3M

Organic Vapor Monitor Sampling and Analysis Guide for Organic Vapor Monitors 3500/3510 and Organic Vapor Monitors 3520/3530

October 1993

INTRODUCTION

This Guide summarizes information on sampling and analysis of 3M Organic Vapor Monitors. This new guide has condensed the information previously found in the separate publications titled: "3M Organic Vapor Monitor Sampling Guide" and the "3M Organic Vapor Monitor Analysis Guide." Based on laboratory testing of over 60 organic vapors with the 3500 monitor and based on the similar chemical nature of organic vapors and their adsorption by charcoal, 3M recommends the more than 128 organic vapors listed in this Guide for the #3500/3510/3520.

3M manufactures a variety of organic vapor monitors. The 3500 and 3510 Organic Vapor Monitors are the same and they contain a single charcoal adsorbent pad. The 3500 monitor is designed to be analyzed by the user or by an independent laboratory. The 3510 includes a prepaid analysis from 3M for up to three compounds per monitor. The 3520 and 3530 Organic Vapor Monitors are the same and they both contain two adsorbent pads. The 3520 monitor is designed to be analyzed by the user or by an independent laboratory. The 3530 includes a prepaid analysis from 3M for up to three compounds per monitor.

Effective September 1993, 3M has changed the type of carbon that has been used since the introduction of the organic vapor monitors. This change in carbon does not affect sampling rate; however, it does slightly affect capacity and recoveries for some gases and vapors. These changes can be found in the enclosed tables. In order to identify if you have the original or the current carbon in your organic vapor monitor, please refer to the monitor code number found on the back of the monitor. The original carbon ("O" carbon) does not have a letter after the four digit number. The current carbon being used ("C" carbon) has the letter "C" after the four digit number; in addition, the shipping box will be stamped with a 009.

SAMPLING INFORMATION

- Standards

The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) and the OSHA Permissible Exposure Limit (PEL) standards are the most cited airborne standards. TLVs are recommendations or guidelines and are reviewed on a periodic basis; and if sufficient data warrants the TLVs are adjusted.

The ACGIH booklet has three categories for TLVs. First, "Threshold Limit Value-Time Weighted Average (TLV-TWA) - the time weighted average concentration for a normal 8-hour workday and a 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects. Second, "Threshold Limit Value-Short Term Exposure Limit (TLV-STEL) – the concentration to which workers can be exposed continuously for a short period of time without suffering; 1) irritation; 2) chronic or irreversible tissue damage; or 3) narcosis of sufficient degree to increase the likelihood of accidental injury." The STEL is defined as a 15 minute TWA exposure which should not be exceeded at any time during a workday even if the 8 hour TWA is within the TLV-TWA. Third, Threshold Limit Value – Ceiling (TLV-C) - the concentration that should not be exceeded during any part of the working exposure.

The OSHA standards (PELs) can be found in the Code Federal Regulations 29 CFR 1910.1000 and are legally enforceable standards. OSHA PELs have the same three categories as TLVs.

The 3M Organic Vapor Monitors can be used to sample 8 hour TLV-TWAs and PELs. The Organic Vapor Monitors can also be used to sample TLV-STEL and PEL-STEL if during the 15 minute sampling period, the monitor collects a sufficient quantity of contaminant for analysis. The Organic Vapor Monitor is not recommended for sampling periods less than 15 minutes to evaluate ceiling limits.

- Minimum Sampling Time

To confirm quantitatively the presence and concentration of a contaminant in the atmosphere, most analysts must have a minimum of 10 micrograms for G.C. analysis. A sampling period of at least 15 minutes is recommended even when 10 micrograms of the contaminant could be collected in a shorter period.

- Unsuitable Compounds

The OVM should not be used with the compounds listed below because of adverse or inadequate interactions with the sorbent material. This list is not exhaustive, but is representative of classes of compounds not suitable for use with the OVM.

Questions about specific compounds not listed should be directed to the OH&ESD toll-free technical service line at 1-800-243-4630.

Compounds

Ammonia	Methane, Ethane, Propane
Carbon Monoxide	Methyl Alcohol (Methanol)
Ethylene Oxide (1)	Methyl Chloride
Formaldehyde (2)	Methyl, Dimethyl, Trimethyl Amines
Hydrogen Sulfide	Organic Solids
Isocyanates	Sulfur Dioxide

(1) Ethylene Oxide can be monitored using 3M 3550/3551 Ethylene Oxide Monitor

(2) Formaldehyde can be monitored using 3M 3720/3721 Formaldehyde Monitor.

