1/1	30.91	38.04
1/2	22.80	32.04
1/3	23.75	32.40

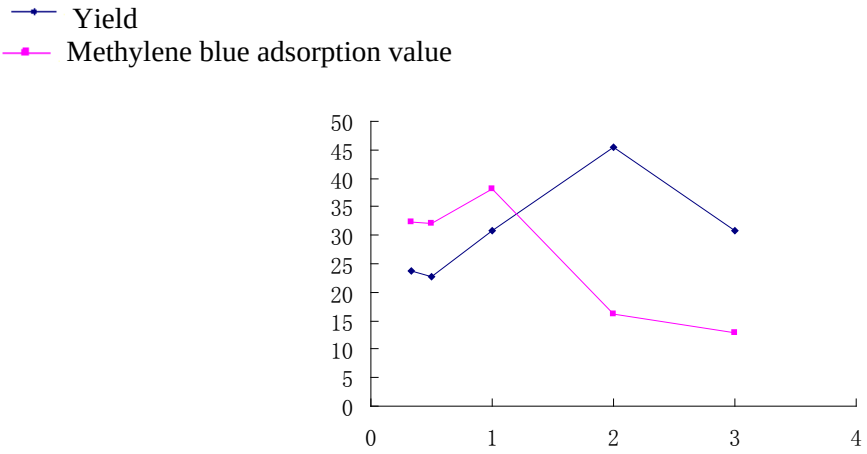

Fig. 4 Effect of solid-liquid ratio

Effect of pyrolysis temperature

The experimental condition is: solid-liquid ratio 1g/4mL, Activation temperature 20℃, activation time 1.0h,ZnCl2 5mol/L,KOH 5mol/L,ZnCl2/KOH=1/1,adsorption time 0.5h. Then it could be get the effect of activation time from graph 5.As a result, the best pyrolysis temperature is 550℃.

Table 5 Effect of pyrolysis temperature

Temperature	Yield(%)	Methylene blue adsorption value(mg/g)
450	34.83	35.20
550	30.83	38.04
700	34.5	37.57

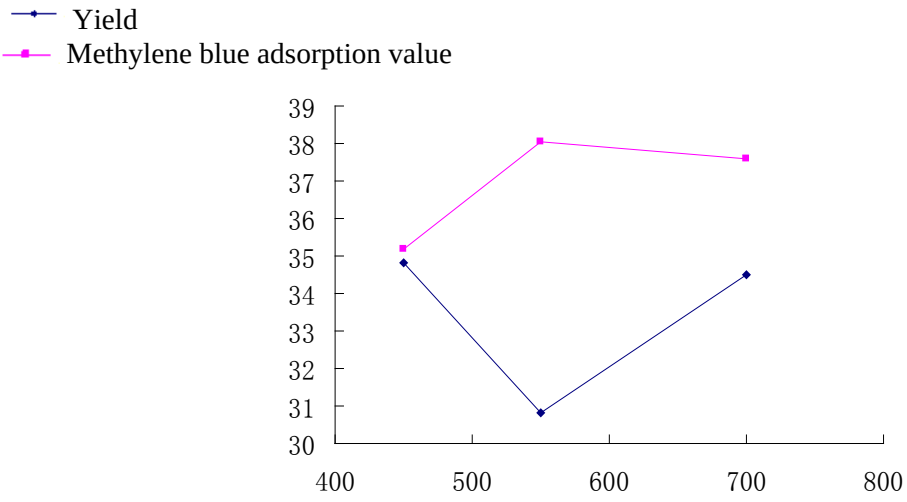

Fig. 5 Effect of pyrolysis temperature

Talbe 6 Effect of washing temperature

Temperature	Yield(%)	Methylene blue adsorption value(mg/g)
25℃	36.18	138.82
40℃	34.37	139.49
80℃	38.91	143.90
90℃	39.17	145.93

Effect of washing temperature

The experimental condition is: solid-liquid ratio 1g/4mL ,Activation temperature 20℃,activation time 1.0h,ZnCl2 5mol/L,KOH 5mol/L, ZnCl2/KOH=1/1, pyrolysis temperature 550℃. Then it could be get the effect of activation time from graph 6.As a result, the best washing temperature is 90℃.

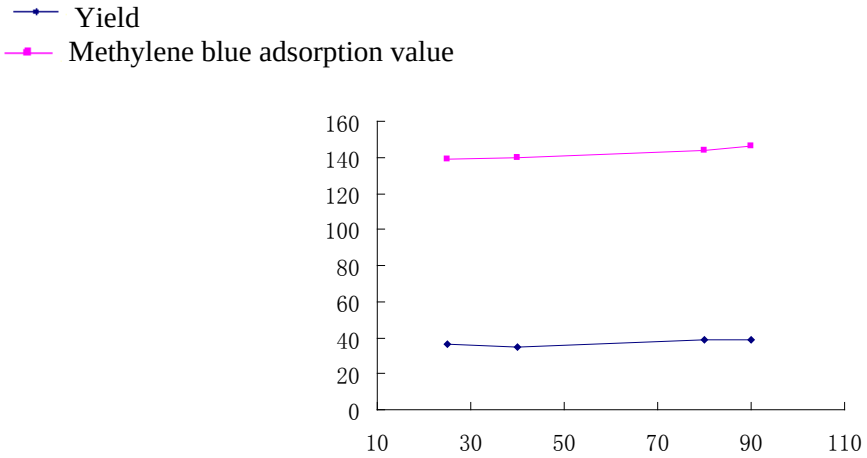

Fig. 6 Effect of washing temperature

Concluding remarks

In This experiment, Methylene blue adsorption value by corn straw activated carbon is used as the measure standard. It could be get the best process condition: ZnCl2 and KOH as the activators, Activation temperature 20℃,activation time 1.0h,ZnCl2 5mol/L,KOH 5mol/L,ZnCl2/KOH=1/1, solid-liquid ratio 1g/4mL, pyrolysis temperature 550℃, washing temperature 90℃. It could be satisfid the satae provisions and requirements, by using activated carbon which prepared with agricultural straw. And because of the economic and feasible preparation technology, this product will have a broad application prospects.

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