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Research of pre-oxidation property of catalytic and mesoporous adsorbent coal

Object of research — coal from Xinjiang Shuixigou prepared activated carbon by adding catalyst and the use of pre-oxidation. Research results shows that the pore size of the activated carbon was 8.55 nm, the specific surface area was 311.89 m^2/g and the iodine adsorption value was 332.13 mg/g. After adding the urea, the nickel nitrate and the iron nitrate, the specific surface area of activated carbon were increased respectively 1.7 times, 1.9 times, 1.7 times. And the iodine adsorption value is increased respectively 2.6 folds, 1.9 folds, 1.9 folds. After adding the ammonium nitrate, the pore size of activated carbon had a significant increase, reaching 16.34 nm. After the air pre-oxidation, the specific surface area of activated carbon increased 2.2 times and the iodine adsorption value increased 1.7 times. Research results indicated that it can improve the specific surface area and adsorptive property of activated carbon by adding catalyst and the use of air pre-oxidation. The ammonium nitrate is contributed to forming the mesopore of the activated carbon.

Key words: coal, catalyst, pre-oxidation, Adsorbent coal, urea, nickel nitrate, iron nitrate.

Today, due to increased demand and the widespread use of adsorbent coal its production development grows. Since the adsorbent coal is porous, it is often used as absorber [1]. The adsorption capacity of adsorbent coal is dependent on the relative surface area and pore size, and therefore now calculate the surface area and pore diameter of the adsorbent coal has become an object of study [2, 3]. According to literary data [4, 5], the effect of the catalyst on the surface area of the adsorbent coal is high. The diameter of the pore and structure the main factor affecting to the adsorption property of the adsorbent coal [6].

According to international standards, the activated charcoal is divided into small pore (d <2 nm), medium porous (2 nm < d <50 nm) and macroporous (d > 50nm). Now, using traditional methods of production of medium porous adsorbent coal to create problems of less relative surface area, which affects to the absorption properties of adsorbent coal. At large porous carbon processing by adding the metal compounds can be prepared medium porous adsorbent coal with larger relative surface area. It is possible to obtain coal with different pore diameters with pre-oxidation. With pre-oxidation is possible to obtain coal with different pore diameters. It is possible to increase the absorption properties of the coal, therefore using as raw material Shuixigou coal, using pre-oxidation in presence of catalysts, using two methods it is possible to improve adsorption properties and increase surface area of adsorbent coal. According to literary source [7], coal ash decreases till 5 %, evaporation is 25–40 %, humidity goes down to 10 %.

T a b l e

Analysis data of Shuixigou carbon

	Industrial analysis, %			Element analysis, %				
Shuixigou coal/carbon	M_{ad}	A_d	V_{daf}	C_d	H_d	O_d	N_d	$S_{t,d}$
	5.42	2.35	34.15	78.52	4.42	13.59	0.84	0.30

According to the Table Shuixigou coal has low ash content, evaporation and humidity, it is good for increasing content of carbon.

Discussion of catalyst influence to adsorbent coal:

1. Without catalyst.
2. Adding NH_4NO_3.
3. $CO(NH_2)_2$.
4. $Ni(NO_3)_2 \cdot 6H_2O$.
5. $Fe(NO_3)_3 \cdot 9H_2O$.

Figure 1 shows the effect of adsorbent coal on iodine adsorption.

According to the figure 1 after adding catalyst carbon iodine adsorption is increasing. At 1 — number value of carbon iodine adsorption is 332.13 mg/g. At numbers 2, 3, 4 and 5 value of carbon iodine adsorption is reaching 432.31 mg/g, 878.34 mg/g, 634.45 mg/g and 616.97 mg/g, along with it after adding of catalyst value of carbon iodine adsorption reaches to its increasing limit. So we can see adding of catalyst is profitably for growth of carbon iodine adsorption value.