- 3M Analytical Service

Selected compounds will be analyzed by 3M using the 3M 3510 or 3530 Monitor sold with a prepaid analysis. For more information, contact your 3M Sales Representative or your local 3M OH&ESD safety products distributor.

DEFINITION OF TABLE

3M monitor sampling and analytical information is contained in the table. The table outlines recommended sampling periods for a variety of organic compounds, capacity information for the original carbon ("O" carbon) and current carbon ("C" carbon) and recovery information for both the "O" and "C" carbons. In addition, the table contains calculation constants for compounds found in the guide.

- Sampling rates

The (*) compounds in the guide tables have been subjected to an extensive amount of laboratory work to verify the sampling rate. The sampling rates given for the remaining compounds in this table were determined from empirical relationships as outlined in a publication on *Sampling Rate Validation*. The sampling rates are tabulated as cubic centimeters/minute. The publication on *Sampling Rate Validation* can be obtained from 3M on request. Sampling rates for compounds not found in the guide are available upon request.

The sampling rate using the new carbon monitor will not change because the geometry of the monitor remains the same.

The top section of the 3520 has the same geometry dimensions as the 3M Organic Vapor Monitor 3500; therefore, the sampling rate is the same as the 3500.

- Length of Sampling Period

The recommended sampling period has been estimated using the capacity of the 3M 3500/3510 Organic Vapor Monitor, a relative humidity of <70% and the 1993 ACGIH Threshold Limit Values. Full work shift sampling periods are recommended as the most comprehensive measure of worker exposure. When sampling some organic contaminants, sampling periods shorter than a full work shift are required in order not to exceed the recommended capacity of the monitor. Under these circumstances, sequential sampling with several monitors can be performed. For those compounds where the recommended length of the sampling period for the Organic Vapor Monitor 3500/3510 is less than a full workshift, the length of the sampling period can be increased when using the 3520/3530 Organic Vapor Monitor.

- Capacity

The capacity of the monitor for each individual compound is a function of molecular structure, vapor pressure, environmental conditions, etc. The capacity values in the guide are used to determine the length of a recommended sampling period.

The table contains capacity information on both the original ("O") and current ("C") carbons.

Because of the back up section, the effective sampling time of the Organic Vapor Monitor 3520/3530 is greater than the values listed for the 3500/3510.

When sampling environments containing mixtures and/or high relative humidity, it is difficult to accurately define the capacity. Therefore, under those conditions we recommend using the 3520/3530. When sampling listed contaminants, the combined weights of the contaminants collected should not exceed the listed value for the single contaminant with lowest capacity. When using the 3520/3530 , the weight (Ws) collected by the secondary adsorbent on the backup section can be compared with the weight (Wp) collected by the primary adsorbent to determine sample validity. The ratio Ws/Wp must be equal to or less than 0.50 for a valid sample.

- Recovery Coefficients (Desorption Efficiency)

The collected sample is removed from the activated carbon wafer for analysis by desorption with carbon disulfide (CS_2) or other suitable solvents. In order for the laboratory analyst to determine accurately the amount of contaminant collected by the adsorbent, it is necessary to know the efficiency of the desorption process.

The recovery coefficient or desorption efficiency is determined by adding a known weight of contaminant onto the adsorbent and measuring the weight of contaminant in the desorbing solvent. The recovery coefficient is calculated by dividing the recovered weight of contaminant by the known amount.

The table contains recovery coefficients for the original and current carbon using carbon disulfide (CS_2), unless otherwise indicated. We recommend that these recoveries be used only as a guideline, and that laboratories perform their own recovery studies. Industrial Hygiene literature/methods should be consulted for elution solvents which exhibit improved recovery when CS_2 is not adequate. Refer to the analysis section of this guide for further information on determining recovery coefficients.

