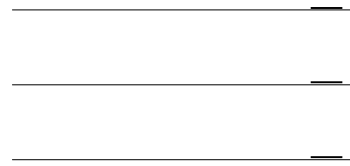


2

3

2 3

2001 6



가

. 2

가

가

2001 6

.....

. 1

. 4

1. 4

2. 6

3. 7

4. 10

5. 12

. 13

1. 가 13

2. 15

. 21

. 25

..... 27

..... 31

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(sodium hydroxide, NaOH)

, , , , , , , , , ,

NaOH

3

(membrane)

2

OSHA

2

3

2

가

10

2

47%가

(+)

, 2

3

1.84

NaOH

3

2

. NaOH

가

: , OSHA , .

•

(sodium hydroxide, NaOH)

가

. NaOH

1998

50

5

1999

1,069,308

1,045,292

(, 2000).

NaOH

(Budavari , 1996; Cooper ,

1979; Rubin , 1992).

NaOH

(融解壞死)

(Budavari , 1996; Ellenhorn Barceloux, 1988;

NIOSH, 1990)

가

(Wilhelm ,

1990).

, 250mg/ m³

(Clayton , 1993).

1N NaOH

15

가

, 60

가

(Raffn , 1989).

NaOH

20

63

x-

(Rubin , 1992).

NaOH (ceiling) 2 mg/m³
(, 1991), NaOH
(Occupational Safety and
Health Administration, OSHA) 0.8µm mixed cellulose
ester (MCE)

Method No ID- 121 (OSHA, 1990)
(National Institute for Occupational Safety and Health,
NIOSH) 1µm polytetrafluoroethylene (PTFE) membrane

Method No 7401 (NIOSH, 1994) .
NaOH , 가 ,
(Cooper
, 1979). OSHA 121 (Sodium, Na)
가 , 가 ,
가 . NIOSH 7401
가
가 .

가 (Buchan , 1986; Liden , 2000; Mao , 2000; Puskar
, 1991; Rando Hammad, 1985). Puskar (1991)

37mm 3

. Beaulieu (1980) , , ,
 ,
 . Toluenediisocianate (TDI) 3
 가 2
 membrane 가
 (Mao , 2000).

가 (spacer) 2
 2
 가 2 3

1.

OSHA 37mm 0.8 μ m

MCE 3 (3-piece cassette holder, SKC, USA) 3 (spacer) 2

, 2 3

MCE , 100mm,

7mm MCE .

() 가 5.5mm 32mm

MCE (Figure 1). 2 3

(Figure 2). 2

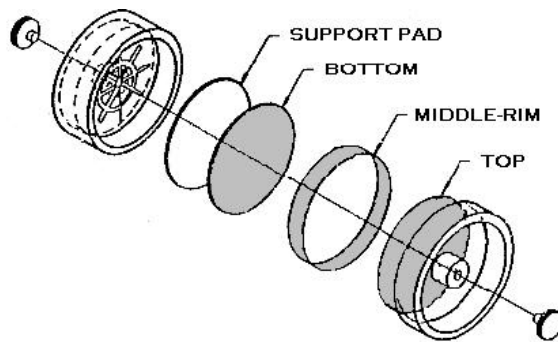


Figure 1. Description of a modified 2-piece cassette holder (gray, membrane)

