CO2 Adsorption on Nanoporous Activated Carbon

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Introduction

Carbon dioxide separation is very important in natural gas sweetening. It is one of the most important gases that have a greenhouse effect, and it has destructive effects on the earth's environment. Therefore, its separation and storage is of high importance.A suitable method for the separation and storage of carbon dioxide is using carbonic adsorbents[1,2]. Activated carbon is one of the most important industrial adsorbents of carbon, and the optimization of the effective parameters in its synthesis has a great importance[3,4]. The adsorption capacity of carbon nanotubes as a new carbon structure has been compared to that of the activated carbon. The adsorption isotherms compared to those of activated carbon have been presented as well.

Experimental

Three active agents ZnCl2, KOH, and H3PO4 were used in the experiments. Walnut shell was used as the raw material to synthesis the activated carbon. Walnut shell was mixed with the active agent for two hours at 60-80°C. Then obtained sample was kept at 150°C for 12 hours.

The obtained sample was put in the furnace, based on the type of the active agent and operating condition on table1.

Table 1. Operating Conditions for three active agent

Adsorbent	Active agent	Temperature of Activation	Time of Activation
AC-1	H3PO4	450	55 min
AC-2	KOH	750	1 h
AC-3	ZnCl2	550	1 h

After being washed with acid and being neutralized, the sample was kept at 110°C for 12 hours.

As shown in Fig. 1, such an apparatus was devised and used to measure gas uptake. At the beginning of the adsorption test, the sample column was filled approximately with two grams of AC sample. To release all the existing gases, it was degassed at 150 °C in vacuum pressure. After about two hours, the column was cooled and put in a water bath with constant temperature. Note that during the test both tanks were kept in the constant ambient temperature due to get an isothermal adsorption.

At first, we let the storage tank to get to pressure we need. Next the stored gas is led to the sample column to be adsorbed. Finally, the time of adsorption and the equilibrium pressure will be recorded. This test will be also repeated with Helium gas as a voucher. Since the pressure gradient in methane test doesn't stand for the amount of gas adsorbed, the pressure difference recorded during Helium test should have been subtracted from previous data. Subsequently, the reported pressure gradient will be used to account the mass of adsorbed gas.

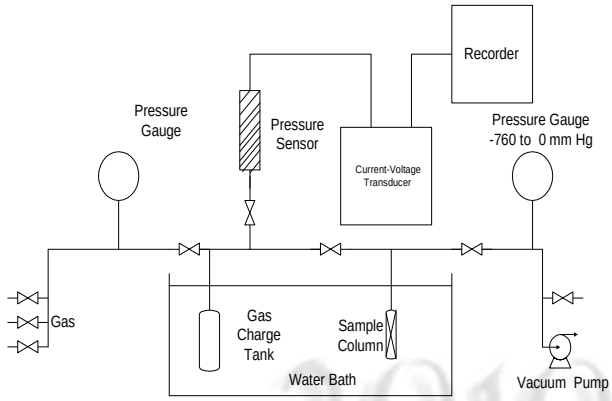

Fig. 1 schematic of experimental apparatus for gas adsorption

Results and Discussion

Carbon dioxide adsorption isotherm data was obtained for each of the absorbents at the 25°C and at a pressure of 1-10 bars. The following table includes the adsorption capacity of the adsorbents at 10 bars.

Adsorbent	CO2 Adsorption Capacity (cc/gr)
AC-1	113
AC-2	135
AC-3	107

Table 2. Adsorption capacity for three adsorbent

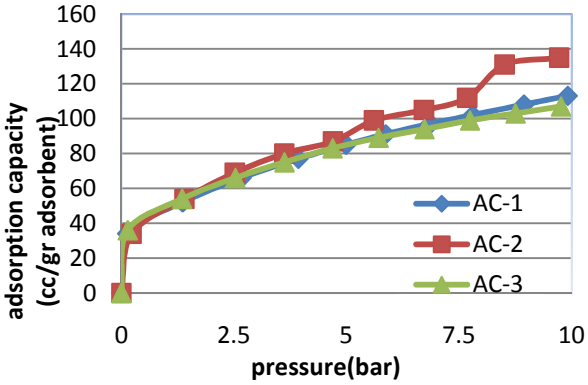

Fig 1: The comparison of the adsorption isotherms absorbent with different activating agent

Considering the proper adsorption capacity of the adsorbent prepared with KOH, the effect of activation temperature was studied. Therefore, two new adsorbents were prepared at 650°C and 700°C. The adsorption capacity and isotherm of the said adsorbents are shown in table 2.