Procedure to Calculate Contaminant Concentrations

The time-weighted-average concentration of the environment sampled can be calculated by knowing the length of the sampling period, the contaminant weight determined by gas chromatography, the recovery coefficient, and the calculation constant either A or B. The calculation constant A is used to calculate the concentration when expressed in units of milligrams per cubic meter (mg/m^3) and constant B when expressed in units of parts per million (ppm). The calculation constants A and B have been determined for every contaminant in the Analysis Guide by the following expressions:

$$A = \frac{1000}{\text{Sampling Rate}}$$

$$B = \frac{1000}{\text{Sampling Rate}} \times \frac{(24.45)}{\text{(Molecular Weight}}$$

The contaminant concentration can be calculated with the following information:

- **Sampling Information**

  Contaminant
  Length of Sampling Period (min.) **t**

- **Contaminant information from tables in Analysis Guide**

  Calculation Constant **A** or **B**

- **Analytical Results**

  Contaminant weight recovered **W** (Micrograms) corrected for blank
  Recovery Coefficient (r)

- **Temperature Effects**

  The following expressions calculate the time-weighted-average concentrations at a sampling temperature of 25°C (298°K) and pressure of 760 mm. When sampling at other environmental conditions, the expressions need to be corrected only for variations in temperature. The expressions can be multiplied by the following temperature correction factors (CF_T) for samples collected at temperatures other than 25°C (77°F).

Sampling (°C)	Temperature (°F)	Temperature Correction Factor (CF_T)
44	111	0.97
37	99	0.98
31	88	0.99
25	77	1.00
19	66	1.01
13	55	1.02
7	45	1.03
2	36	1.04
-3	27	1.05
-8	18	1.06

From the above table, every 10-11° above or below 77°F requires one percent correction to the calculated time-weighted-average concentration.

Calculation Procedures

A. #3500 Organic Vapor Monitor

The time-weighted-average concentration in milligrams per cubic meter of the contaminant in the environment sampled can be calculated from the following expression:

$$C(mg/m^3) = \frac{W \text{ (micrograms)}}{r \times t \text{ (minutes)}} \quad \mathbf{X\ A}$$

The time-weighted-average concentration in parts per million (ppm) of the contaminant can be calculated from the following expression:

$$C(ppm) = \frac{W \text{ (micrograms)}}{r \times t \text{ (minutes)}} \quad \mathbf{X\ B}$$

If the temperature correction is desired, the time-weighted-average concentration can be calculated by the following expression:

$$C(mg/m^3) = \frac{W \text{ (micrograms)}}{r \times t \text{ (minutes)}} \quad \mathbf{X\ A\ X\ CF}_T$$

$$C(ppm) = \frac{W \text{ (micrograms)}}{r \times t \text{ (minutes)}} \quad \mathbf{X\ B\ X\ CF}_T$$

Example Calculation

Contaminant		**Benzene**
Length of Sampling Period (t)		**420 minutes**
Temperature (T)		**75°F**
Calculation Constant	**A**	**28.2**
	or	
	B	**8.83**

Contaminant Weight Recovered (W)	**27.2 micrograms**
Recovery Coefficient (r)	**1.02**

Using Calculation Constant **A**:

$$C(mg/m^3) = \frac{27.2}{(1.02)\quad(420)} \quad \mathbf{X\ 28.2}$$

$C = 1.79\ mg/m^3$

Using Calculation Constant **B**:

$$C(ppm) = \frac{27.2}{(1.02)\quad(420)} \quad \mathbf{X\ 8.83}$$

$C = 0.56$ ppm

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B. #3520 Organic Vapor Monitor with back-up section

Upon analysis of each adsorbent, the validity of the sample can be determined. But in order to assure a valid sample under all sampling conditions, the ratio of the contaminant weight (W_S) on the secondary adsorbent to the contaminant weight (W_P) on the primary adsorbent must meet the following criteria.

$$\frac{W_S}{W_P} \leq .50$$

W_P – weight collected on the primary adsorbent corrected for recovery and blank (micrograms)

W_S – weight collected on the secondary adsorbent corrected for recovery and blank (micrograms)

t – length of sampling period (minutes)

$$C\ mg/m3 = \frac{(W_P + 2.2\ W_S)\ X\ A}{t}$$

$$C\ ppm = \frac{(W_P + 2.2\ W_S)\ X\ B}{t}$$

A – calculation coefficient (mg/m^3)

B – calculation coefficient (ppm)

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- **Recommended Procedure For Determination of Recovery Coefficients for 3M Organic Vapor Monitor #3500/3520**

3M publishes the recovery coefficient for many of the organic vapors in the 3500 Compound Guide. However, we encourage the user to verify the recovery coefficients, since techniques and presence of multiple contaminants can affect recovery coefficients.