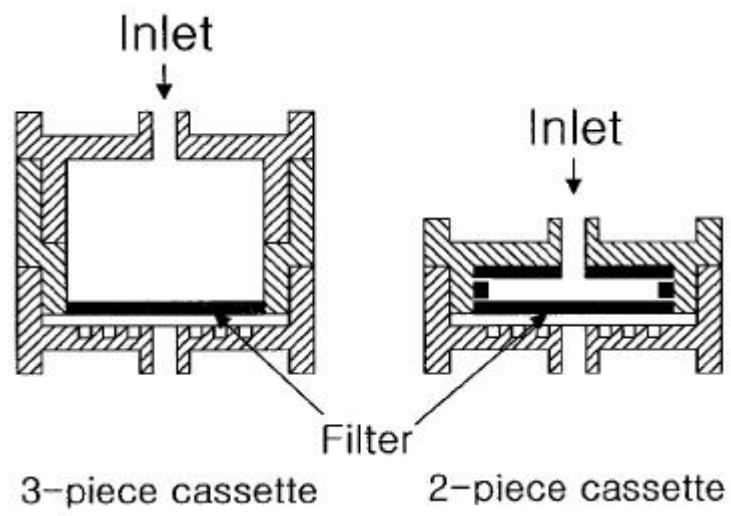


Figure 2. Cross-sections of the 3-piece and modified 2-piece cassette holder (black, membrane)

2.

가 37mm MCE
(Gelman, USA) , 1.5 /min
(Gilian, USA) .
가 NaOH (97% Kanto, Japan)
6 6 . NaOH
(標正) HCl .
Milli Q plus
(Model 67120, Millipore SA, France)
0.45 μ m PTFE (Gelman, USA)
(atomic absorption spectrometer, Varian SpectrAA-300 AAS, Australia,
AAS) .

3.

OSHA 121

가.

OSHA 121	pore size 0.8 μ m,	37mm	MCE	backup
pad	3		2 /min	
4	8	480	960	

(OSHA, 1990).

15M μ 가 5 ,

Table 1 ,

($r^2=0.9999$)

(Figure 3). (limit of detection, LOD) NIOSH (1995)

($Y = mX$

+ b) (y) (standard

error of regression, sy) (1)

(2).

$$\text{LOD} = 3 \text{ sy} / m \dots\dots\dots (1)$$

$$\text{sy} = \left[(y_i - \bar{Y}_i)^2 / (N - 2) \right]^{1/2} \dots\dots\dots (2)$$

, N = , m =

가

X

(Y

)

가

.

Table 1. Operating conditions of flame atomic absorption spectrophotometer

Descriptions	Condition
Lamp wavelength	589.6 nm
Spectral slit width	0.5 nm
Lamp current	5 mA
Fuel	acetylene
Support	air
Flame stoichiometry	reduction
Replicates of readings	3
Measurement time	2 sec
Delay time	1 sec
Background correction	off

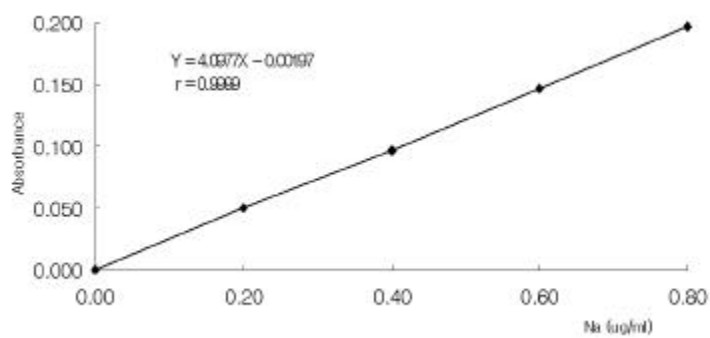


Figure 3. Calibration curve of sodium by atomic absorption spectrophotometry

4.

가. NaOH

250 4 Na₂CO₃ 2.5g 1
 0.05N Na₂CO₃ 5Mℓ , 0.01N HCl
 . HCl (N) (N_{HCl}) (3) .

$$N_{HCl} = \frac{(g Na_2CO_3)(5ml Na_2CO_3 solution)}{(52.99)(ml HCl)} \dots \dots (3)$$

NaOH (4) .

$$N_{NaOH} = (N_{HCl})(ml HCl) / (ml NaOH) \dots \dots (4)$$

. 가

NaOH 가 OSHA MCE NaOH
 가 . 가 2 mg/m³
 0.5 , 1 , 2 6 (95.68, 474.42, 765.47, 956.83,
 1435.25, 1913.66 μg) 6 ,
 0.45μm PTFE

10

, 2 3
1.5 /min
(Gilian, USA) 6 . 6
6.67 , 42.35% .

