A STUDY ON PASSIVE SAMPLING METHOD OF VOLATILE ORGANIC COMPOUNDS EMANATING FROM HUMAN SKIN.

(ヒト皮膚から発散する揮発性有機化合物の受動的測定法に関する研究)

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1. Introduction

Volatile organic and inorganic compounds emanating from human skin is potentially a non-invasive indicator of individual health condition. For example, acetaldehyde is well known as metabolite of ethylalcohol, and the measurements of acetone are very important in the diagnosis and treatment of diabetic[1]. We have developed a new type of passive diffusion sampler, which is a simple device to determine an emission flux of acetaldehyde and acetone from the surface of the human skin and then applied to measure influences of individual health conditions of volunteers on the fluxes.

2. Experimental

2.1 Sampling method and probe

Gases emanating from human skin were collected on the tapping filter, and reacted with 2,4-dinitrophenylhydrazine(DNPH) as follows.

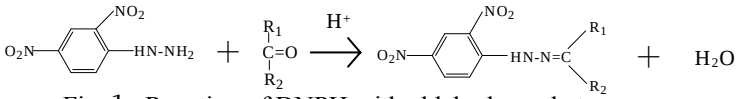

Fig. 1　Reaction of DNPH with aldehydes or ketones.

The sampling probe was prepared by referring a principle of previous Passive Flax Sampler (PFS) [2]. The trapping filter was prepared by dipping filter papers (ADVANTEC, No.51A, 36mmφ, 0.18mmt) into 0.2% DNPH and 1% phosphoric acid in acetonitrile and subsequently drying in a vacuum desiccator. It directly covers 7.79cm^2 of skin surface, as shown in Fig.2.

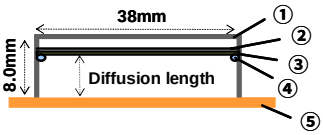

Fig.2 Schematic diagram of the collection system for human skin gas (Passive Flux Sampler: PFS).
①Circular metal plate ②PTFE plate ③DNPH impregnated filter ④O-ring(PTFE) ⑤Human skin

2.2 Sampling of emanated gases from human skin

The samplers were tightly put on the surface of one forearm and palm. Samplings were conducted for 60 minutes at room temperature. At the same time, the sampler was put on the petri dish for 60 minutes at room temperature, to collect carbonyl compounds in internal space of PFS as backgraund. After extraction by 10ml acetonitrile, collection amounts of analytes, *W* were determined by high performance liquid chromatography. The emission flux, *E* was calculated by (1).

$$E = \frac{W}{S \cdot t} \qquad (1)$$

E (mg/cm^2/h):emission flux　　W (ng):collection amount
S (cm^2):cross-section of the exposed human skin
t (h):sampling time

(A)　(B)　(C)

Fig.3 Schematic views of collection of emanating gases from sampling position. (A): Sampling from palm. (B): Sampling from a forearm. (C): Sampling of gases in internal space of PFS.

3. Results and Discussion

3.1 Construction of PFS

To construct the PFS, effect of diffusion length on the emission flux was investigated. The emission flux from a forearm was determined by changing the diffusion length of PFS. Test volunteer was a woman of 22 years old. Table 1 shows the emission fluxes of acetaldehyde from human skin at each diffusion length of PFS. The emission flux did not changed by the difference of the diffusion length of PFS. When the diffusion length of PFS is up to 0.75cm, the emission flux does not depend on the length. Therefore, the emission rate of skin gases is rate-determing process, and equation (1) can be practically used for determing the emission flux.

Table1. The released rate of acetaldehyde at each diffusion length (A=0.45cm B=0.75cm)

RUN	A	B	A/B
1	1.30	1.30	1.00
2	2.72	2.31	1.17
3	1.11	1.73	0.65
4	12.1	11.1	1.09
5	14.8	14.5	1.02

3.2 Effect of sampling position on the emission flux

Emission fluxes at 50% of the accumulated frequency of acetaldehyde and acetone emanated from palm and forearm of 26 men and 33 women are shown in Table 2. Their ages ranged from 20 to 65 years old. The 50% value was calculated by typical histogram show in Fig.4. Emission fluxes of acetaldehyde and acetone from forearm were higher than those from palm for both man and woman. Fig.5 shows relationships between the emission fluxes of acetaldehyde and acetone gas from skin and dermal moisture of one forearm of 60 volunteers. The emission fluxes of acetaldehyde increased with increase in dermal moisture. As for the emission flux of acetone, such a tendency was not found. Therefore, the dermal moisture at the collection point must have influenced emission flux of acetaldehyde. The emission flux of acetaldehyde and acetone of man is higher than those of woman.

Table2. Emission fluxes at 50% of the accumulated frequency of acetaldehyde and acetone emanated from palm and forearm of test volunteers.

Subject	acetaldehyde ($ng/cm^2/h$)	acetone ($ng/cm^2/h$)	Average of dermal moisture (F)
Palm of 26 men	50	N.D.	35
One forearm of 26 men	110	2.7	55
Palm of 33 women	30	N.D.	40
One forearm of 33 women	40	2.0	45

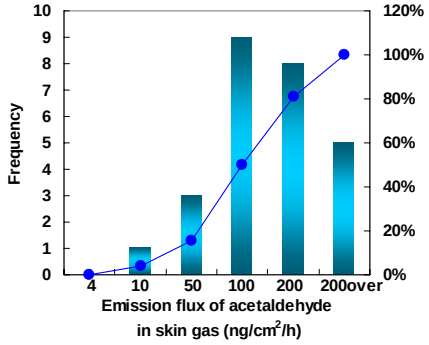

Fig.4 Histogram of emission flux of acetaldehyde from one forearm of 26 men.

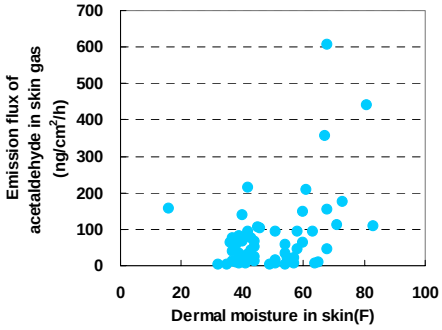

Fig.5 Relationship between emission flux of acetaldehyde and dermal moisture in one forearm of 60 volunteers.

4. Conclusion

Passive flux sampler was practically applied to the measurement of emission fluxes of acetaldehyde and acetone from human skin. When the diffusion length is not more than 0.75cm, the emission flux is not related diffusion length of PFS. Relationship between the flux of acetaldehyde and dermal moisture suggested the gas emanated with sweating.

Reference:1) K.Naitoh, et al.,: *Instr.Sci.Tec.*,**39**,267-280(2002) 2) M.Fujii, et al.,: *Atmos.Environ.*,**37**,5495-5504(2003)