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On the Improvement of Odor Control with the Adsorption and Absorption Methods

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Abstract. To control the various malodorous substances efficiently, we have analyzed various kinds of odor emission factories, and considered the control of major kinds odor components especially in adsorption and absorption technology. We studied about efficient adsorption of ACF(Activated Carbon Fiber) onto fixed bed according to the degree of surface characteristics such as treatment by chemical substance, acid-base and the degree of impregnation or with the degree of humidity. The major methods of odor analysis was air dilution sensory methods with the olfactory odor detection. We could compare the good and various conditions of odor control devices. And we could find a optimal methods to control various odorous materials with absorption and adsorption with major kinds of chemical processes.

Keywords: Activated carbon fiber(ACF), fixed bed, impregnated liquid, adsorption, absorption, organic functions test, air dilution olfactory method

1. Introduction

Due to complex function of cities, we could observe the residential regions vulnerable to odor pollutions from the manufacturing areas and landfill facilities in most big cities in Korea. Especially in the manufacturing areas adjacent to apartment regions, we can find out the civil appeals of odor pollutions which are from human livings.

The chemical substances such as ammonia(NH_3), methyl mercaptan(CH_3SH), hydrogen sulfide(H_2S), acetaldehyde(CH_3CHO), and trimethylamine(C_3H_9N) are mentioned as representative malodorous substances. And we could perceive the smell of that partial malodorous substances with a very thin concentration. Because of the property not to be diluted with air, the effect of the substances may cover a long distance even with a low degree. Also, the malodorous arising in work places could have some effects on human bodies as they are discharged with harmful air contaminating substances.

In this study, we reviewed various kinds of adsorbents to control the malodorous substances efficiently [1]. And, especially, the samples from adsorption and absorption control devices were analyzed with air dilution sensory methods to evaluate the performance of control devices.

2. Experimental

In general, we have studied some kinds of method such as absorption method, combustion method, oxidation method and adsorption method to eliminate the malodorous substance, and in those methods, the adsorption method which is remarkably simple and economic. Fig. 1 depicts porousactivated carbon particle with many pores [2]. Active carbon is commonly used as an adsorbent for adsorption method to eliminate the bad smell, however, active carbon has small capacity in eliminating adsorption, so that we suggest to treat or develop the surface of active carbon with some chemical substances or to impregnate the chemical substances.

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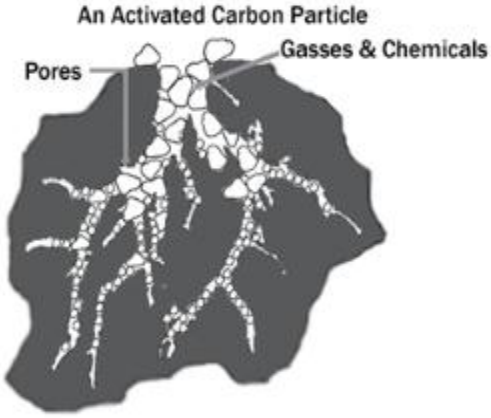


Fig. 1: Porous activated carbon particle with many pores [2]

2.1. Air Dilution Sensory Methods

The method of measuring the odor concentration which gives human to have disgust feeling is used to analyze the emission source and boundary region in terms of odor intensity. The criterion of odor emission standards were illustrated in Table I.

Table I: Criterion of odor emission standards

Classification	Emission standard (dilution ratio)		Range of strictemission standard (dilution ratio)	
	Industrial area	Other zone	Industrial area	Other zone
Stacks	Below 1000	Below 500	500~1000	300~500
Boundary zone	Below 20	Below 15	Below 15~20	10~15

2.2. Odor Panel

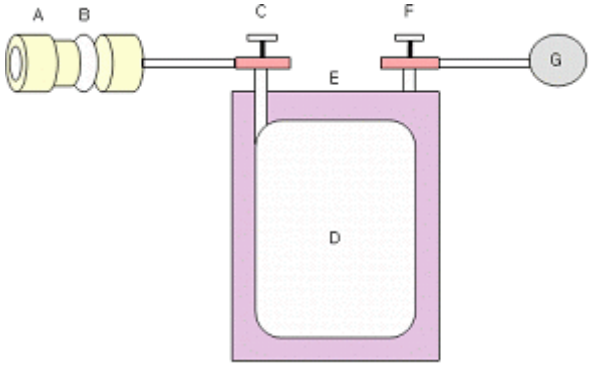
The Odor Panels are consisted of at least the first five persons and they are selected after passing organic functions test using the panel test solution as shown in Table II.

