3M

Organic Vapor Monitor # 3500

Analysis Guide

ANOTHER STEP TOWARDS BETTER OCCUPATIONAL HEALTH AND SAFETY

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Occupational Health and Safety Products Division/3M

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Organic Vapor Monitor
Analysis Guide

USE OF THE ANALYSIS GUIDE TABLES:

The Analysis Guide is designed for the customer involved in the analysis of the 3M #3500 Organic Vapor Monitor by the gas chromatograph. The following tables summarize the 3M monitor sampling rate, capacity, recovery coefficient and calculation constants. The analysis guide provides the necessary information to calculate the time-weighted-average concentration in parts per million (ppm) or milligrams per cubic meter (mg/m^3).

A. Monitor Sample Information

- **Sampling Rate**

The (*) compounds in the Sampling 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. All sampling rates have an accuracy of ± 5%. The sampling rates are tabulated as either cubic centimeters/minute or micrograms/ppm-hour.

- **Capacity**

The capacity of the monitor for each individual compound is a function of molecular structure, vapor pressure, environmental conditions, etc. The capacity is stated in terms of weight (milligrams). For a single contaminant, if the analyst finds the weight collected by the monitor is greater than the defined capacity, then the validity of the sample should be questioned.

When sampling multiple contaminants, the combined weights of the contaminants collected should not exceed the defined value for the single contaminant with the lowest capacity.

- **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 by the known weight. It is recommended that each analytical laboratory determine recovery coefficients according to the procedure outlined by the 3M laboratory contained in the Analysis Guide as "Recommended Procedure for Determination of Recovery Coefficients." Recovery coefficients determined by the 3M laboratory are tabulated in the following tables.

B. 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 constant A and B have been determined for every contaminant in the Analysis Guide by the following expressions:

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

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

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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)
  Recovery Coefficient (**r**)

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

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

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

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

The above 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 above expressions need to be corrected only for variations in temperature. The above expressions can be multiplied by the following temperatures 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	.97
37	99	.98
31	88	.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 a one percent correction to the calculated time-weighted-average concentration.

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

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

$$C(ppm) = \frac{W\ (micrograms)}{r \times t\ (minutes)} \times B \times CF_T$$

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Exampl Calculati n

Contaminant	Benzen
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:

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

$C = 1.79\ mg/m^3$

Using Calculation Constant B:

$$C\ (ppm) = \frac{27.2}{(1.02)\ (4.20)} \times 8.83$$

$C = .56\ ppm$

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	Sampling Rate (cc/min)	Capacity (mg)	Recovery Coefficient	Calculation Constant	
				A (mg/m^3)	B (ppm)
Acetone*	40.1 ± .9	3	.87	24.9	10.51
Acetonitrile	48.2	14	—	20.8	12.37
Acrylonitrile	43.8	11	—	22.8	10.53
Allyl Alcohol	40.4	20	—	24.75	10.43
Allyl Chloride	35.1	1	—	28.5	9.05
n-Amyl Acetate*	26.0 ± .5	>25	1.08	38.6	7.26
s-Amyl Acetate	27.2	>25	—	36.8	6.91
n-Amyl Alcohol*	31.2 ± .4	>25	1.00+	32.1	8.91
i-Amyl Alcohol*	32.3 ± .4	>25	.99+	31.0	8.63
s-Amyl Alcohol	32.3	>25	.99+	31.0	8.60
Benzene*	35.5 ± .6	13	1.02	28.2	8.83
Benzyl Chloride	27.2	>25	1.05	36.8	7.08
Bromoform	29.3	>25	1.05	34.1	3.30
Butadiene	42.8	.4	—	23.4	10.53
n-Butyl Acetate	31.6	25	1.04	31.7	6.67
s-Butyl Acetate	28.6	>25	1.07	35.0	7.37
t-Butyl Acetate	29.4	19	1.05	34.0	7.17
Butyl Acrylate	28.7	>25	—	34.8	6.66
Butyl Alcohol*	34.3 ± .7	>25	.98+	29.2	9.63
s-Butyl Alcohol	34.8	19	.97+	28.7	9.44
t-Butyl Alcohol	35.2	13	—	28.4	9.39
Butyl Cellosolve* (2-Butoxyethanol)	28.2 ± .6	>25	.86	35.5	7.35
Butyl Glycidyl Ether (BGE)	27.0	>25	—	37.0	6.97
p-tert-Butyltoluene*	20.7 ± .4	>25	1.10	48.3	7.98
Camphor	21.4	>25	—	46.7	7.52
Carbon Disulfide	42.8	1	—	23.4	7.52
Carbon Tetrachloride*	30.2 ± .4	14	1.05	33.1	5.26
Cellosolve* (2-Ethoxyethanol)	32.4 ± .9	>25	.78	30.9	8.39
Cellosolve Acetate* (2-Ethoxyethyl Acetate)	26.6 ± .4	>25	1.03	37.6	6.96
Chlorobenzene*	29.3 ± .6	>25	1.00	34.1	7.38
o-Chlorostyrene	26.0	>25	—	38.5	6.77
o-Chlorotoluene	27.3	>25	—	36.6	7.05
Chlorobromomethane*	34.4 ± .9	10	1.00	29.1	5.51
Chloroform	33.5	7	.98	29.9	6.13
1-Chloro-1-nitropropane	30.4	>25	—	32.9	6.49
Chloroprene (2-Chloro-1,3-butadiene)	32.2	5	—	31.1	8.53
Cumene*	24.5 ± .9	>25	.96	40.8	8.32
Cyclohexane*	32.4 ± .7	22	1.07	30.9	8.98
Cyclohexanol*	29.5 ± .3	>25	1.00+	32.7	8.48
Cyclohexanone*	28.9 ± .3	>25	.97	34.6	8.63
Cyclohexene*	32.3 ± .4	22	1.02	31.0	9.23
Diacetone Alcohol*	28.2 ± .4	>25	1.04+	35.5	7.47
o-Dichlorobenzene*	27.8 ± .6	>25	.95	36.0	5.98
p-Dichlorobenzene*	27.8 ± .6	>25	.95	36.0	5.98
1,1 Dichloroethane	33.2	4	—	30.1	7.44
1,2 Dichloroethylene*	35.2 ± .5	1	.99	28.4	7.16
1,1 Dichloro-1-nitroethane	28.5	>25	—	35.1	5.96
Dichloroethyl Ether	26.1	>25	—	38.3	6.55

