

# REMOVAL OF DIMETHYL SULFIDE (DMS) IN CITY GAS WITH IMPREGNATED ACTIVATED CARBONS AND CARBON FIBERS

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## Introduction

Large capacity of active carbons to trap sulfur is most wanted to apply city gas as the clean fuel for fuel cell. The present authors reported that the active carbons could trap completely DMS for some time, and the breakthrough capacity appears to depend on the oxygen and nitrogen as well as surface area. Pore size appears also to be influential.

In the present study, active carbons and carbon fibers were oxidized with HNO<sub>3</sub> impregnated and heat-treated at 100–200 to improve their capacities for DMS trap. The pore size was concerned because HNO<sub>3</sub> most penetrate into the pore.

## Experimental

The active carbons and active carbon fibers examined on the present study are listed in Table 1. The surface areas distributed from 450 to 3100 /g. The pores were as meso (MP60, 90) and MGC micro (other adsorbents), Oxygen content distributed from 5% to 13%. Adsorption capacity was measured by a flow system (Figure 1). City Gas

supplied by Tokyo Gas was diluted with N<sub>2</sub> and flown at 30 through the adsorbent bed (200mg) in the reactor. the flow rate was 100 ml/min.

## Results

Figure 1 illustrates the breakthrough profiles of DMS over HNO<sub>3</sub>-treated ACFs and as-received FE-100. HNO<sub>3</sub> treated MP-90 was as long as 60h, being 30times that of as-received MP-90. It is of value to note that enhancement by treatment depended on the ACF and that the degree of enhancement was independent up on the capacity of as-received forms. Large surface and large pore appear keys for the larger enhancement. Table 1 shows the oxygen contents of ACFs after the HNO<sub>3</sub> treatment, which increased the content very remarkably. However the content itself was not directly related to the capacity.

Figure 2 compares breakthrough profiles

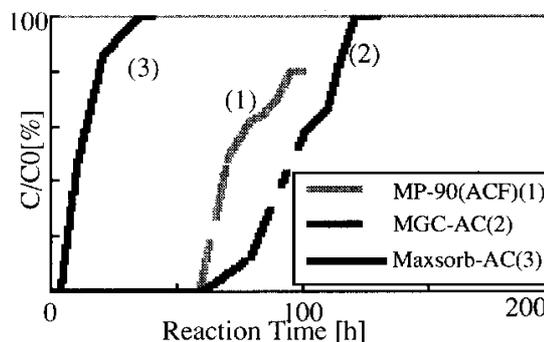


Figure 2 Breakthrough Profiles of DMS over HNO<sub>3</sub>-heat treatment(120°C)ACF and ACs

Table 1 Analysis of heat treated 120 °C ACFs after HNO<sub>3</sub> treated

	Elemental analysis[wt/%]			
	C	H	N	O(diff:)
(Pitch-ACF)				
OG-20A	70.3	1.6	1.3	26.8
MP-90	66.3	1.5	1.7	30.5
(PAN-ACF)				
FE-100	58.6	2.0	6.9	32.5

Table 1 Analysis of heat treated 120°C ACFs after HNO<sub>3</sub> treated

	Elemental analysis[wt/%]			
	C	H	N	O(diff:)
Maxorb	62.2	1.5	1.1	35.2
MGC	73.5	0.8	4.5	21.1

of ACs HNO<sub>3</sub> treated. Mesoporous MGC obtained a largely increased breakthrough time which was comparable to that of MP-90 treated, and gradual increase of outlet DMS concentration. In contrast, Maxsorb did not show marked increase of breakthrough time. Large increase is oxygen contents of both ACs. It suggests the pore size is an important factor for the enhancement by HNO<sub>3</sub> treatment.

Figure 3 illustrates breakthrough profiles of MGC-AC HNO<sub>3</sub> treated at 120~200 °C. Treatment at 150 °C appears best to give the largest breakthrough time as long as 120hr. Gradual increase of outlet DMS was also reserved by this treatment.

Table 3 shows the oxygen content of treated MGC-AC. Treatment at 150 °C provided the longest oxygen content and nitrogen content significantly. Some decomposition of the oxygen functional group may take place beyond 150 °C.

### Discussion

HNO<sub>3</sub> treatment of ACs and ACFs enhanced DMS removal markedly. The breakthrough time beyond 120h in the present study may promise the practical application. The HNO<sub>3</sub> treated AC trapped TBS also very efficiently.

HNO<sub>3</sub> treatment is very effective to mesoporous active carbons and active carbon fibers. Heat treatment at 150 °C appears best to increase the oxygen at this temperature. Such results suggest the DMS is oxidized the active carbon to form SO<sub>3</sub> adsorbed on the pore wall surface. Pore size may be important by two ways. One is related to the penetration of HNO<sub>3</sub> into the pore, and the other is trapping SO<sub>3</sub> in the pore. Mesopore can accept HNO<sub>3</sub> which is oxidized the pore wall. When heated above 120 °C the oxygen function groups on the wall may leave the largest amount

of oxygen functional groups on the pore wall by the maximum oxidation and minimum decomposition of the group SO<sub>3</sub> stays in the pore, Hence pore volume influences also the capacity for DMS trap and cleaning.

Thus mesoporous carbon enjoys the results of HNO<sub>3</sub> treatment.

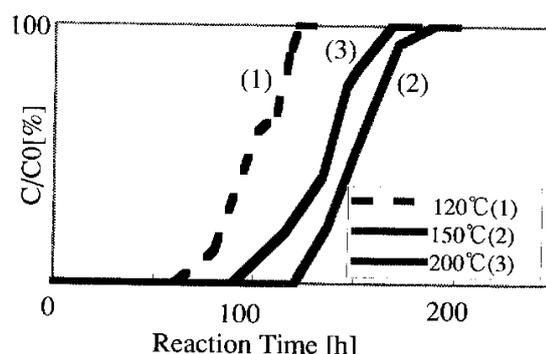


Figure 3 Breakthrough Profiles of DMS over HNO<sub>3</sub>-heat treat MGC

Table 3 Analysis of heat treated 120,150,200 °C MGC-AC after HNO<sub>3</sub> treated

		Elemental analysis [wt/%]			
		C	H	N	O(diff.)
120	Ž @ 73.5	0.8	4.5	21.1	
150	Ž @ 72.5	0.4	5.1	21.9	
200	Ž @ 76.1	0.5	4.9	18.5	