Table II: Panel Test Solution

Test Solution	Concentration	Manufacturing Solution	Smell of nature
Acetic acid	1.0 wt%	Distilled water	Vinegar scent
Trimethlyamine	0.1 wt%	Distilled water	Stench of fish
Methlcyclopentenolone	0.32 wt%	Liquid paraffin	Burnt sugar-like
β-Penylethylalcohol	1.0 wt%	Liquid paraffin	A rose smell

2.3. Sampling of Odors

We conducted the odor sampling experiment with indirect vacuum box with Tedlar bags. We measured the temperature, pressure using thermometer and pressure gauge at the sampling port. Sampling locations were at the stacks and boundary zone of each factory. Sampling system is shown in Fig. 2.



A: holder **B**: filter **C**: coke **D**: sampling bag
E: sampling system **F**: suction coke **G**: suction pump

Fig. 2: Sampling system

3. Results & Discussions

From the air dilution sensory methods, it couldbe obtained that various target efficiency with good case and the opposite case as in Table III. And typical characteristics of AC and ACF are summarized in Table IV [3].

Table III: Results of air dilution sensory methods

Control Devices [m³/min]	inlet	outlet
T-Factory, Adsorption 300	310	24
D-Factory,Absorption 1000	448	17

ControlDevices [m³/min]	inlet	outlet
M-Factory,Adsorption 400	100	44
S-Factory, Absorption 600	120	310

Table IV: Comparison of the AC and ACF [3]

	Activated Carbon Fiber	Pellet Carbon
Pore structure	-Composed of micropore	-Composed of Micropore ,mesopore and micropore
feature	-Adsorption is faster than Pellet Carbon -Activated carbon fiber has an excellent adsorption due to the specific surface area much larger than Pellet Carbon. -Range of application is very wide.	-Are widely used in various fields. -Microporesis relatively well developed and surface is greater.
Driving feature	-Less dust and easy to handle.	-upper and lower packing density of activated carbon is being differently due to vibration during operation. -The wear of the granular activated carbon is generated by the wind pressure.
fault	-The price is expensive as compared to Pellet Carbon.	-There are drifting phenomenon and the pressure loss at large and the device driver. -Adsorption speed slower when compared with Activated Carbon Fiber.
Surface	-Surface area is wider approximately 1.4 times than the granular activated carbon.	

Table V: Object gas ofACF with type of impregnated-liquid [4]

Object Gas	Type of impregnated-liquid
hydrogen sulfide(H_2S)	NaOH, KI, Na_2CO_3
methyl mercaptan(CH_3SH)	NaOH, KI, Na_2CO_3
ammonia(NH_3)	HNO_3, H_3PO_4,H_2SO_4
trimethylamine(C_3H_9N)	HNO_3, H_3PO_4,H_2SO_4

From the results of the experiments conducted by Kim Ki Hwan [3], it was demonstrated that, H_2S - acid odor increased by 2.1 times in case of treating NaOH compared with pure ACF and, increased by 7.2 times in case of Na_2CO_3 impregnation. In terms of CH_3SH, with NaOH treatment and Na_2CO_3 impregnation,there was little increase in elimination efficiency but the velocity of the adsorption appeared to increase slightly [3]. Also, the efficiency of C_3H_9N increased by 2.5 times in treating H_2SO_4 [5], and these are illustrated in Table V. Especially with KI, both CH_3SH and H_2S showed significant increases, obtaining the results that they achieved elimination efficiency [6]-[8]. The base odor - NH_3 and C_3H_9N showed some increases after treating acid substances [9]. The elimination efficiency of NH_3 increased by 3.4times in treating H_3PO_4 , by 5.8 times in treating H_2SO_4 and the efficiency of C_3H_9N increaed by 1.7 times in treating H_3PO_4 [10].

From this study, it would be known that absorption is more desirable than adsorption according to the solubility of adsorbate with the organic or inorganic properties. Because of complex properties with odor components, there are many factors for optimal design of absorbers that more studies would be continued with operation of absorption for the control of odors [13], [14].

4. Conclusions

From this study, it could be known that the best and the opposite condition of odor removal in the control device in the adsorption and absorption from the air dilution sensory methods in our measurements. And it could bereviewed that optimal operating conditions comparing the adsorbent operation on variousodor in terms of acid oder - H_2S and CH_3SH. And if we impregnate KI liquid on ACF, it could be expected that more efficient elimination compared with the case of pure ACF. And in the future, we will make a plan to operating the continuous experiments comparing the adsorption onto fixed bed and adsorption onto fluidized bed.

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