+ Methylene Chloride as the solvent

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	Sampling Rate (cc/min)	Capacity (mg)	Recovery Coefficient	Calculation Constant	
				A (mg/m^3)	B (ppm)
Diisobutyl Ketone*	24.6 ± .8	>25	1.07	40.7	7.00
Dimethyl Formamide	32.4	>25	—	30.9	10.34
p-Dioxane	34.5	>25	—	29.0	8.05
Dipropylene Glycol Methyl Ether	25.3	>25	—	39.5	6.53
Enflurane (2-Chloro-1,1,2 trifluoro-ethyl difluoromethyl ether)	28.3	4	—	35.3	4.68
Epichlorohydrin (1-Chloro-2,3-epoxy-propane)	29.6	>25	.95	33.8	8.88
Ethyl Acetate*	34.5 ± .6	10	1.01	29.0	8.05
Ethyl Acrylate	32.2	19	—	31.1	7.59
Ethyl Alcohol	51.2	12	—	19.5	10.38
Ethyl Benzene	27.3	>25	—	36.6	8.45
Ethyl Bromide*	36.4 ± .3	1	1.03	27.5	6.16
Ethyl Butyl Ketone (3-Heptanone)	28.0	>25	—	35.7	7.66
Ethyl Ether	36.8	.4	—	27.2	8.98
Ethyl Formate	38.8	1	—	25.8	8.52
Ethylene Chlorohydrin (2-Chloroethanol)	33.9	>25	—	29.5	8.90
Ethylene Dibromide* (1,2-Dibromomethane)	29.6 ± .4	>25	1.04	33.8	4.39
Ethylene Dichloride* (1,2-Dichloroethane)	33.2 ± .7	18	1.02	30.1	7.44
Furfural	34.3	>25	—	32.8	8.35
Furfuryl Alcohol	32.6	>25	—	30.7	7.65
Glycidol (2,3-Epoxy-1-propanol)	37.1	>25	—	27.0	8.91
Halothane (2-Bromo-2-chloro-1,1,1 trifluoroethane)	30.2	4	—	33.1	5.96
Heptane*	28.9 ± .7	>25	1.08	34.6	8.46
Hexachloroethane	26.7	>25	—	37.5	3.86
Hexane*	32.0 ± .7	18	1.05	31.3	8.88
s-Hexyl Acetate	28.1	>25	—	35.6	6.04
Isoamyl Acetate	27.2	>25	—	36.8	8.64
Isoamyl Alcohol*	32.3 ± .4	>25	1.03+	31.0	8.60
Isobutyl Acetate*	31.0 ± .3	>25	—	32.3	6.80
Isobutyl Alcohol*	35.9 ± .7	>25	1.02+	27.9	9.20
Isophorone*	21.7 ± .7	>25	1.03+	46.1	8.16
Isopropyl Acetate	31.7	15	1.05+	31.5	7.58
Isopropyl Alcohol	39.4	17	—	25.4	10.34
Isopropyl Ether	31.2	10	—	33.0	7.91
Isopropyl Glycidyl Ether	29.1	>25	—	34.4	7.24
Mesityl Oxide*	31.2 ± 1.2	>25	.99	32.1	8.00
Mesitylene* (Trimethyl Benzene)	26.3 ± .7	>25	1.06	38.0	7.75
Methyl Acetate*	37.0 ± .6	2	1.00	27.0	8.93
Methyl Acrylate	35.8	11	—	27.9	7.94
Methylal (Dimethyoxymethane)	37.9	1	—	26.4	8.49
Methyl Amyl Ketone (2-Heptanone)	27.9	>25	—	35.8	7.69
Methyl Bromide	46.5	.5	—	21.5	5.53
Methyl Butyl Ketone* (2-Hexanone)	29.7 ± .7	>25	1.00	33.7	8.23
Methyl Isobutyl Ketone* (Hexanone)	30.0 ± .4	>25	1.06	33.3	8.15
Methyl Cellosolve* (2-Methoxyethanol)	36.3 ± .4	>25	.75	27.5	8.86

