

On-Demand Lecture

Basics of VOCs passive samplers

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Features of Active and Passive Methods

Active method (adsorption tube method)

【Advantages】

- Less susceptible to environmental effects such as temperature, humidity, and wind
- High concentration rate and short sampling time

【Disadvantages】

- Complicated to operate and requires skill
- High cost of measurement due to the need for pumps, etc.
- Requires a power supply at the point of measurement

Passive method (diffusion sampler method)

【Advantages】

- Easy to handle
- No power supply required (simultaneous observation at multiple locations possible)

【Disadvantages】

- Short sampling time is difficult in ambient air
- **Sampling rate (SR)**, a coefficient for converting the amount of adsorbed substance to be measured to the ambient concentration, is required.

Calculation of ambient air concentrations using the passive method

Concentration Calculation Method

$$C = \frac{M_d - M_b}{t \times SR}$$

C : Concentration of target substance ($\mu\text{g}/\text{m}^3$)

M_d : Amount of adsorbed target substances collected by passive sampler (μg)

M_b : Amount of target substances in unused passive samplers (μg)

t : Exposure time (h)

SR : Sampling rate (m^3/h)

Sampling rate calculation method

- ① Simultaneous measurement of active and passive methods for ambient air
(Issue) Difficulty in controlling temperature, humidity, wind speed, etc., may result in different values under different sampling condition.
- ② Calculation Method
(Issue) Difficulty in accurately determining the diffusion length, a necessary parameter in the calculation
- ③ Calculation based on exposure tests
(Issue) Expensive experimental equipment and complicated experimental operation

Sampling Rate Calculation Method

Sampling rate calculation by parallel measurement of the canister method and the passive method (diffusion tube method) using real ambient air

$$SR = \frac{M_d - M_b}{C_{can} \times t}$$

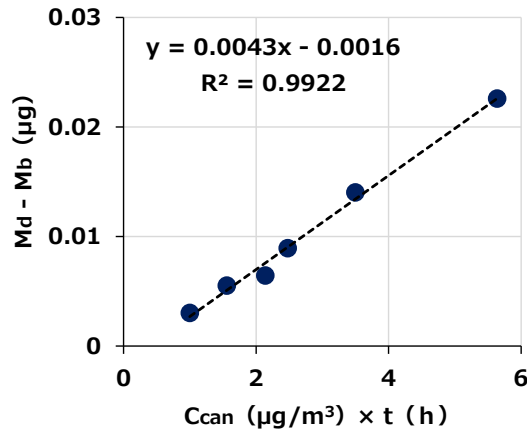
SR : Sampling rate (m³/h)

C_{can} : Concentration of the target substance measured in the canister (μg/m³)

M_d : Amount of adsorbed target substances collected by passive sampler (μg)

M_b : Amount of target substances in unused passive samplers (μg)

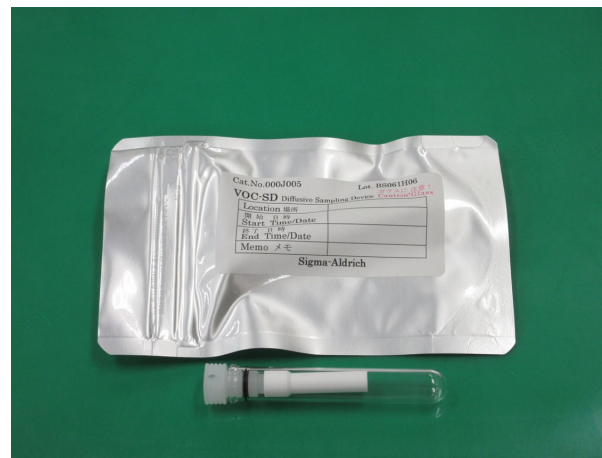
t : Exposure time (h)



SR : Slope of a straight line

Calculation requires concentration range of actual ambient air

Supelco



SIBATA



Measurement sampling rate

[Sampling point]

Koto-ku, Tokyo

(on the rooftop of the Tokyo Metropolitan Research Institute of Environmental Protection)

[Survey Date]