The recovery coefficient is determined by vapor-state spiking of monitors. The following procedures are recommended for spiking 3M Organic Vapor monitors:

1) Remove plastic ring and white film from a monitor.

2) Place a 2.5 cm diameter filter paper on spacer plate.

3) The closure cap is snapped on the monitor.

4) Calculate the amount of material to be injected. The following formula will calculate the injection amount, in milligrams, that corresponds to the amount that would be collected by a monitor at sampling conditions chosen. By varying the chosen concentration levels and exposure times, a recovery coefficient curve can be generated.

   $W = (K_o) \times (C) \times (t) \times (10^{-6}\ m^3/cm^3)$

Where:

W = Amount of liquid injection in milligrams
K_o = Sampling rate of monitor cm^3/min.
C = Average concentration in mg/m^3
t = Sampling time in minutes

For compounds that are solid at room temperature, prepare a solution in Carbon Disulfide such that no more than a 5 microliter injection is needed to spike the required number of milligrams of compound.

A suggested starting point would be assuming an average concentration of one PEL (Permissible Exposure Limit) and an 8 hour exposure period, as long as the amount in milligrams does not exceed the recommended exposure limit of monitor.

5) Inject the known quantity of the organic material onto the filter paper through the center port.

6) The monitor is allowed to sit 16-24 hours to allow total transfer of the organic material from the filter paper to the sorbent before elution.

7) Remove filter paper from monitor.

8) Proceed with elution and determination of amount recovered by G.C. analysis. See #3500 Organic Vapor Monitor Instructions for Use.

For further assistance, call 3M Occupational Health and Environmental Safety Division Technical Service toll free on 1-800/243 4630, or write 3M Occupational Health and Environmental Safety Division, 3M Center, Building 275-6W-01; PO Box 33275, St. Paul, MN 55133-3275.