+ Methylene Chloride as the solvent

ANALYSIS GUIDE

	Sampling Rate (cc/min)	Capacity (mg)	Recovery Coefficient	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
Methyl Cellosolve Acetate* (Ethylene Glycol Methyl Ether Acetate)	29.0 ± .5	>25	1.00	34.5	7.14
Methyl Chloroform*	30.9 ± .3	12	1.03	32.4	5.95
Methyl Cyclohexane*	28.9 ± .4	>25	1.05	34.6	8.63
Methyl Cyclohexanol	28.8	>25	—	34.7	7.45
Methyl Ethyl Ketone* (2-Butanone)	36.3 ± .9	12	1.00	27.5	9.35
Methyl Formate	45.0	.2	—	22.2	9.06
5-Methyl-3-heptanone (Ethyl Amyl Ketone)	26.4	>25	—	37.9	7.24
Methyl Iodide	36.7	.2	—	27.3	4.69
Methyl Isobutyl Carbinol (Methyl Amyl Alcohol)	29.2	>25	—	34.2	8.21
Methyl Isoamyl Ketone	28.0	>25	—	35.7	7.66
Methyl Methacrylate	31.8	24	—	31.5	7.69
Alpha Methyl Styrene*	25.0 ± .5	>25	1.01	40.0	8.29
Methylene Chloride* (Dichloromethane)	37.9 ± .3	2	.90	28.9	7.59
Naphtha (VM&P)*	33.2 ± .7	20	1.04	30.1	7.36
Naphthalene	24.6	>25	—	40.7	7.76
Nonane*	24.6 ± .6	>25	1.09	40.7	9.04
Octane*	26.6 ± .6	>25	1.08	37.6	8.06
Pentane*	35.3 ± .9	7	1.02	28.3	9.62
2-Pentanone* (Methyl Propyl Ketone)	33.0 ± .5	23	1.03	30.3	8.62
Perchloroethylene*	28.3 ± .5	>25	1.05	35.3	5.20
Phenyl Ether	24.1	>25	—	41.5	5.97
Phenyl Glycidyl Ether	20.8	>25	—	48.1	7.84
n-Propyl Acetate*	30.1 ± .5	21	-	33.3	7.96
n-Propyl Alcohol*	39.7 ± .7	25	.93+	25.2	10.26
Propylene Dichloride* (1,2 Dichloropropane)	30.6 ± .4	25	1.04	32.7	7.07
Propylene Glycol Monomethyl Ether	32.4	>25	—	32.3	7.58
n-Propyl Nitrate	33.3	>25	—	30.0	8.25
Stoddard Solvent	24.3	>25	—	41.2	6.99
Styrene*	26.8 ± .8	>25	1.08	37.3	8.77
1,1,2,2-Tetrachloroethane	28.4	>25	.89	35.2	5.12
1,1,1,2-Tetrachloro-2,2-difluoroethane	29.7	5	—	33.9	4.06
1,1,2,2-Tetrachloro-1,2-difluoroethane	28.2	5	—	35.5	4.25
Tetrahydrofuran	37.2	8	—	26.8	9.13
Toluene*	31.4 ± .6	25	1.05	31.8	8.46
1,1,2-Trichloroethane*	29.7 ± .6	>25	1.02	33.7	6.19
Trichloroethylene*	31.1 ± .2	20	1.00	32.2	6.00
1,1,2-Trichloro-1,2,2-trifluoroethane	31.4	.5	—	31.9	4.16
1,2,3-Trichloropropane	27.4	>25	—	36.5	6.07
Vinyl Acetate	35.8	7	1.02	27.9	7.94
Vinyl Bromide	41.0	.3	—	24.4	5.57
Vinyl Chloride*	40.8 ± .5	.04	1.02	24.4	9.56
Vinylidene Chloride	38.4	.5	—	25.9	6.53
Vinyl Toluene	26.8	>25	—	37.3	7.73
Xylene*	27.3 ± .5	>25	1.07	36.6	8.45

+ Methylene Chloride as the solvent

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