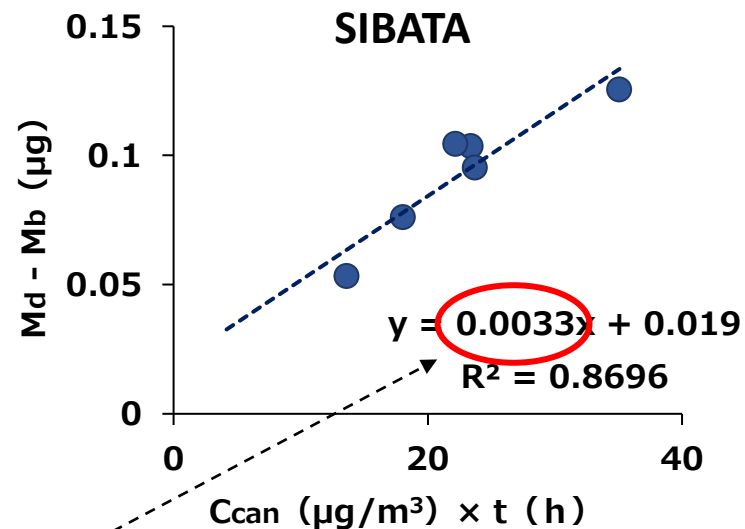
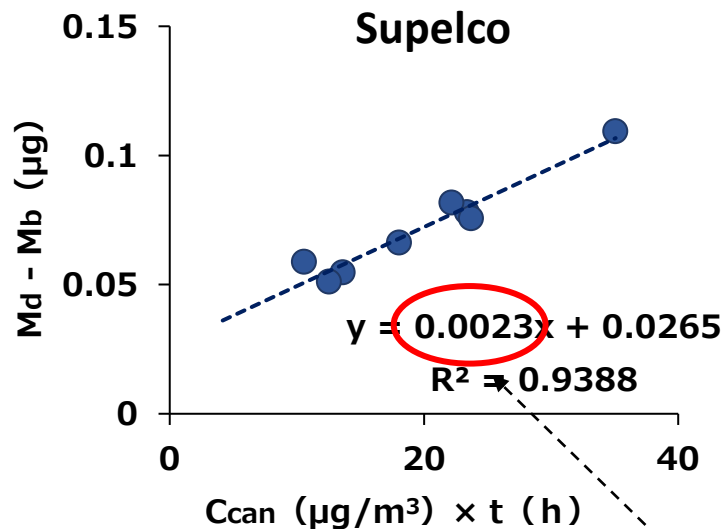
July 20-27, 2022 24h Sampling

[Analytical Method]

Canister : Low-temperature concentration-GC/MS

Diffusion tube sampler : Solvent (CS₂) extraction-GC/MS

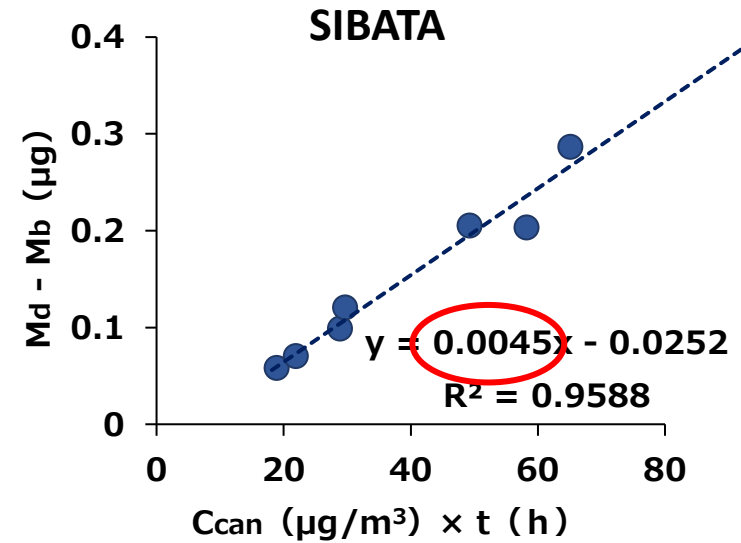
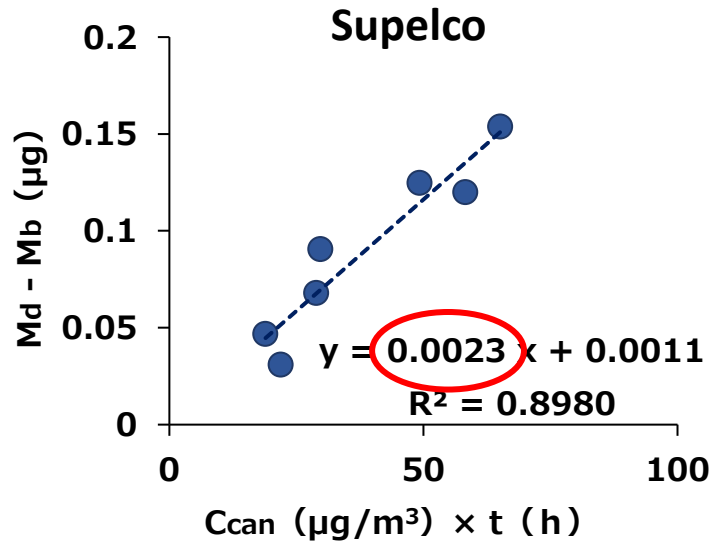
Benzene