Sampling and Analysis Guide

	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (O-Carbon) (mg)	Capacity (C-Carbon) (mg)	Recovery Coefficient (O-Carbon)	Recovery Coefficient (C-Carbon)	Calculation Constant	
							A (mg/m^3)	B (ppm)
Acetone*	40.1 ± 0.9	1.5	4	7	0.91	0.91	24.9	10.51
Acetonitrile	48.2	0.5	0.1	–	0.82	0.71	20.8	12.37
Acrylonitrile	43.8	8	4	–	0.79	0.71	22.8	10.53
Allyl Alcohol	40.4	8	3	5	0.78 +	0.74 +	24.8	10.43
Allyl Chloride	35.1	8	2	3	0.87	0.86	28.5	9.05
i-Amyl Acetate	27.2	8	>25	>25	0.98	0.97	36.8	6.90
n-Amyl Acetate*	26.0 ± 0.5	8	>25	>25	0.78	0.82	38.6	7.26
s-Amyl Acetate	27.2	8	>25	–	–	–	36.8	6.91
i-Amyl Alcohol*	32.3 ± 0.4	8	>25	–	0.82	0.77	31.0	8.63
n-Amyl Alcohol (1-Pentanol)*	31.2 ± 0.4	8	25	24	1.01 +	0.96 +	32.1	8.91
s-Amyl Alcohol (2-Pentanol)	31.2	8	>25	–	0.99 +	–	32.1	8.89
Benzene*	35.5 ± 0.6	8	16	22	1.02	0.95	28.2	8.83
Benzyl Chloride	27.2	8	>25	>25	0.88	0.89	36.8	7.08
Bromoform	29.3	8	>25	>25	1.01	1.02	34.1	3.30
1,3-Butadiene‡	42.8	–	0.4	–	–	–	23.4	10.53
i-Butyl Acetate*	31.0 ± 0.3	8	>22	25	1.01	1.02	32.3	6.80
n-Butyl Acetate	31.6	8	>25	>25	1.04	1.07	31.7	6.67
s-Butyl Acetate*	28.6 ± 0.4	8	>25	>25	0.99	0.98	35.0	7.37
t-Butyl Acetate	29.4	8	23	23	0.99	0.98	34.0	7.17
Butyl Acrylate	27.3	8	>25	>25	1.07	1.06	36.6	6.99
i-Butyl Alcohol*	35.9 ± 0.7	8	17	19	0.96 +	0.93 +	27.9	9.20
n-Butyl Alcohol*	34.3 ± 0.7	8	19	21	0.95 +	0.95 +	29.2	9.63
s-Butyl Alcohol	34.8	8	15	19	0.89 +	0.89 +	28.7	9.44
t-Butyl Alcohol	35.2	8	11	15	0.76	0.74	28.4	9.39
Butyl Cellosolve (2-Butoxyethanol)*	28.2 ± 0.6	8	>25	>25	0.91 +	0.91 +	35.5	7.35
Butyl Cellosolve Acetate (2-Butoxyethyl Acetate)*	24.3 ± 1.0	8	>25	>25	0.98	0.90	41.2	6.28
Butyl Glycidyl Ether (BGE)	27.0	8	>25	25	0.93	0.93	37.0	6.97
t-Butyl Methyl Ether (MTBE)*	32.9 ± 1.4	8	12	17	0.98	0.95	30.4	8.43
p-tert-Butyltoluene*	20.7 ± 0.4	8	>25	25	1.08	1.07	48.3	7.98
Camphor	21.4	8	>25	–	–	–	46.7	7.52
Carbon Disulfide	42.8	8	1	–	0.82++	–	23.4	7.52
Carbon Tetrabromide	26.6	–	–	–	–	–	37.6	2.77
Carbon Tetrachloride*	30.2 ± 0.4	8	>25	>25	1.04	0.95	33.1	5.26
Cellosolve (2-Ethoxyethanol)*	32.4 ± 0.9	8	22	>25	0.93+	0.92+	30.9	8.39
Cellosolve Acetate* (2-Ethoxyethyl Acetate)	26.6 ± 0.4	8	>25	>25	0.93	0.96	37.6	6.96
Chlorobenzene*	29.3 ± 0.6	8	>25	>25	1.01	0.96	34.1	7.38
Chlorobromomethane*	34.4 ± 0.9	8	7	18	0.91	0.90	29.1	5.51
Chloroform	33.5	8	12	21	0.95	0.95	29.9	6.13
Chloroprene (2-Chloro-1,3-butadiene)	32.2	8	5	–	–	–	31.1	8.53
o-Chlorostyrene	26.0	8	>25	–	0.80	–	38.5	6.77
2-Chloro-1,1,1,2-tetrafluoroethane (HCFC 124)	35.8 ± 2.1	–	–	6	–	0.87+++	27.9	5.00
o-Chlorotoluene*	27.3	8	>25	–	–	–	36.6	7.05