Table 2. The comparison of the adsorbents with KOH activating agent at various temperatures

Adsorbent	Adsorption Capacity (cc/gr)
AC-2-750	135
AC-2-700	172
AC-2-650	78

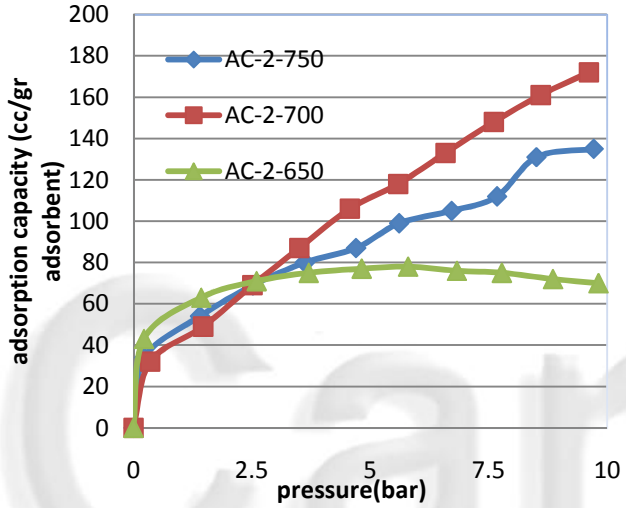

Fig 2: The comparison of the adsorbents prepared with KOH activating agent at various temperatures

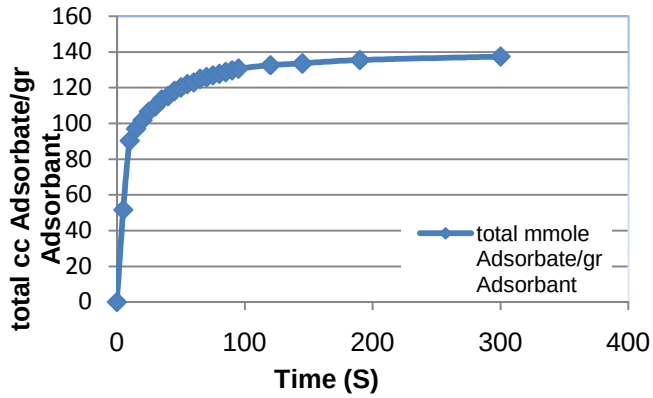

Fig 3: shows the kinetics of adsorbent AC-2-700 as the best synthesised absorbent.

Afterwards, the adsorption capacity of carbon nanotubes as a new carbon nanostructure was studied.single walled carbon nanotubed was prepared by CVD method , according to our previous work[5]. carbon dioxide adsorption capacity was compared to that of the activated carbon. As shown in Fig.4 the CO2 adsorption capacity 60cc/gr adsorbent was obtained

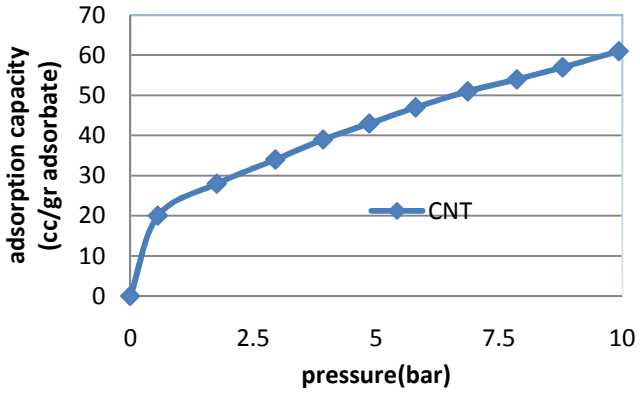

Fig 4: CO2 adsorption isotherms of single-walled nanotubes

Conclusions

Activated carbon was prepared by chemical activation method. Effects of Temperature and activating agent (ZnCl2, KOH, and H3PO4) were studied on Activated carbon preparation and the products were used for CO2 adsorption. And the optimum condition for activated carbon synthesis was obtained.

CO2 adsorption was studied at 25°Cand at 1-10 bars. The results show that the adsorbent with KOH activating agent and 700°Cagent had a higher adsorption capacity (172cc/gr adsorbent) than the other adsorbents. In addition, single walled carbon nanotubes was used as an adsorbent for CO2 adsorption and compared with activated carbon. Results revel that the prepared activated carbon adsorbents has a higher CO2 adsorption capacity compare to carbon nanotubes adsorbent.

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