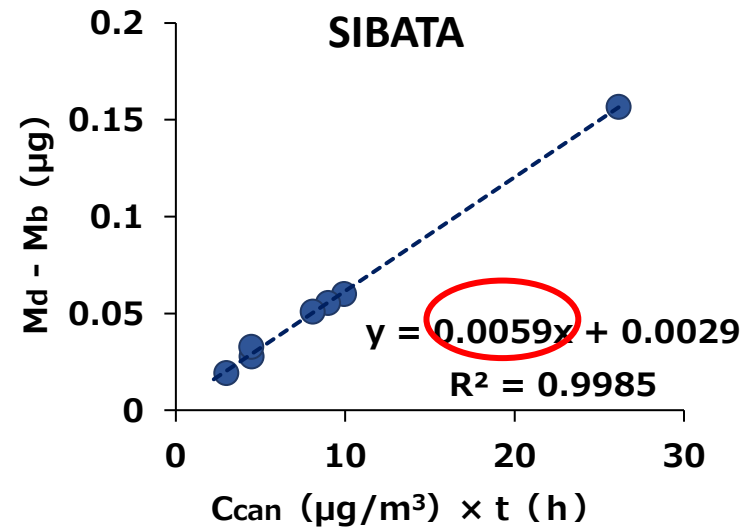
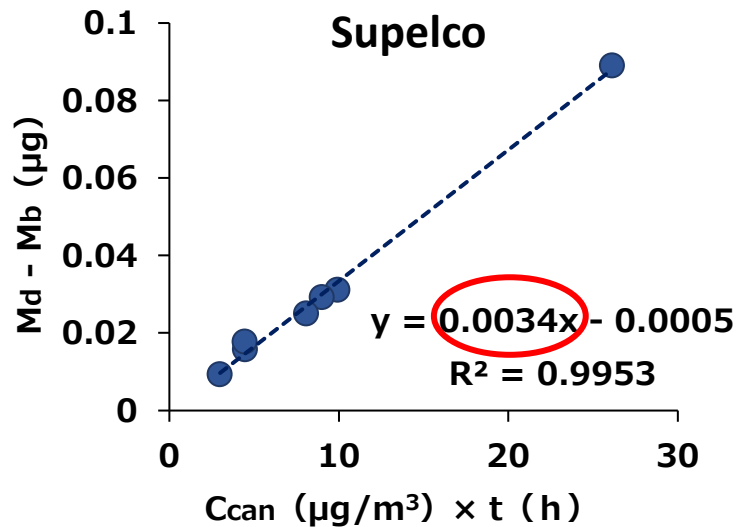
SR

Measurement sampling rate

Toluene

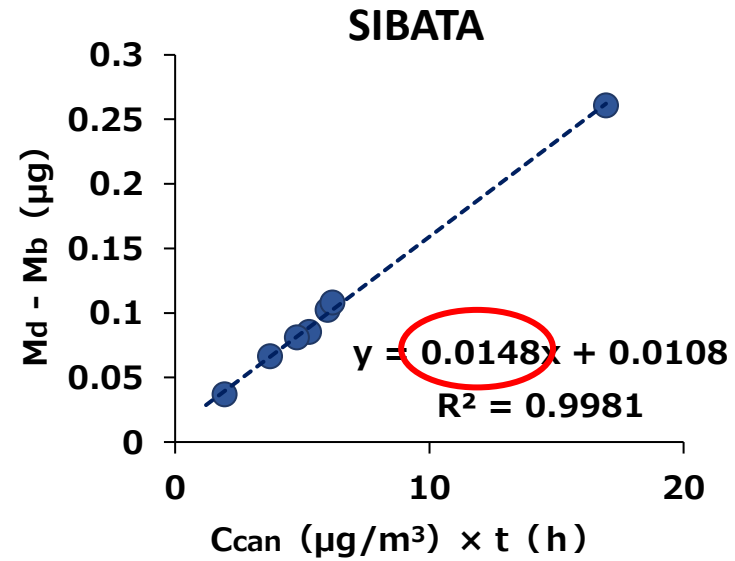
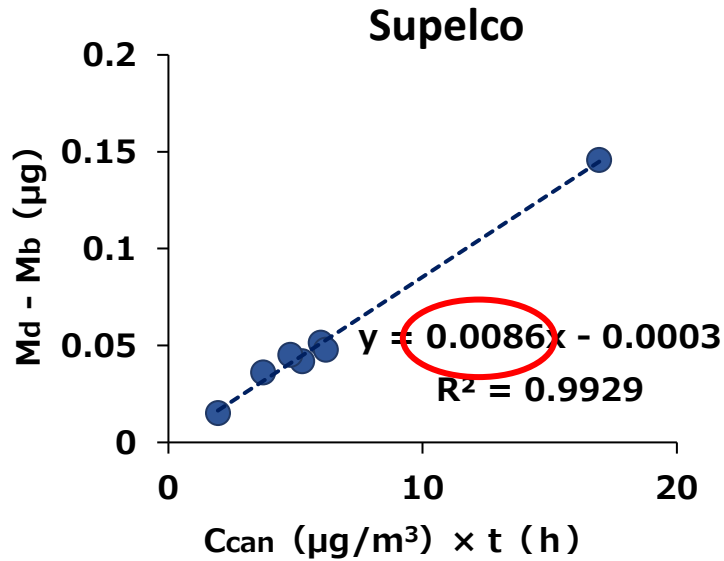