\+ Methylene Chloride as the solvent

‡ See Technical Data Bulletin 63

++ Acetonitrile as the Solvent

+++ Isopropyl Alcohol as the Solvent

Sampling and Analysis Guide

	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (O-Carbon) (mg)	Capacity (C-Carbon) (mg)	Recovery Coefficient (O-Carbon)	Recovery Coefficient (C-Carbon)	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
Cumene*	24.5 ± 0.9	8	>25	>25	1.04	1.01	40.8	8.32
Cyclohexane*	32.4 ± 0.7	6	7	13	1.01	1.02	30.9	8.98
Cyclohexanol*	29.5 ± 0.3	8	23	22	1.03 +	1.02 +	33.9	8.27
Cyclohexanone*	28.9 ± 0.3	8	21	22	1.04	1.05	34.6	8.63
Cyclohexene*	32.3 ± 0.4	8	17	21	1.01	0.99	31.0	9.23
Cyclopentadiene	39.5	–	–	–	–	–	25.3	9.36
Cyclopentane	36.2	1	3	5	1.02	1.02	27.6	9.63
n-Decane*	23.1 ± 0.5	8	>25	>25	1.04	1.05	43.3	7.44
Diacetone Alcohol*	28.2 ± 0.4	8	>25	>25	1.00 +	0.94 +	35.5	7.47
o-Dichlorobenzene*	27.8 ± 0.6	8	>25	>25	0.90	0.87	36.0	5.98
p-Dichlorobenzene*	27.8 ± 0.6	8	>25	–	0.95	–	36.0	5.98
1,1-Dichloroethane	33.2	8	7	13	1.08	0.92	30.1	7.44
1,2-Dichloroethylene*	35.2 ± 0.5	0.5	1	–	0.99	–	28.4	7.16
Dichloroethyl Ether	26.1	8	>25	–	–	–	38.3	6.55
1,1-Dichloro-1-nitroethane	28.5	8	>25	–	–	–	35.1	5.96
1,1-Dichloro-2,2,2-trifluoroethane (HCFC-123)*	30.9 ± 2.6	–	14	–	0.99	–	32.4	5.17
Dicyclopentadiene	23.6	–	–	–	–	–	42.4	7.84
Diethyl Ketone	32.7	–	–	–	–	–	30.6	8.68
Diisobutyl Ketone*	24.6 ± 0.8	8	>25	–	1.07	–	40.7	7.00
Dimethylacetamide	32.0	–	–	–	0.85 +	–	31.3	8.77
Dimethyl Formamide	35.5	8	>25	>25	0.74 +	0.65 +	28.2	9.42
p-Dioxane	34.5	8	>25	–	0.80	–	29.0	8.05
Dipropylene Glycol Methyl Ether	25.3	8	>25	–	–	–	39.5	6.53
Dipropyl Ketone	27.8	–	–	–	0.67	0.66	36.0	7.70
Divinyl Benzene	23.3	8	21	20	0.51	0.47	42.9	8.06
n-Dodecane*	21.5 ± 0.9	8	>25	>25	1.04	1.09	46.5	6.68
Enflurane (2-Chloro-1,1,2-trifluoroethyl difluoromethyl ether)	28.3	8	6	8	0.84	0.81	35.3	4.68
Epichlorohydrin (1-Chloro-2,3-epoxypropane)	29.6	8	13	20	0.86	0.85	33.8	8.88
Ethyl Acetate*	34.5 ± 0.6	6	15	20	0.99	0.99	29.0	8.05
Ethyl Acrylate	32.2	8	24	>25	0.96	0.93	31.1	7.59
Ethyl Alcohol*	43.7 ± 2.5	2	12	–	0.89++	0.89++	22.9	12.14
Ethyl Benzene	27.3	8	23	24	0.94	0.96	36.6	8.45
Ethyl Bromide*	36.4 ± 0.3	8	2	6	0.98	0.94	27.5	6.16
Ethyl Butyl Ketone (3-Heptanone)	28.0	8	>25	–	0.70	0.68	35.7	7.66
Ethylene Chlorohydrin (2-Chloroethanol)	33.9	8	>25	–	–	–	29.5	8.90
Ethylene Dibromide (1,2-Dibromoethane)*	29.6 ± 0.4	8	>25	–	1.04	–	33.8	4.39
Ethylene Dichloride (1,2-Dichloroethane)*	33.2 ± 0.7	8	9	16	1.00	0.98	30.1	7.44
Ethyl Ether	36.8	4	7	12	1.02	0.86	27.2	8.98
Ethyl Formate	38.8	1	1	–	–	–	25.8	8.52
Ethyl Mercaptan	41.1	–	–	–	–	–	24.3	9.57
Furfural	34.3	8	>25	>25	0.71+	0.62+	29.2	7.42
Furfuryl Alcohol	30.6	8	>25	>25	0.76+	0.71+	32.7	8.14
Gasoline*	30.5 ± 1.3	–	–	–	1.05	–	32.8	7.49
Glycidol (2,3-Epoxy-1-propanol)	37.1	8	>25	–	–	–	27.0	8.91

