

PREPARATION OF ACTIVATED CARBON FIBERS FOR XENON ADSORPTION II: EFFECT OF STRUCTURE ON XENON ADSORPTION CAPACITY*

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Abstract: In this paper, a series of activated carbon fibers with different pore width distribution were tailored. Their pore structure and surface chemical structure were characterized. The static adsorption characteristics of these ACF for Xenon, and the effect of pore structure and modification of ACF on adsorption for Xenon were studied. The results indicated that the width of micropore could be easily tailored by changing activation temperature. Increasing the activation temperature, the specific surface areas of SACF increase, and the distribution of pore diameter is broadened, however, which led to the decrease of the adsorption capacities of these ACFs for xenon gas. The experimental results also revealed that the adsorption of xenon on ACF was a kind of process that Xenon molecule fills in the micropores; thus, the narrow pore width would be advantageous to the adsorption of xenon molecule due to the high adsorption potential. The results also reveal that the chemical modification of carbon surface will also increase their xenon adsorption capacity.

Keywords: Activated carbon fiber, Adsorption, Xenon

1. INTRODUCTION

Activated Carbon Fibers (ACF) is a new type fiber adsorbent, with plenty of micropore structure, and high specific surface area. It has been widely used in a lot of fields such as environment protection, catalyzing, as well as medical and military industries.

The adsorption of radioactive noble gases by Activated carbon fiber (ACF) has many usages, which includes the capture and purification of radioactive waste gas from nuclear power plants, and the concentration of fissile noble gas for the monitoring of nuclear test. Our previous works showed that activated carbon fiber have high adsorption capacity for xenon gas, and the adsorption amounts also has close relationship with the pore structure of ACF. In this paper, a series of ACF were prepared, and then have been chemically modified. Their xenon adsorption performance has been studied.

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2 EXPERIMENT

Viscose or pitch based activated carbon fiber employed in this paper were prepared by heating viscose fiber or pitch fiber to a certain high temperature under inert atmosphere and then activated with steam for different time. ACF fabrics were treated with NaOH, CuSO₄, and FeCl₃, independently, then dried under vacuum at 100 °C. The different kinds of modified ACF fabric were put into a self-constructed adsorption device for the test of their adsorption coefficient for Xenon under 0 °C and 40 °C.

3 RESULT AND DISCUSSION

Fig 1 shows the xenon adsorption isotherms at 0 °C on ACFs activated at different temperature. The results show that the xenon adsorption capacities of ACF decrease with the activation temperature increase. The higher the activation temperature, the lower the xenon adsorption capacity of the ACF, which may due to the enlarge of micro-pore size of ACF while they were activated at high temperature, and the enlarged micropore become less adsorption potential to the xenon molecules.

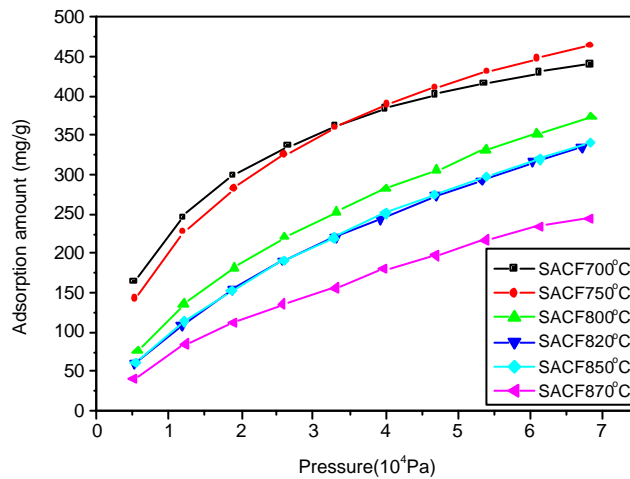


Fig.1 The xenon adsorption at 0 °C on SACF activated at different temperature

Fig 2 and Fig 3 show the isotherm of Xenon adsorption at 0 °C and 40 °C on ACF fabrics treated by NaOH. Compared with that of the original ACF fabric only washed with water, the adsorption coefficient of those ACF treated by NaOH have obvious increase. Adsorption capacity of ACF fabrics treated by different concentration of NaOH solution differ each other, it seems that those ACFs treated by lower concentration of NaOH have higher xenon adsorption capacities than ACFs treated by higher concentration NaOH.

The adsorption amounts of xenon on ACFs at 40 °C were only half of that at 0 °C, however, they show the similar trend, xenon adsorption capacity was enhanced by the treatment with proper concentration of sodium hydroxide solution.