Ethylbenzene

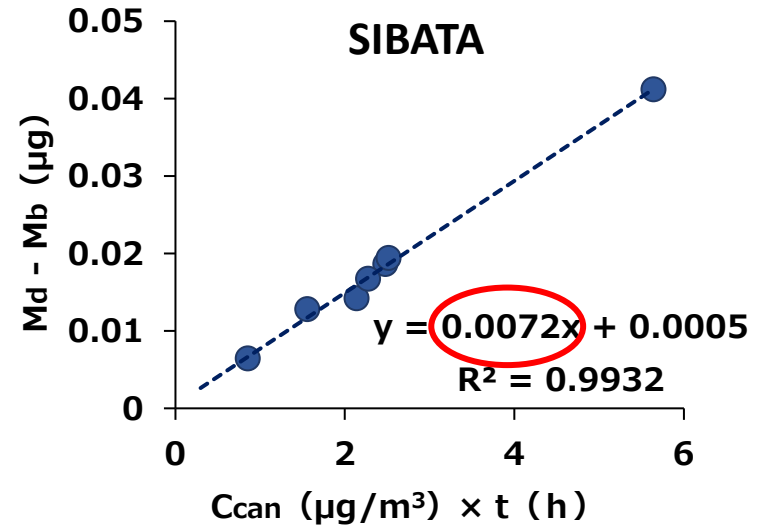
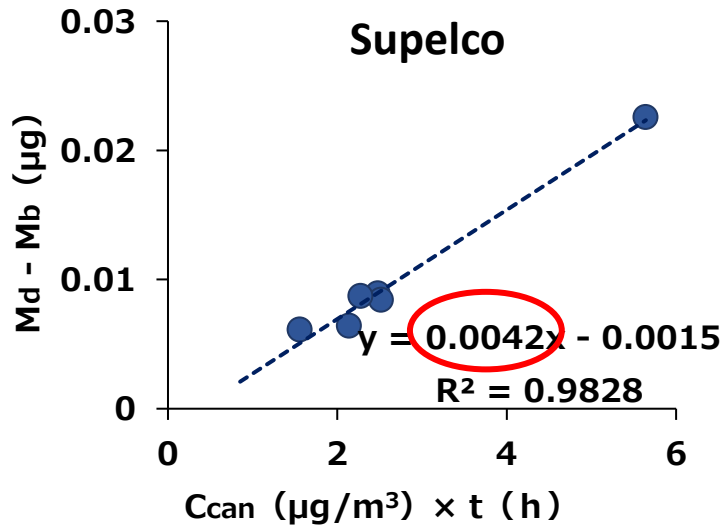


Measurement sampling rate

m,p-Xylene



o-Xylene



Comparison of sampling rates

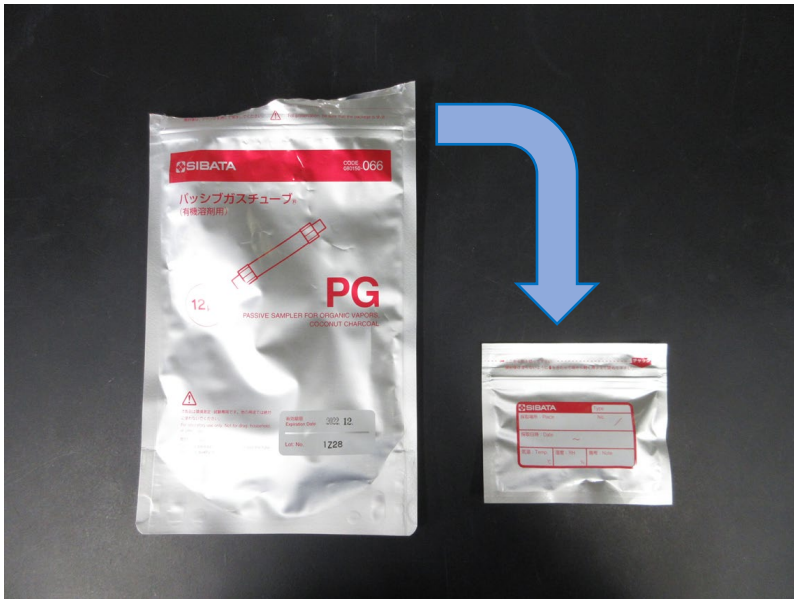
(m³/h)

	Supelco		SIBATA	
	Manufacturer set value	Parallel Test Calculated Value	Manufacturer set value	Parallel Test Calculated Value
Benzene	0.0022	0.0022	0.0033	0.0033
Toluene	0.0028	0.0023	0.0028	0.0045
Ethylbenzene	0.0023	0.0034	0.0018	0.0059
m,p-Xylene	0.0044	0.0086	0.0050	0.0148
o-Xylene	0.0021	0.0042	0.0025	0.0072

- The sampling rates of Benzene and Toluene (Supelco) are consistent with the manufacturer's sampling rates.
- Ethylbenzene, m,p-xylene, and o-xylene differ from the manufacturer's sampling rate.