5.

(% recovery) |Bias|

(5) (6) (NIOSH, 1995; Taylor, 1987).

$$(\%) = \frac{\text{가}}{\text{가}} \times 100 \dots \dots \dots (5)$$

$$| \text{Bias} | = | [(\text{가} - \text{가}) / \text{가}] \times 100 | \dots \dots \dots (6)$$

(coefficient of variation, CV)

(overall CV, CV_{pooled})

CV CV_{pooled} (7) (8) (NIOSH,

1995; OSHA, 1990).

$$CV = \frac{(s)}{(x)} \dots \dots \dots (7)$$

$$CV_{pooled} = \left[\frac{\sum_{i=1}^n f_i (CV)^2}{\sum_{i=1}^n f_i} \right]^{1/2} \dots \dots \dots (8)$$

i = n 가

$CV_i = i$

$f_i = (- 1)$

3 2 가

t-test

•

1. 가

NaOH 6 (95.68, 474.42,
765.47, 956.83, 1435.25, 1913.66 μ g) 6 .

0.45 μ m PTFE

가 Table 2

. 가 blank

1.29 μ g . 105.51% (99.96 109.42%)

|Bias| 5.53% (0.04 9.42%) . CV_{pooled}

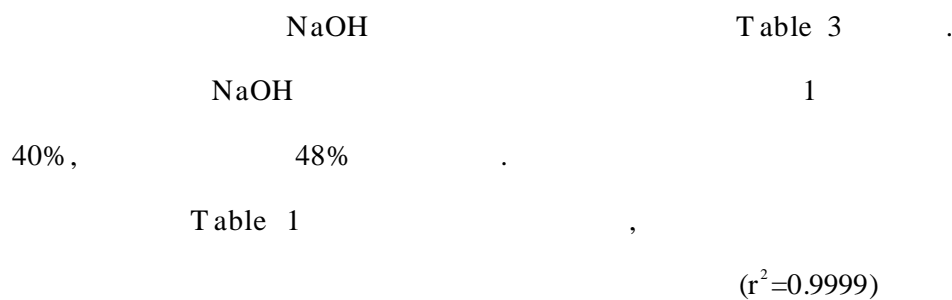
0.11% . 0.0018 μ g/M \emptyset

Table 2. Recovery rate and analytical precision of sodium (sodium hydroxide)

Level	spiked Na (NaOH) μg	N	detected Na (NaOH) μg	Recovery rate (%)	Bias (%)	CV (%)	CV _{pooled} (%)
1	54.98 (95.65)	6	56.71 \pm 1.15* (98.66 \pm 2.01)	103.15 \pm 2.10	3.15	2.04	
2	274.99 (478.42)	6	274.88 \pm 1.09 (478.24 \pm 1.89)	99.96 \pm 0.39	0.04	0.39	
3	439.98 (765.47)	6	457.20 \pm 5.32 (795.43 \pm 9.25)	103.91 \pm 1.21	3.91	1.16	
4	549.97 (956.83)	6	34.64 \pm 34.64 (1026.19 \pm 60.26)	107.25 \pm 6.30	7.25	5.89	0.11
5	824.96 (1435.25)	6	902.42 \pm 47.04 (1570.00 \pm 81.83)	109.39 \pm 5.70	9.39	5.21	
6	1099.95 (1913.66)	6	1203.61 \pm 6.14 (2094.01 \pm 10.68)	109.42 \pm 0.56	9.42	0.51	
Total		36		105.51 \pm 2.71	5.53		

*, Mean \pm SD

2.



(Figure 3).