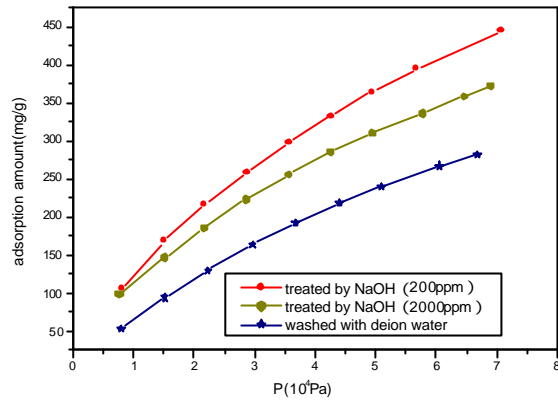


Fig 2: Isotherm of Xenon adsorption at 0°C on ACF modified by NaOH

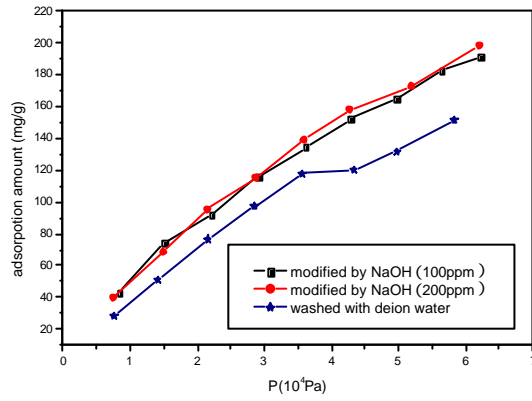


Fig 3: Isotherm of Xenon adsorption at 40°C on ACF modified by NaOH

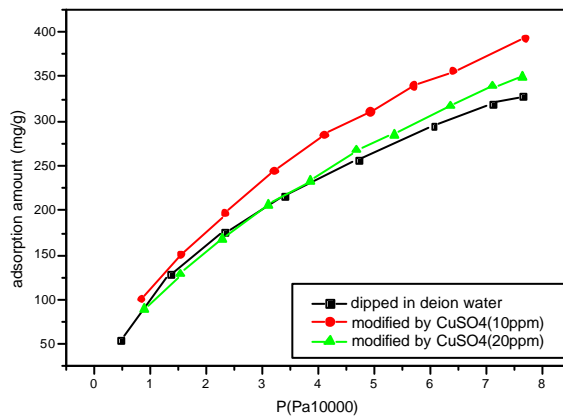


Fig 4 Isotherm of Xenon adsorption at 0°C on ACF modified by CuSO₄

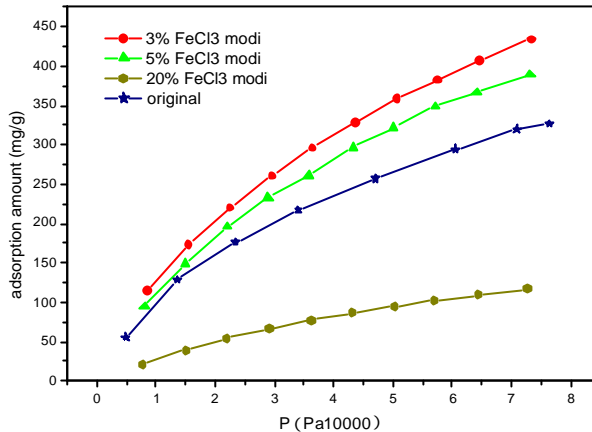


Fig 5 Isotherm of Xenon adsorption at 0°C on ACF modified by FeCl₃

Fig 4 shows the Isotherm of Xenon adsorption at 0 °C on ACF modified by CuSO₄. The results show that the adsorption coefficient of ACF fabrics modified by proper concentration of CuSO₄ can be obviously increased.

Fig 5 shows the Isotherms of Xenon adsorption at 0°C on ACF fabrics modified by FeCl₃. The results indicate that Xenon adsorption on ACF fabrics can also be enhanced by the modification of FeCl₃, it seems that the treatment with 3% FeCl₃ solution has the highest increase in the xenon adsorption capacity.

4 CONCLUSION

The xenon adsorption capacity of activated carbon fiber closely relate to their pore and surface chemical structure. By controlling the activation condition, the pore size distribution of activated carbon can be tailored, and can thus increase their xenon adsorption capacity. Moreover, proper chemical modification of surface structure of activated carbon fiber can also enhance the interaction between carbon surface on xenon molecules, thus increase the adsorption capacity of activated carbon fiber for noble gas.

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