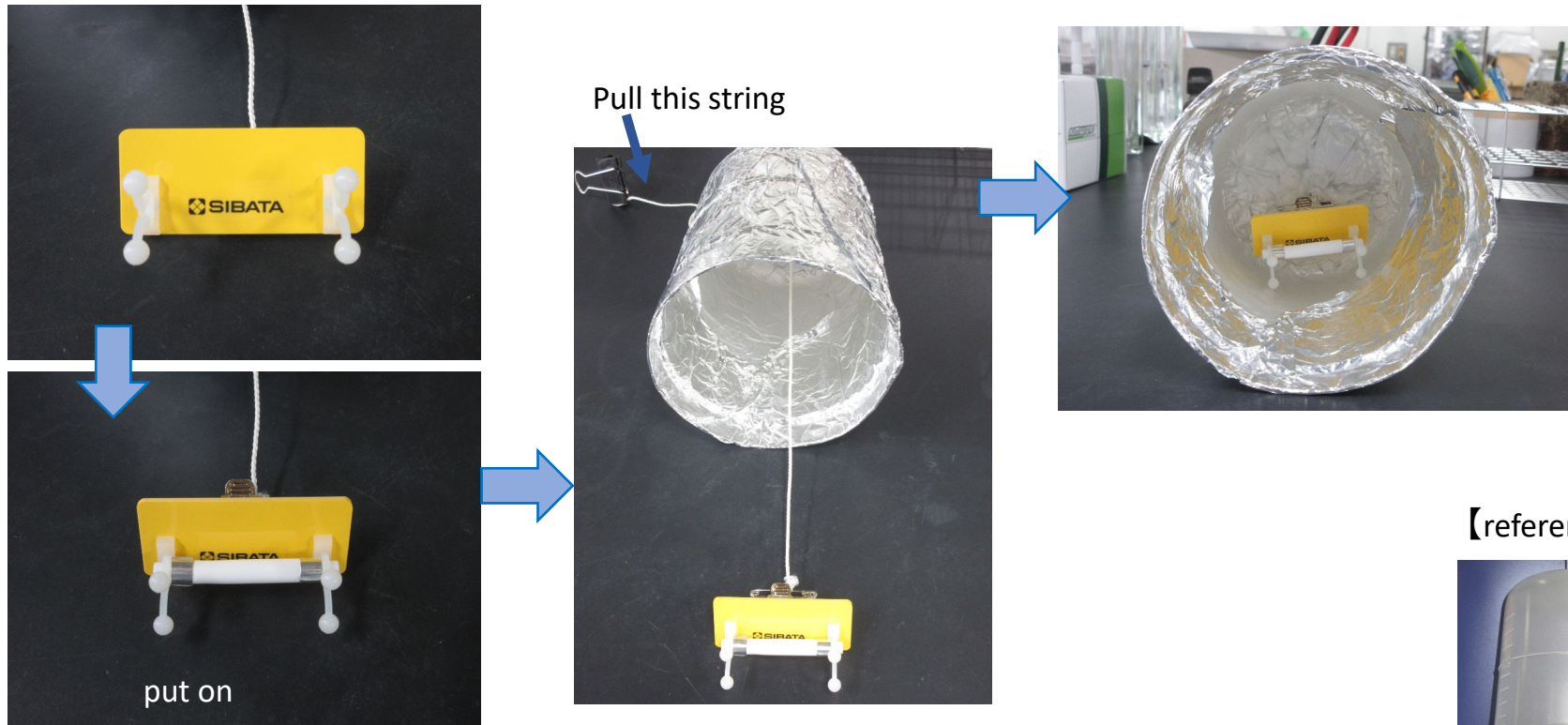
Better to check based on measured values at each measurement point

1. take out of a bag



- Sampling begins when the passive sampler is removed from the small bag
- Use gloves when handling the passive sampler

2. Attach passive sampler to holder and place in shelter



- Can be clipped with office clips, etc., instead of a dedicated holder.

