

# Analyses procedure of passive samplers for SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, NH<sub>3</sub>, HCl, HNO<sub>3</sub> and carboxylic acids

## Sample preparation

	Impregnating chemical	Solvent for extraction	Method	Analyte
NO <sub>2</sub>	Triethanolamine, PTIO	Saltzman Reagent <sup>(1)</sup> , DIW	UV-VIS <sup>(1)</sup> , IC	NO <sub>2</sub> <sup>-</sup>
SO <sub>2</sub>	Potassium Carbonate	H <sub>2</sub> O <sub>2</sub> 0.03% in DIW <sup>2</sup>	IC	SO <sub>4</sub> <sup>2-</sup>
O <sub>3</sub>	Sodium Nitrite	DIW	IC	NO <sub>3</sub> <sup>-</sup>
NH <sub>3</sub>	Citric Acid	DIW, Reagent for NH <sub>3</sub> <sup>(3)</sup>	IC, UV-VIS <sup>(4)</sup>	NH <sub>4</sub> <sup>+</sup>
HNO <sub>3</sub>	NaCl, glycerin	DIW	IC	Cl <sup>-</sup> , NO <sub>3</sub> <sup>-</sup>
HCl, Fatty acids	Triethanolamine	DIW	IC	RCOO <sup>-</sup>

DIW water for IC application.

- 1. Reagent for NO<sub>2</sub> and NO<sub>x</sub>:** Fill a reagent tube almost full of water and shake until complete dissolution.
- 2. H<sub>2</sub>O<sub>2</sub> 0.03%:** add 0.1 ml H<sub>2</sub>O<sub>2</sub> 30% into 100 ml DI water.
- 3. Reagent for NH<sub>3</sub>:** Contact Enviochem Binh Lan for details.

- 1. Remove the cover.**



- 2. Turn or pry the upper part to open passive samplers.**



- 3. Cut a filter into pieces and transfer to a plastic tube.**



- 4. Add 5 ml of solvent.**



- 5. Shake 45 min. Wait 1h.**



- 6. Quantify by UV-VIS analyzer (NO<sub>2</sub>, NH<sub>3</sub>, NO<sub>x</sub>) or IC.**



**Note:** Resemble of passive samplers should be done in clean environment. Operate with glove and forcets while working with passive samplers.

Smaller or bigger volume of solvent may be used depending on duration of exposure and level of air pollutants in the environment to be monitored.

## 1. Quantification of extracts

### 2.1 Methods

- **NO<sub>2</sub>, NH<sub>3</sub>, NO<sub>x</sub>:** spectrophotometric method using a **VIS analyzer**.
- **NO<sub>2</sub>, NH<sub>3</sub>, NO<sub>x</sub>, SO<sub>2</sub>, NH<sub>3</sub>, O<sub>3</sub>, HNO<sub>3</sub> và HCl:** ion-exchange method using an **ion exchange column**.
- **Carboxylic acids:** ion-exclusion method using an **ion exclusion column**.

### 2.2 Standards

Working standards of 0.200; 0.500; 1.00; 2.00; 5.00 và 10.0 mg/l (µg/ml) are made by dilution of a stock standard and should be discarded after 24 hours. The stock standards of 1000 mg/l are supplied by Envibiochem Binh Lan.

ST <sub>1</sub> 10,0 mg/l		ST <sub>2</sub> 5,00 mg/l		ST <sub>3</sub> 2,00 mg/l		ST <sub>4</sub> 1,00 mg/l		ST <sub>5</sub> 0,500 mg/l	
Stock	Water*	ST <sub>1</sub>	Water*	ST <sub>1</sub>	Water*	ST <sub>3</sub>	Water*	ST <sub>3</sub>	Water*
1 ml	Fill up to 100 ml	10 ml	10 ml	4 ml	16 ml	10 ml	10 ml	5 ml	15 ml

\* DI water (for IC) should be used to avoid contamination. NO<sub>2</sub>, NO<sub>x</sub> standards are diluted with the Saltzman Reagent, NH<sub>3</sub> standards are diluted with the Reagent for NH<sub>3</sub> in the case of the spectrometric quantification.

## 2.3 Calibration

Calibration curves of  $C_i = f(S_i)$ , where  $i$  refers to a pollutant of interest,  $C$  is concentration of the pollutant in the extract and  $S$  is a pick area of the pollutant, should have correlation coefficient not lower than 0.997.