\+ Methylene Chloride as the solvent

‡ See Technical Data Bulletin 63

++ Acetonitrile as the Solvent

+++ Isopropyl Alcohol as the Solvent

Sampling and Analysis Guide

	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (O-Carbon) (mg)	Capacity (C-Carbon) (mg)	Recovery Coefficient (O-Carbon)	Recovery Coefficient (C-Carbon)	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
Halothane (2-Bromo-2-Chloro-1,1,1-trifluoroethane)	30.2	8	7	10	0.93	0.92	33.1	4.10
n-Heptane*	28.9 ± 0.7	8	>25	>25	1.02	1.04	34.6	8.46
Hexachlorobutadiene	22.9	–	–	–	–	–	43.7	4.09
Hexachlorocyclopentadiene	22.1	–	–	–	–	–	45.2	4.06
Hexachloroethane	26.7	8	>25	–	–	–	37.5	3.86
n-Hexane*	32.0 ± 0.7	8	20	24	1.00	1.03	31.3	8.88
Hexane Isomers*	32.0 ± 0.7	7	20	24	1.00	1.03	31.3	8.87
s-Hexyl Acetate	25.2	8	>25	–	–	–	39.7	6.73
Isoflurane (Forane)	28.3	8	6	7	0.75	0.76	35.3	4.68
Isooctyl Alcohol	25.1	–	–	–	0.84	0.80	39.8	7.48
Isophorone*	21.7 ± 0.7	8	>25	>25	0.75	0.75	46.1	8.16
Isopropoxyethanol	29.5	8	23	23	0.95	0.92	33.9	7.96
Isopropyl Acetate	31.7	7	15	–	0.97	0.96	31.5	7.56
Isopropyl Alcohol	39.4	2	6	–	0.66	0.49	25.4	10.34
Isopropyl Ether	31.2	5	10	–	1.03	1.03	32.1	7.67
Isopropyl Glycidyl Ether	29.1	8	>25	–	–	–	34.4	7.24
Mesitylene (Trimethyl Benzene)*	26.3 ± 0.7	8	>25	>25	1.08	1.05	38.0	7.75
Mesityl Oxide*	31.2 ± 1.2	8	24	>25	0.85	0.89	32.1	8.00
Methyl Acetate*	37.0 ± 0.6	2	1	3	1.02	0.92	27.0	8.93
Methyl Acrylate	35.8	8	11	11	0.91	0.87	27.9	7.94
Methylal (Dimethoxymethane)	37.9	1	5	10	0.92	0.97	26.4	8.49
Methyl Amyl Ketone (2-Heptanone)	27.9	8	>25	–	–	–	35.8	7.69
Methyl Bromide	40.9	8	0.5	–	–	–	24.4	6.30
Methyl Butyl Ketone (2-Hexanone)*	29.7 ± 0.7	8	23	24	1.01	1.00	33.7	8.23
Methyl Cellosolve (2-Methoxyethanol)*	36.3 ± 0.4	8	24	>25	0.83+	0.86+	27.5	8.86
Methyl Cellosolve Acetate (2-Methoxyethyl Acetate)*	29.0 ± 0.5	8	>25	>25	0.89	0.86	34.5	7.14
Methyl Cyclohexane*	28.9 ± 0.4	7	21	20	1.02	1.03	34.6	8.63
Methyl Cyclohexanol	25.3	8	>25	–	0.88	0.83	39.5	8.46
Methylene Chloride (Dichloromethane)*‡	37.9 ± 0.3	–	3	7	0.97	0.97	26.4	7.59
Methyl Ethyl Ketone (2-Butanone)*	36.3 ± 0.9	8	12	18	0.96	0.94	27.5	9.35
Methyl Formate	45.0	0.5	0.2	0.5	0.93+	0.76+	22.2	9.06
5-Methyl-3-heptanone (Ethyl Amyl Ketone)	26.4	8	24	24	0.82	0.83	37.9	7.24
Methyl Iodide	36.7	7	0.2	–	–	–	27.3	4.69
Methyl Isoamyl Ketone	28.0	8	>25	>25	1.01	1.01	35.7	7.66
Methyl Isobutyl Carbinol (Methyl Amyl Alcohol)	29.2	8	21	21	0.83	0.81	34.2	8.21
Methyl Isobutyl Ketone (Hexone)*	30.0 ± 0.4	8	>25	>25	0.99	0.99	33.3	8.15
Methyl Isopropyl Ketone	32.8	–	–	–	0.95	0.91	30.5	8.65
Methyl Methacrylate	31.8	8	25	>25	1.05	0.98	31.5	7.69
1-Methyl-2-pyrrolidinone	28.8	–	–	–	0.43	–	34.7	8.56
alpha-Methyl Styrene*	25.0 ± 0.5	8	25	25	1.07	1.02	40.0	8.29
Morpholine	33.1	–	–	–	–	–	30.2	8.48