【reference】



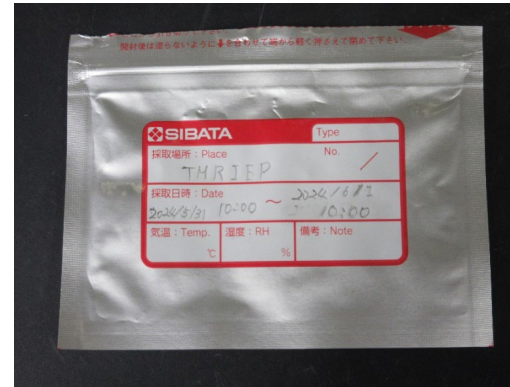
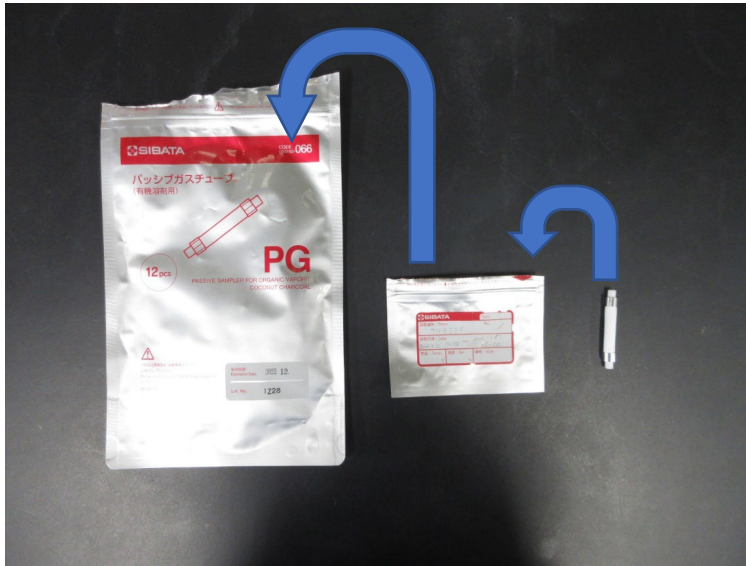
3. Shelters are placed at sampling sites



roll up the string and fix in place

- If the string is long, it can be agitated by the wind and become upside down, so roll up

4. Collect sampled passive samplers in their original bags

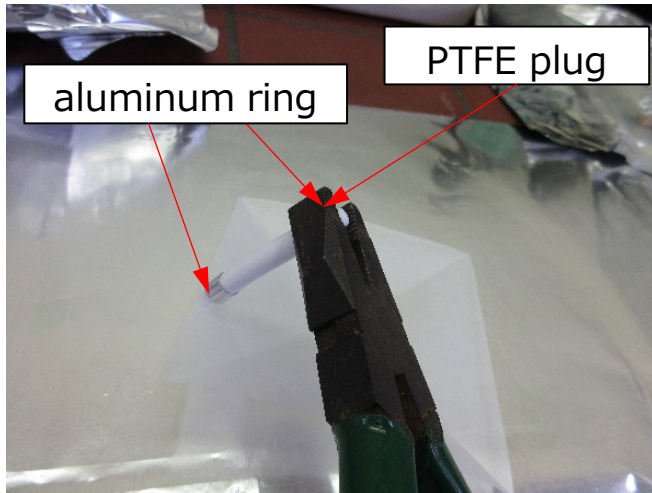


Record the location, date, and time of collection on the bag.

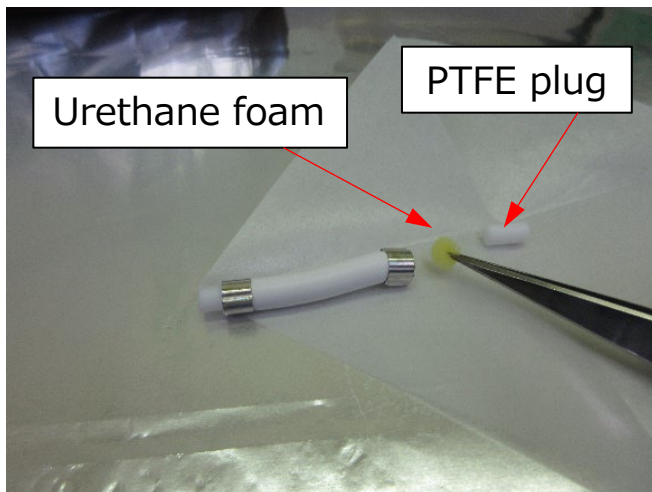
Refrigerated or frozen after collection

- Gloves should also be worn when picking up the sampler after sampling is complete.
- Sampling time is the time between removal from the bag and return to the bag.
- A field book may be made to record the date and time of collection.

1. Adsorbent removal

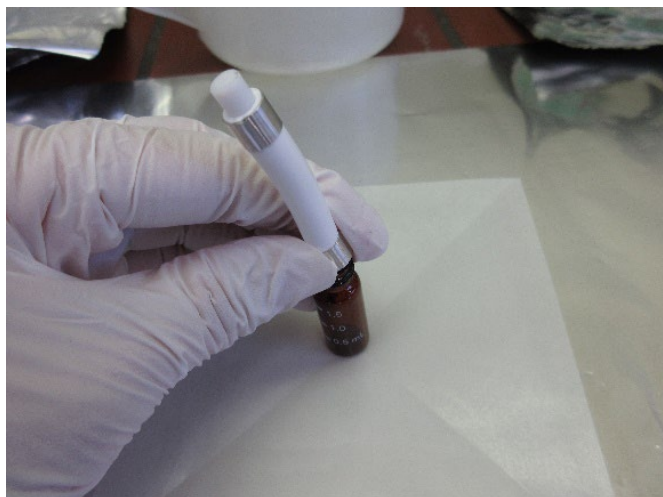


- Clamp the aluminum ring with a pair of pliers and deform it slightly.
- Place the powder paper on top of the aluminum foil so that the adsorbent can be collected in case of spillage.