The effect of the catalyst on the amount of product. Figure 2 illustrates that at 3, 4, 5 numbers amount of adsorbent coal product is higher than carbon without catalyst, at number 4 amount of product is 15.2 %, at number 2 amount product of adsorbent coal is the lowest, it is 7 %. Also with the addition of various catalysts adsorbent coal adsorption is different, and the product of adsorbent coal is of poor quality. Adding these catalysts $CO(NH_2)_2$, $Ni(NO_3)_2 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$ decreases burning of coal, and amout of product of adsorbent coal increases, but adding NH_4NO_3 as catalyst increases burning of coal, and amout of product of adsorbent coal decreases.

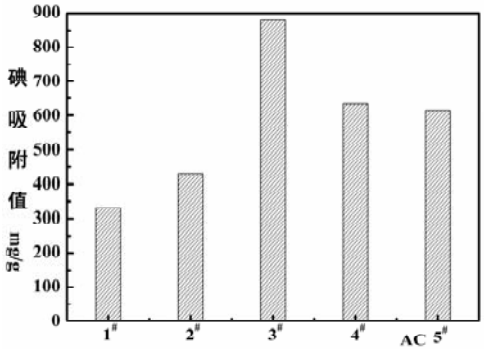

Figure 1. Effect of adsorbent coal on iodine adsorption

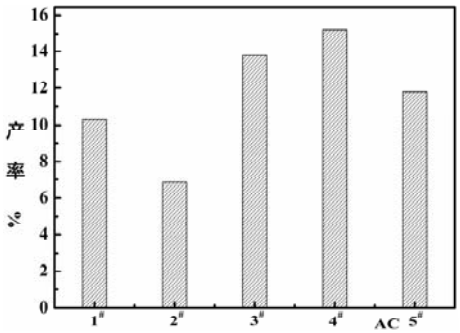

Figure 2. Effect of the catalyst on the amount of product

The effect of catalyst to carbon pore size. According to the Figure 3 pore of carbon is 8.55 nm, volume of pore is 667 sm^3/g, at 3, 4, 5 numbers pore of carbon doesn't change, but volume increases. At number 2 the pore of carbon growths until 16.34 nm. So with ammonium nitrate catalyst mesopore of carbon is formed.

The effect of catalyst to surface area and microporous area of carbon. Figure 4 shows the effect of catalyst on adsorbent coal surface area and microporous area of carbon.

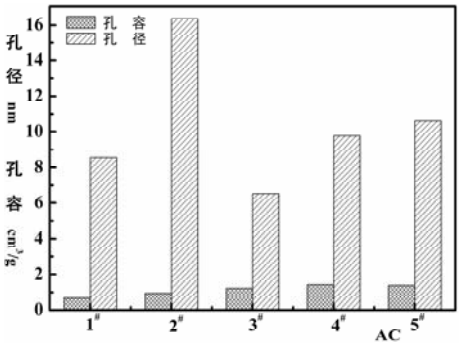

Figure 3. The effect of catalyst on adsorbent coal pore size

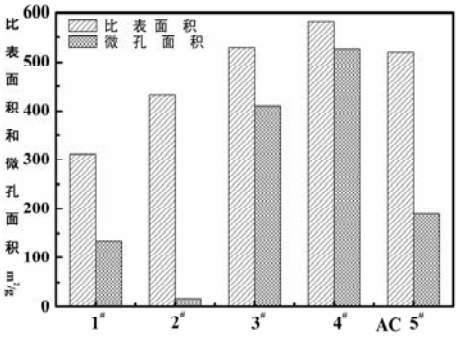

Figure 4. The effect of catalyst on adsorbent coal surface area and microporous area of carbon

According to the Figure 4, at number 1 surface area of carbon is low, after adding catalyst it increases. At 3, 4, 5 numbers surface areas of adsorbent coal are 529.94 mg/g, 580.71 mg/g, and 519.33 mg/g, and at 3 and 4 numbers pore area of carbon is the largest. It is 410.20 mg/g, 527.21 mg/g, so adding urea, nickel nitrate, iron nitrate contributes to improving of surface area of adsorbent coal.