\+ Methylene Chloride as the solvent

‡ See Technical Data Bulletin 71

++ Acetonitrile as the Solvent

+++ Isopropyl Alcohol as the Solvent

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Sampling and Analysis Guide

	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (O-Carbon) (mg)	Capacity (C-Carbon) (mg)	Recovery Coefficient (O-Carbon)	Recovery Coefficient (C-Carbon)	Calculation Constant	
							A (mg/m^3)	B (ppm)
Naphtha (VM&P)*	33.2 ± 0.7	8	20	–	1.04	–	30.1	7.36
Naphthalene	24.6	8	>25	–	–	–	40.7	7.76
n-Nonane*	24.6 ± 0.6	8	>25	>25	1.05	1.09	40.7	7.75
n-Octane*	26.6 ± 0.6	8	>25	25	1.02	1.05	37.6	8.06
n-Pentane*	35.3 ± 0.9	3	9	12	1.00	0.98	28.3	9.62
2,4-Pentanedione	31.7	–	–	–	0.85	–	31.5	7.70
2-Pentanone (Methyl Propyl Ketone)*	33.0 ± 0.5	8	23	24	0.94	0.93	30.3	8.62
Perchloroethylene*	28.3 ± 0.5	8	>25	>25	1.07	1.00	35.3	5.20
Phenyl Ether	20.3	8	>25	>25	0.93	0.90	49.3	7.08
Phenyl Glycidyl Ether	22.2	8	>25	–	–	–	45.0	7.33
n-Propyl Acetate*	30.1 ± 0.5	8	24	25	1.01	1.00	33.3	7.96
n-Propyl Alcohol*	39.7 ± 0.7	6	5	8	0.85+	0.85+	25.2	10.26
Propylene Dichloride (1,2-Dichloropropane)*	30.6 ± 0.4	8	25	–	1.04	–	32.7	7.07
Propylene Glycol Monomethyl Ether (PGME)*	32.4 ± 2.1	8	>25	>25	0.92+	0.86+	30.9	8.37
Propylene Glycol Monomethyl Ether Acetate (PGMEA)*	25.2 ± 1.1	8	>25	>25	1.00	1.01	39.7	7.34
Propylene Oxide*	37.7 ± 2.5	–	–	–	0.99	0.84	26.5	11.17
n-Propyl Nitrate	33.3	8	22	25	1.03	1.02	30.0	6.99
Resorcinol	25.8	–	–	–	–	–	38.8	8.61
Stoddard Solvent	24.3	8	>25	–	0.82	–	41.2	6.99
Styrene*	26.8 ± 0.8	8	>25	>25	0.94	0.82	37.3	8.77
1,1,1,2-Tetrachloro-2,2-difluoroethane	27.5	0.5	5	–	–	–	36.4	4.36
1,1,2,2-Tetrachloro-1,2-difluoroethane	28.2	0.5	5	–	–	–	35.5	4.25
1,1,2,2-Tetrachloroethane	28.4	8	>25	>25	0.91	0.92	35.2	5.12
1,1,1,2-Tetrafluoroethane (134a)*	37.1 ± 3.9	–	1	2	0.62+++	0.61+++	27.0	6.46
Tetrahydrofuran	37.2	8	8	15	1.09	0.86	26.8	9.13
Toluene*	31.4 ± 0.6	8	25	>25	1.00	1.00	31.8	8.46
1,1,1-Trichloroethane (Methyl Chloroform)*	30.9 ± 0.3	6	20	22	1.03	1.03	32.4	5.95
1,1,2-Trichloroethane*	29.7 ± 0.6	8	>25	>25	1.00	0.95	33.7	6.19
Trichloroethylene*	31.1 ± 0.2	8	>25	>25	1.00	0.99	32.2	6.00
1,2,3-Trichloropropane	27.4	8	>25	>25	1.03	0.99	36.5	6.07
1,1,2-Trichloro-1,2,2-trifluoroethane	29.1	0.5	5	11	0.96	0.92	34.4	4.48
Vinyl Acetate	35.8	8	17	–	1.02	–	27.9	7.94
Vinyl Bromide	37.0	6	0.3	–	–	–	27.0	6.18
Vinyl Chloride*	40.8 ± 0.5	1	0.04	–	1.02	–	24.4	9.56
4-Vinyl-1-cyclohexene*	27.9 ± 1.8	8	–	–	1.13	–	35.8	8.10
Vinylidene Chloride	35.1	8	3	4	0.98	1.00	28.5	7.19
Vinyl Toluene	25.1	8	>25	–	–	–	39.8	8.24
Xylene*	27.3 ± 0.5	8	>25	>25	1.04	0.97	36.6	8.44

\+ Methylene Chloride as the solvent

‡ See Technical Data Bulletin 63

++ Acetonitrile as the Solvent

+++ Isopropyl Alcohol as the Solvent

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