Table 3. Description of sampling sites and consumption amount of sodium hydroxide a month in chemical plants

	Sampling sites	Consumption (ton/month)
1	Washing	1.59
2	Production	40,722.00 *
3	Acid neutralization	129.99
4	Acid neutralization	151.80
5	Regeneration of Ion exchange resin	14.65
6	Regeneration of Ion exchange resin	12.99
7	Regeneration of Ion exchange resin	15.69
8	Washing	144.00
9	Washing	5.00
10	Recovery	250.00

*, productive amount

가. 2 3

Table 4 . NaOH
 , 1 40% NaOH

Table 4. Comparison of total airborne sodium (sodium hydroxide) concentrations using the 3-piece and modified 2-piece cassette holder in chemical plants

Sampling sites (paired)	(A) modified 2-piece cassette ($\mu\text{g}/\text{m}^3$)	(B) 3-piece cassette ($\mu\text{g}/\text{m}^3$)	concentration ratios (A/B)	P - value*
1	40.09 (69.74)	28.72 (49.97)	1.40	p 0.01
2	59.06 (102.75)	35.86 (62.39)	1.65	
3	23.39 (40.69)	16.95 (29.49)	1.38	
4	29.12 (50.66)	17.20 (29.92)	1.69	
5	32.89 (57.22)	16.66 (28.98)	1.97	
6	27.97 (48.66)	12.89 (22.43)	2.17	
7	30.85 (53.67)	12.31 (21.42)	2.51	
8	45.19 (78.62)	17.87 (31.09)	2.53	
9	37.68 (65.55)	17.79 (30.95)	2.12	
10	29.12 (50.66)	17.20 (29.92)	1.69	
Total	35.54 (61.82)	19.35** (33.66)	1.84 \pm 0.42***	

*, paired t-test; **, Mean; ***, Mean \pm SD

2 35.54 (61.82) $\mu\text{g}/\text{m}^3$ 3
 19.35 (33.66) $\mu\text{g}/\text{m}^3$ 2
 3 (p
 0.01). NaOH
 2 2 3 59.06 (102.75),
 35.86 (62.39) $\mu\text{g}/\text{m}^3$ 가 .
 NaOH 6 3
 12.89 (22.43) $\mu\text{g}/\text{m}^3$ 가 , 2
 pH NaOH
 3 23.39 (40.69) $\mu\text{g}/\text{m}^3$ 가 .
 8 3 2
 2.53 가 , 1 1.40 가

Figure 4 .

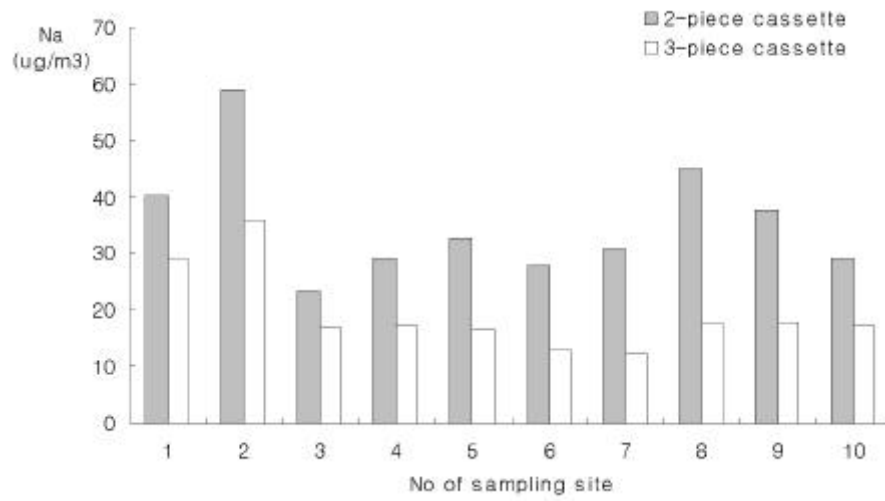


Figure 4. Comparison of total airborne sodium concentrations using the 3-piece and modified 2-piece cassette holder in chemical plants

2

2 Table

5 (+)

2

47.55% (29.51 61.12%) .

