

INFLUENCE OF WATER VAPOUR ON THE ADSORPTION OF SO₂ ON ACTIVATED CARBON FIBER

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Introduction

Activated carbon materials have been used commercially to remove SO₂ from coal combustion flue gases^[1,2]. Recent studies have showed that activated carbon fibers (ACFs) may have potential in this application due to their high SO₂ adsorption capacity^[3,4]. The presence of water vapor will increase the SO₂ adsorption on activated carbon^[5]. However, how H₂O affect the adsorption of SO₂ over ACFs are not established. This is the main objective of this work.

Experimental

ACF prepared by activation with 3.5M ammonia was heat-treated in N₂ atmosphere at 1000 °C for 1h. Some properties of calcined ACF are summarized in Table 1.

The weight gain of ACF after gas adsorption was calculated by the basis of the weight of fresh sample in all cases. SO₂ and H₂O retained by ACF were determined by weighting. 0.10g ACF was packed in a glass tube (10mm diameter) where N₂ (containing 2000 ppm of SO₂ with or without 5-15vol%) is flowing (100ml/min) for 1h at 60 °C.

Temperature programmed desorption (TPD) experiments were performed on the ACF after SO₂ adsorption. 0.1g of sample was heated in N₂ (100ml/min) up to 450 °C at a rate of 5 °C/min. A flame photometric detector (SP-502) was used to monitor the amounts of SOx evolved.

Results and discussion

Table 2 summarized the weight gain of ACF and the amounts of SOx evolved after SO₂ and/or H₂O adsorption. The marked difference in the weight gain of ACF was observed when the adsorption of SO₂ and H₂O over ACF was carried out separately in the different order. This means that the adsorption of them over ACF interfered each other, suggesting that SO₂ and H₂O competed for the same surface sites. When H₂O was first adsorbed onto the carbon and SO₂ subsequently adsorbed, H₂O preadsorbed over ACF was displaced by SO₂. On the contrary, when

SO₂ and H₂O was adsorbed separately in the opposite sequence, H₂O did not wash out SO₂ preadsorbed on the carbon, indicating that the adsorption ability of H₂O is much weaker than that of SO₂.

The weight gain of ACF after simultaneous adsorption of SO₂ and H₂O on carbon was much larger than that of ACF after adsorption of SO₂ and H₂O separately in the different order. When the content of H₂O was increased at constant concentration of SO₂, the weight gain of ACF increased rapidly, whereas the amounts of SOx desorbed decreases. This confirmed that the sites which were occupied by SO₂ and H₂O were same.

Figure 2 illustrated that TPD profiles of thermally desorbed ACF after the adsorption of SO₂ in the presence of H₂O. One desorption peak with a temperature range between 150 °C and 400 °C, corresponding to strongly bonded state of SO₂^[2], was observed regardless of content of H₂O. Each peak areas in figure 2 were about 3 times larger than those in figure 1, indicating that the SO₂ adsorption on ACF can be enhanced by the presence of H₂O, and that the increasing amounts of SO₂ adsorbed attributed to the adsorption amount in strongly bonded state of SO₂. However, it is not clear why ACF adsorbed more SO₂ in the presence of water vapor and in the absence of oxygen gas.

Conclusion

When the adsorption of SO₂ and H₂O over ACF was carried out, SO₂ and H₂O competed for the same sites. However, the adsorption ability of SO₂ was much stronger than that of H₂O. The adsorption of SO₂ can be enhanced by the presence of H₂O, the increasing amount of SO₂ adsorbed resulted from the adsorption amounts of strongly bonded state of SO₂.

Reference

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Acknowledge

The authors thanks National Natural Science Foundation of China for financial support (project number: 29577285,29633030)

Table 1. Elemental analysis and pore structure of ACFs

Sample	Elemental analysis(wt%)					S _{BET} m ² /g	V cm ³ /g
	C	H	S	O*	N		
N-4 (HT1000)	97.71	0.69	0.17	1.16	0.27	1470	0.59

*:by difference; S_{BET} :specific surface area; V: total pore volume

Table 2. The weight gain of ACF and the amount of SO_x evolved after SO₂ and/or O₂ adsorption

	weight gain of ACF /mg/g	amount of SO _x evolved/mg/g
adsorption of SO ₂ firstly	14.1	
adsorption of 10vol%H ₂ O subsequently	172.3	13.7
adsorption of 10vol%H ₂ O firstly	121.2	
adsorption of SO ₂ subsequently	20.8	12.7
SO ₂ +5vol%H ₂ O	189.3	42.8
SO ₂ +10vol%H ₂ O	301.2	39.7
SO ₂ +15vol%H ₂ O	369.8	35.2

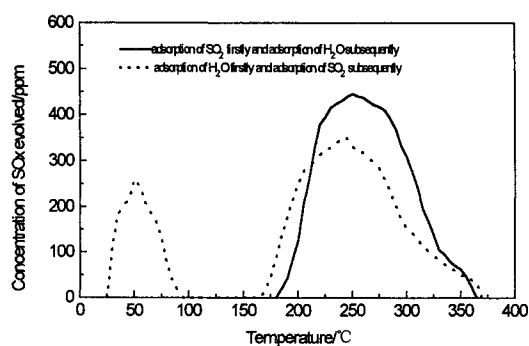


Fig.1 TPD spectra of adsorbed SO₂ species over ACF.

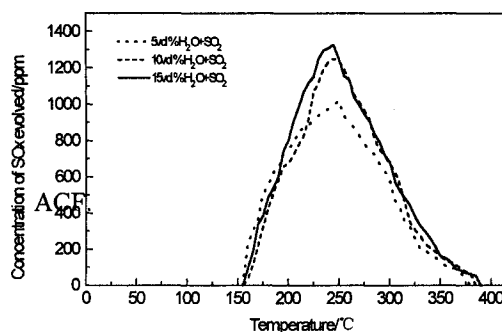


Fig.2 TPD spectra of adsorbed SO₂+H₂O species over