Research and analysis of pre-oxidation of mezoporous adsorbent coal

1. Oxidation with air: Shuixigou coal is pyrolised with heating it until 200 ºC, after it is oxidized with air 2 hours and carbonized, after absorbent coal is taken.

2. Oxidation with HNO_3: Shuixigou coal and HNO_3 solution are poured in flask, filtered, washed and dried, after it is carbonized and absorbent coal is produced.

Figure 5 shows effect of pre-oxidation on iodine adsorption. According to the Figure 5, adsorption of iodine by iodine in sample 2 is the highest, it averages to 562.35 mg/g, but in sample 3 it is lowest, it averages to 279.14 mg/g. Value of adsorption of iodine shows adsorbent properties of adsorbent coal, so the more iodine is adsorbed the better the adsorbent properties of adsorbent coal. That's why oxidation with air improves its adsorbent properties.

Figure 6 shows effect of pre-oxidation to its product amount. According to the Figure 6, in samples 1 and 2 the amount of adsorbent coal product doesn't change, but in sample the amount of product is lowest, it is only 4.3 %. At oxidation of coal with HNO_3, quantity of oxygen rises, properties improves, temperature of activation is decreases, also porosity increases. At oxidation with HNO_3 yield of coal product is decreases.

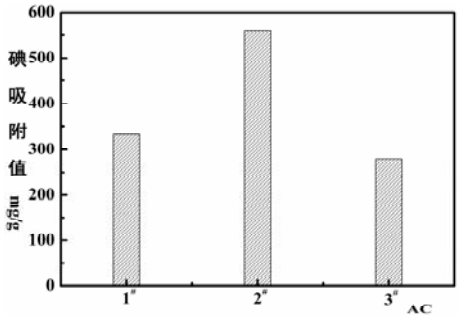

Figure 5. Effect of pre-oxidation on iodine adsorption

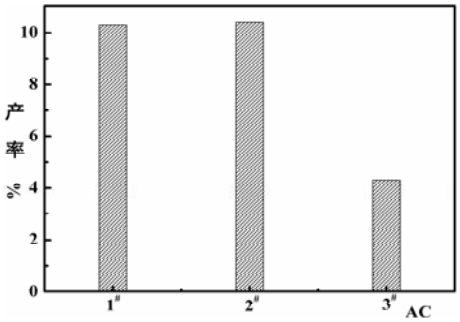

Figure 6. Effect of pre-oxidation on its product amount

Figure 7 shows effect of pore volume on the adsorbent coal. According to the Figure 7, in comparison with sample 1, in sample 2 the pore size doesn't change, but in sample 3 pore size of adsorbent coal is big, it is 18,34 nm.

Surface area and micropore area of pre-oxidized adsorbent coal: as it shown in Figure 8, sample 2 has the biggest surface area about 695.98 mg/g, in number 3 surface area is the least, it is 280.13 m^2/g.