## 2.4 Quantification

Inject 1 standard after each 10 samples to check repeatability. Adjust calibration curves when needed.

Concentration of a pollutant in the extract is evaluated from the calibration curves.

☞ Dilute an extract when concentration in the extract outside calibration curves.

## 2. Evaluation of pollutant concentration in ambient air

The amount of air pollutant collected is estimated by the expression (1)

$$m_a (\mu\text{g}) = V_{\text{extract}} (\text{ml}) \times C_{\text{extract}} (\mu\text{g} / \text{ml}) \quad (1)$$

Where  $V_{\text{extract}}$  is a volume of solvent used for the extraction and  $C_{\text{extract}}$  is concentration of a pollutant in the extract.

Concentration of a pollutant in the ambient air  $C_o$  is evaluated from the amount of the pollutant collected  $m_a$  ( $\mu\text{g}$ ), conversion factors ( $\text{ppb}\cdot\text{h}/\mu\text{g}$ ) and duration of sampling  $t$  (min) by using the following expression

$$C_o (\text{ppb}) = K \frac{m_a}{t} \times 60 \quad (2)$$

Conversion factors at 25°C for the aforementioned pollutants are given in the Table below.

	Analyte	Teflon	SS	F( ppb→ $\mu\text{g}/\text{m}^3$ )	
		windshield K (ppb.h/ $\mu\text{g}$ )	windshield K (ppb.h/ $\mu\text{g}$ )	25°C	30°C
<b>NO<sub>2</sub></b>	NO <sub>2</sub> <sup>-</sup>	527	518	1.88	1.85
<b>O<sub>3</sub></b>	NO <sub>3</sub> <sup>-</sup>	186	167	1.96	1.93
<b>SO<sub>2</sub></b>	SO <sub>4</sub> <sup>2-</sup>	642		2.62	2.57
<b>NH<sub>3</sub></b>	NH <sub>4</sub> <sup>+</sup>	600		0.61	0.60
<b>HNO<sub>3</sub></b>	NO <sub>3</sub> <sup>-</sup>	296		2.58	2.53
<b>HCl</b>	Cl <sup>-</sup>		45.4	1.49	1.47
<b>HCOOH</b>	HCOO <sup>-</sup>		79.4	1.88	1.85
<b>CH<sub>3</sub>COOH</b>	CH <sub>3</sub> COO <sup>-</sup>		73.2	2.45	2.41

Conversion factor is temperature-depending and is adjusted by the following expression

$$K_{T_2} = K_{T_1} \left( \frac{T_1(K)}{T_2(K)} \right)^{1.5} \quad (3)$$

**Example 1:** The amount of  $\text{NO}_3^-$  collected by  $\text{O}_3$  passive sampler with SS windshield after 2 (336 h) of exposure was  $13.7 \mu\text{g}$ . The average ambient air temperature during exposure was  $25^\circ\text{C}$ . Ozone concentration in the ambient air would be

$$\begin{aligned} C_o &= \frac{13.7 \mu\text{g} \times 167 \text{ ppb.h} / \mu\text{g}}{336 \text{ h}} \\ &= 6.81 \text{ ppb} = 6.81 \text{ ppb} \times 1.96 \mu\text{g} / \text{m}^3 \text{ ppb} = 13.3 \mu\text{g} / \text{m}^3 = 13 \mu\text{g} / \text{m}^3 \end{aligned}$$

**Example 2:** as in the example 1, but the average ambient air temperature during exposure was  $30^\circ\text{C}$ . Conversion factor K would be

$$K_{T_2} = 167 \text{ ppb.h} / \mu\text{g} \left( \frac{298}{303} \right)^{1.5} = 163 \text{ ppb.h} / \mu\text{g}$$

Ozone concentration in the ambient air would be

$$\begin{aligned} C_o &= \frac{13.7 \mu\text{g} \times 163 \text{ ppb.h} / \mu\text{g}}{336 \text{ h}} \\ &= 6.99 \text{ ppb} = 6.99 \text{ ppb} \times 1.93 \mu\text{g} / \text{m}^3 \text{ ppb} = 13.49 \mu\text{g} / \text{m}^3 = 13 \mu\text{g} / \text{m}^3 \end{aligned}$$