8 27.62

(48.05) $\mu\text{g}/\text{m}^3$ 가 , pH

NaOH 3 11.02 (19.17) $\mu\text{g}/\text{m}^3$

가 . NaOH

2 41.63 (72.42) $\mu\text{g}/\text{m}^3$ 가 ,

NaOH 6 11.75
 (20.44) $\mu\text{g}/\text{m}^3$ 가 2
 NaOH 2
 30% 가 ,
 8 61% 가
 2 Figure 5

Table 5. Distribution of total airborne sodium (sodium hydroxide) concentrations using the modified 2-piece cassette holder in chemical plants

Sampling sites	Total ($\mu\text{g}/\text{m}^3$)	(A) Upper* ($\mu\text{g}/\text{m}^3$)	(B) Bottom ($\mu\text{g}/\text{m}^3$)	A/T total
1	40.09 (69.74)	16.86 (29.33)	23.23 (40.42)	0.42
2	59.06 (102.75)	17.43 (30.32)	41.63 (72.43)	0.30
3	23.39 (40.69)	11.02 (19.17)	12.37 (21.52)	0.47
4	29.12 (50.66)	13.29 (23.12)	15.84 (27.56)	0.46
5	32.89 (57.22)	13.40 (23.31)	19.49 (33.91)	0.41
6	27.97 (48.66)	16.21 (28.20)	11.75 (20.44)	0.58
7	30.85 (53.67)	14.72 (25.61)	16.13 (28.06)	0.48
8	45.19 (78.62)	27.62 (48.05)	17.57 (30.57)	0.61
9	37.68 (65.55)	21.87 (38.05)	15.81 (27.51)	0.58
10	29.12 (50.66)	13.29 (23.12)	15.84 (27.56)	0.42
Total	35.54 (61.82)	16.57 (28.83)	18.97 (33.00)	0.47 \pm 0.09**

*, Top+middle-rim; **, Mean \pm SD

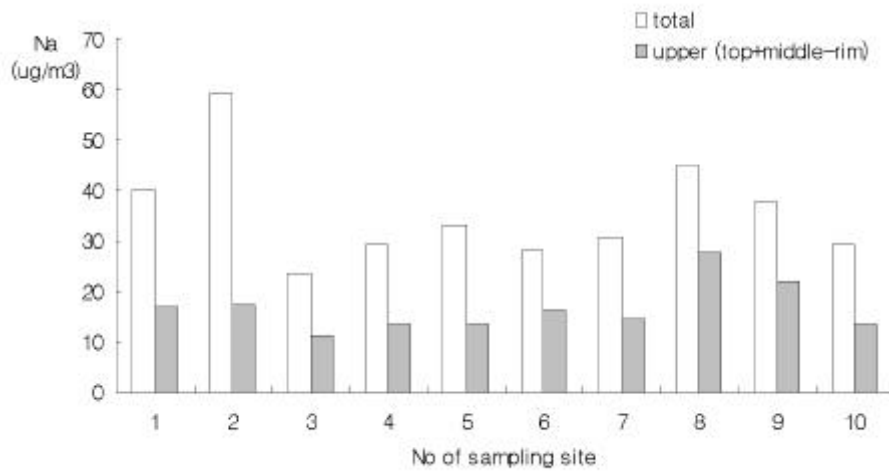


Figure 5. Distribution of total airborne sodium concentrations using the modified 2-piece cassette holder in chemical plants

NaOH 가 , .
 1998 50 5
 1999 1,069,308 1,045,292
 (, 2000).

OSHA
 3 3
 (spacer) 2 , 2
 3 MCE
 , 100mm, 7mm
 MCE , 가
 5.5mm 32mm MCE
 2 3
 . 가 6 (95.68, 474.42, 765.47, 956.83, 1435.25,
 1913.66 μ g) 6 MCE 가
 . 1.5M \emptyset
 /min 2 3
 .
 Puskar (1991) 37mm 3
 62% ,
 16% , 22% 가

. Beaulieu (1980) , , , , , .

가 . TDI 2

21% 가 (Mao , 2000).

	OSHA	MCE	NaOH 가
가	105.51% (99.96	109.42%)	NIOSH
(acceptable)	75%	(preferable) 90%	(NIOSH, 1994c)
	Bias	5.53% (0.04	9.42%)
	CV _{pooled} 0.11%	OSHA method ID- 121	5.8

% .