- After removing the PTFE plug, use tweezers to remove the urethane foam

2. Extraction



- Turn the tube upside down and transfer the adsorbent to the vial.
- Tap off the adsorbent on the inner wall.

Static electricity causes significant adsorption, so it is best to use an electrostatic remover.

- After adding CS₂, stir until bubbles disappear



- Allow to stand for 2 hours



- Transfer the sample supernatant to a vial.



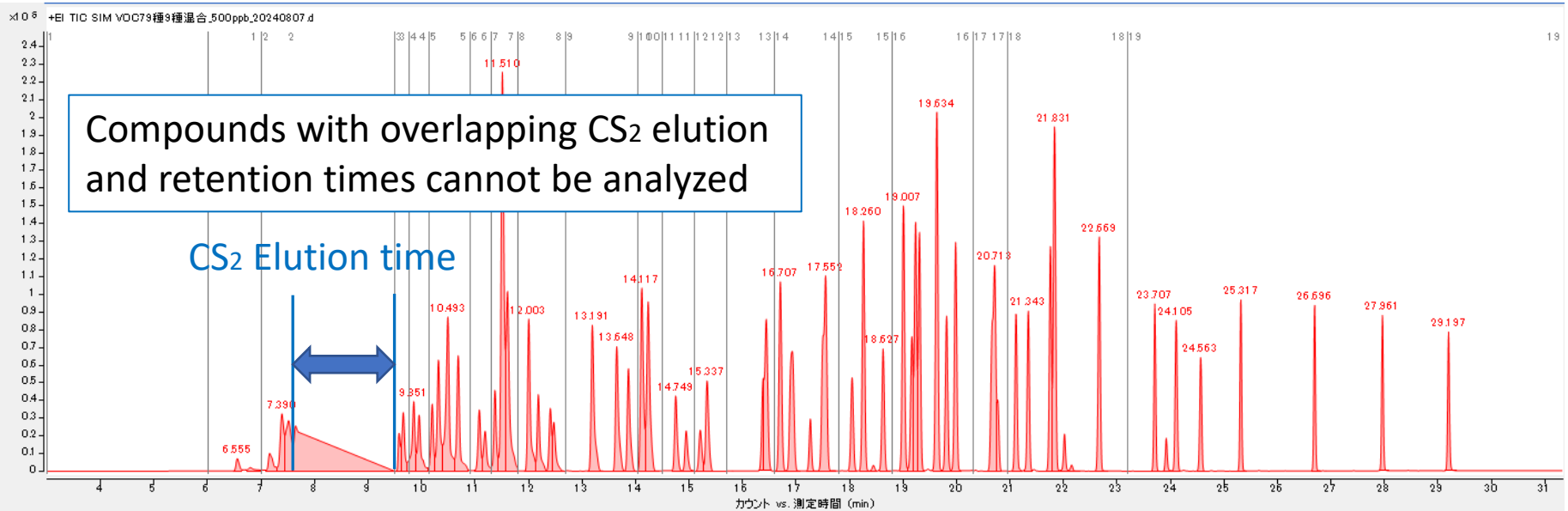
Using a Pasteur pipette, transfer to a vial with an insert.

- Analysis with GC/MS

Analysis Method

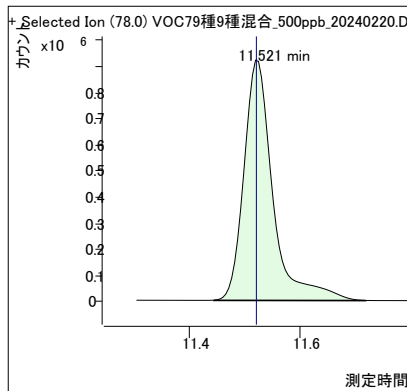
4. Chromatogram and Calibration curve (example)