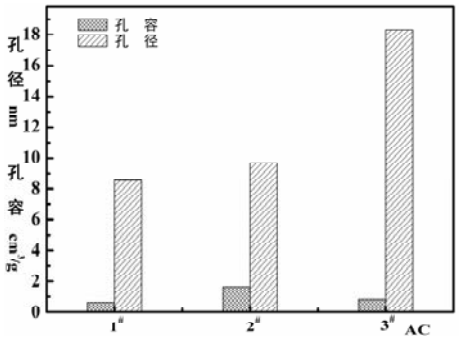

Figure 7. Effect of pore volume on the adsorbent coal

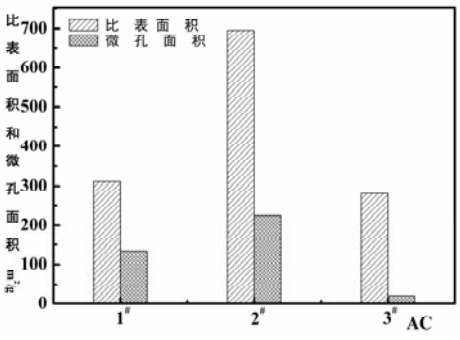

Figure 8. Surface area and micropore area of oxidized adsorbent coal

Conclusion

1. Mezoporous adsorbent coal from Shuixigou coal was gotten, its surface area isn't big, but after adding $CO(NH_2)_2$, $Ni(NO_3)_2 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$ as catalysts surface area achieves 1.7, 1.9, 1.7 particles, and iodine adsorption increases till 2.6, 1.9, 1,9, so catalysts make surface area of adsorbent coal bigger and improves its adsorbent properties.

2. Adding NH_4NO_3 rises the porous of adsorbent coal, which riches 16.34 nm.

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Каталитикалық және мезокеуекті белсендірілген көмірдің алдын ала тотығу қасиетін зерттеу

Ғылыми зерттеу объектісі — Shuixigou Шыңжаң көмірі. Белсендендірілген көмірді екі тәсілмен алуға болады: катализатор қосу және алдын ала тотығуды пайдалану арқылы. Тәжірибе нәтижесінде келесідей мәлімет: Shuixigou белсендірілген көмірінің мөлшері 8,55 нм, нақты бетінің ауданы 311,89 м^2/г, йодтың адсорбция мәні 332,13 мг/г болады. Мочевина, никель нитраты және темір нитратын қосқаннан кейін, белсендірілген көмірдің нақты бетінің ауданы 1,7, 1,9, 1,7 есе және йодтың адсорбция мәні 2,6, 1,9, 1,9 есе жоғарлайды. Сонымен қатар аммоний нитратын қосқан кезде белсендірілген көмірдің кеуектілік мөлшері жоғарлап, 16,34 нм-ге дейін жетеді. Тотығудан кейін белсендірілген көмірдің нақты бетінің ауданы 2,2 есе және йодтың адсорбция мәні 1,7 есе жоғарлайды. Осының нәтижесінде келесідей қорытынды жасауға болады, яғни катализатор қатысында алдын ала тотықтыру арқылы екі түрлі әдіспен белсендірілген көмірдің салыстырмалы беттік ауданын және адсорбциялық қасиетін арттыруға болады және аммоний нитратының қатысында белсендірілген көмірдің мезокеуектілігі қалыптасады.

Шау Ен, Жу Сишун, Ю Шини, Жен Лили, М.И.Байкенов, А.Б.Татеева, Ж.Булаш, Н.А.Оразова, Н.Ж.Рахимжанова, А.Б.Балтабаева

Изучение свойств предварительного окисления каталитического и мезопористого активированного угля

Объект исследования — Shuixigou уголь Шынжан. Получение активированного угля осуществлялось двумя методами: в присутствии катализатора и путем предварительного оксиления. При проведении эксперимента были получены следующие результаты: количество активированного угля Shuixigou составляло 8,55 нм, удельная площадь поверхности равна 3,11 м^2/г, адсорбция йода составляла 332,13 мг/г. При добавлении мочевины, нитрата никеля и железа удельная площадь поверхности активированного угля увеличивается соответственно в 1,7; 1,9; 1,7 раза, а адсорбция йода возрастает в 2,6; 1,9; 1,9 раза соответственно. При добавлении нитрата аммония пористость активированного угля увеличивается и достигает 16,34 нм. После окисления удельная площадь активированного угля увеличилась в 2,2 раза, а адсорбция угля — в 1,7 раза. По результатам исследования сделано следущее заключение, что при предварительном окислении и в присутствии катализатора можно увеличить удельную поверхность и адсорбционную способность активированного угля, а также в присутствии нитрата аммония наблюдается мезопористость активированного угля.