1996 MCE

5 /min 24

. 0.36 ± 0.12

(0.16 0.48)µg/m³ (, 1997)

. 2 3

10

NaOH 2 mg/m³

. 70,722 2

59.06 (102.75)µg/m³, 3 35.86 (62.39)

µg/m³ 2 1.65

. 122.99, 151.80
 2 23.39 (40.69), 29.12 (50.66) $\mu\text{g}/\text{m}^3$, 3
 16.95 (29.49), 17.20 (29.92) $\mu\text{g}/\text{m}^3$ 2
 1.38 1.69 . 14.65, 12.99, 15.69
 2 32.89 (57.22), 27.97 (48.66),
 30.85 (53.67) $\mu\text{g}/\text{m}^3$ 3 16.66 (28.98), 12.89 (22.43), 12.31
 (21.42) $\mu\text{g}/\text{m}^3$ 1.97, 2.17, 2.51 .
 1.59, 144, 5.00 2 40.09
 (69.74), 45.19 (78.62), 37.68 (65.55) $\mu\text{g}/\text{m}^3$ 3 28.72
 (49.97), 17.87 (31.09), 17.79 (30.95) $\mu\text{g}/\text{m}^3$ 1.40, 2.53, 2.12
 . 250 2
 29.12 (50.66) $\mu\text{g}/\text{m}^3$ 3 17.20 (29.92) $\mu\text{g}/\text{m}^3$
 1.69 . NaOH 2
 3
 2 3
 2 1.84 ,
 2 (+)
 47.24%가 . 3
 가 .
 .
 NaOH
 . NaOH NaOH가

2

. NaOH

가 .

•

2 MCE 2

3

2 가 2 3

1. 가 가 105.51 %

(99.96 109.42 %) |Bias| 5.53 % (0.04 9.42 %) .

CV_{pooled} 0.11 % OSHA 121

5.8 % .

2. 2 (+)

2 47.24

% (29.52 61.12 %) .

3. 2 63.17 (40.69

102.75)µg/m³ , 3 33.23 (21.41

62.39)µg/m 2 3

1.84 (p 0.01).

가 . 2 3 NaOH
2

91-21 , 1991

, 2000

가 , 1997

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=Abstract=

Comparision of sampling efficiency of total sodium on the modified 2-piece and 3-piece cassette holder

Young Shik, Yoon

Department of Occupational Health

Graduate School of Health Science and Management

Yonsei University

(Directed by Professor Young Bong Cho, Ph.D)

Sodium hydroxide (NaOH) is one of the chemicals produced in greatest quantity in Korea. It has various uses including acid neutralization, petroleum refining, electroplating, metal cleaning, laundering, bleaching, dish washing and manufacture of paper, cellulose, textiles, plastics, explosives, dyestuffs, paint, paint remover, and soap.

The aims of this study were to compare the sampling efficiency of the 3-piece cassette holder with the modified 2-piece cassette holder which whole inner surface was attached to cellulose ester membrane filter (MCE) at the chemical plants which were used the sodium

hydroxide.

Total sodium sampling was performed by using the OSHA method ID 121 which is used as method of occupational environment measurement and analysis. Air samplings were performed by simultaneous samplings using 3-piece and the modified 2-piece holders at the same time and same place. The significant difference between average adsorbed amounts on the membrane filters of the modified 2-piece cassette holder and 3-piece cassette holder were found. Sampling amounts of the modified 2-piece cassette holder was 1.84times higher than the 3-piece cassette holder ($p < 0.01$). 47% of total sodium was detected at the upper (inlet+middle-rim) side of the modified 2-piece cassette holder.

As the result of this study, it is verified that the modified 2-piece cassette holder is more effective than 3-piece cassette holder for total sodium sampling.

Key words : Sodium hydroxide, OSHA method, Sampling efficiency.
cassette holder, membrane