Standard solution chromatogram (TIC) : each compound 500ng/mL

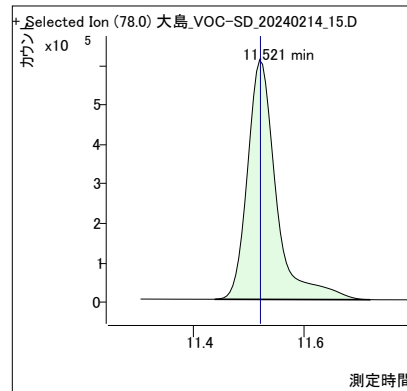


Benzene

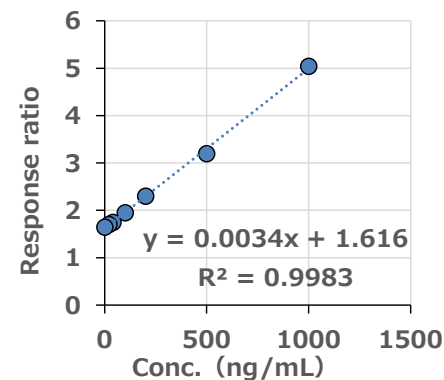
Standard solution



Sample of Izu Oshima



Calibration curve

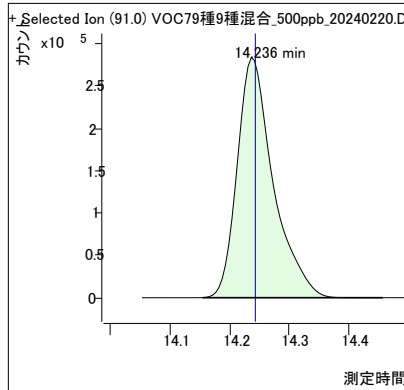


Calibration curve for Benzene made with CS₂ solution always has an intercept

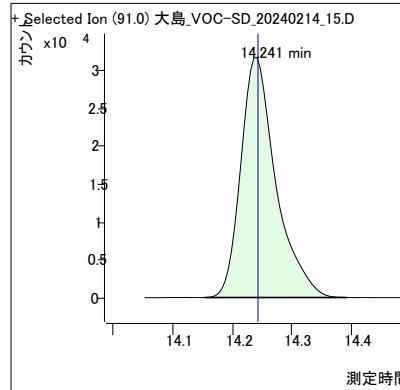
4. Chromatogram and Calibration curve (example)

Toluene

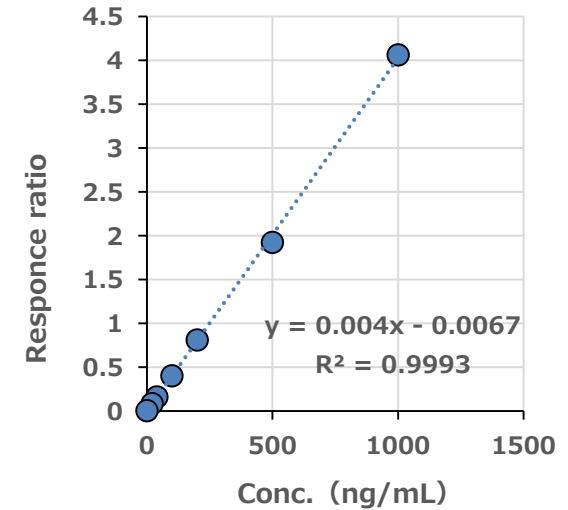
Standard solution



Sample of Izu Oshima

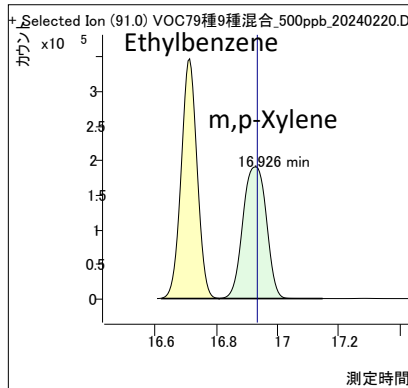


Calibration curve

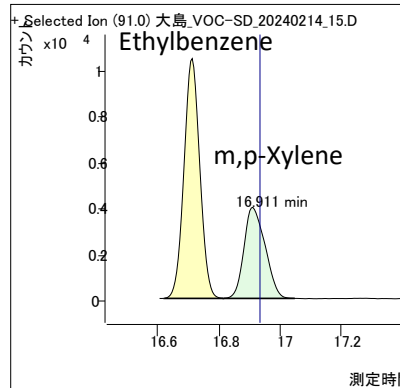


Ethylbenzene m,p-Xylene

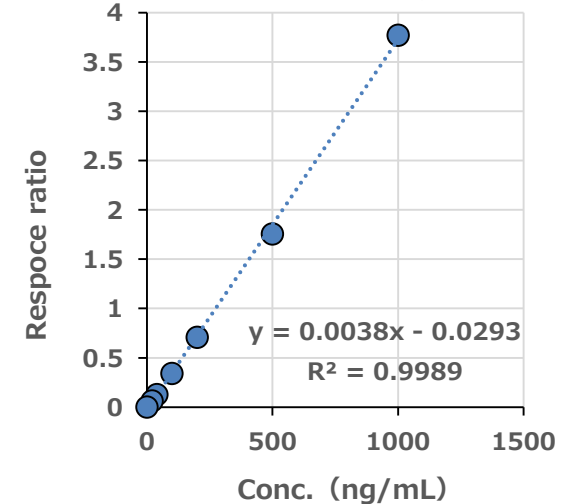
Standard solution



Sample of Izu Oshima



Calibration curve(m,p-Xylene)



- The passive method (diffusion tube method) has the advantage of easy handling and does not require a power supply. However, a sampling rate (SR) is required for each substance.
- Two passive samplers (Supelco, SIBATA) with no significant difference in measurement accuracy for BTX
- Sampling rates calculated in ambient air by parallel testing with the canister method showed values for some substances that differed from the manufacturer's sampling rate. Sampling rates should be checked at the monitoring sites.
- In BTX, the peak shape of the GC/MS analysis is good and the calibration curve is also linear. However, there is an intercept (solvent blank) in the calibration curve for benzene.