

VIII. REFERENCES

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IX. APPENDIX I

SAMPLING AND ANALYTICAL METHODS

The recommended sampling and analytical methods for tetramethylsuccinonitrile and acetonitrile are adapted from Methods S155 and S165 of the NIOSH Manual of Analytical Methods [94]. Both methods utilize charcoal tubes for sampling and a gas chromatograph equipped with a flame-ionization detector for analysis. Other methods of analysis for these two nitriles may be used, provided their precision and sensitivity are determined to be at least equivalent to the recommended methods.

TETRAMETHYLSUCCINONITRILE

Principle of the Method

(a) A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

(b) The charcoal in the tube is transferred to a small, stoppered sample container, and the analyte is desorbed with carbon disulfide.

(c) An aliquot of the desorbed sample is injected into a gas chromatograph.

(d) The area of the resulting peak is determined and compared with areas obtained for standards.

Range and Sensitivity

This method was validated over the range of 1.80-8.20 mg/cu m at an atmospheric temperature and pressure of 22 C and 760 mmHg, using a 55-liter sample. Under the conditions of sample size (55 liters), the probable useful range of this method is 0.5-10 mg/cu m. The method is capable of measuring much smaller amounts if the desorption efficiency (DE) is adequate. Desorption efficiency must be determined over the range used.

The upper limit of the range of the method is dependent on the adsorptive capacity of the charcoal tube. This capacity varies with the concentrations of tetramethylsuccinonitrile and other substances in the air. The first section of the charcoal tube was found to hold at least

0.78 mg of tetramethylsuccinonitrile when a test atmosphere containing 3.63 mg/cu m of tetramethylsuccinonitrile in air was sampled at 0.90 liter/minute for 240 minutes; breakthrough was not observed at this time since no tetramethylsuccinonitrile was detected in the backup section of the charcoal tube. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam.) If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

Interference

When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.

When interfering compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample.

It must be emphasized that any compound that has the same retention time as the analyte at the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered proof of chemical identity.

If the possibility of interference exists, separation conditions (column packing, temperature, etc) must be changed to circumvent the problem.

Precision and Accuracy

The coefficient of variation for the total analytical and sampling method in the range of 1.80-8.20 mg/cu m was 0.075. This value corresponds to a 0.23 mg/cu m standard deviation at 3 mg/cu m.

A collection efficiency of 1.0 was determined for the collecting medium; thus, no bias was introduced in the sample collection step. There was also no apparent bias in the sampling and analytical method for which a DE correction was made. Thus, coefficient of variation is a satisfactory measure of both accuracy and precision of the sampling and analytical method.

Advantages and Disadvantages

The sampling device is small and portable and involves no liquids. Interferences are minimal, and most of those that do occur can be

eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick instrumental method. The method also can be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions.

One disadvantage of the method is that the amount of sample that can be collected is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25% of that found on the front section, the possibility of sample loss exists.

Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flowrate and cause the volume to be imprecise because the pump usually is calibrated for one tube only.

Apparatus

(a) Calibrated personal sampling pump with a flowrate that can be accurately determined within $\pm 5\%$ at the recommended rate.

(b) Charcoal tubes: glass tube with both ends flame sealed, 7 cm long with a 6-mm OD and a 4-mm ID, containing two sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoal is prepared from coconut shells and fired at 600 C prior to packing. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silylated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flowrate of 1 liter/minute.

(c) Gas chromatograph equipped with a flame-ionization detector.

(d) Column (6-feet x 1/4-inch ID stainless steel) packed with 5% SE-30 on 80/100 mesh Chromosorb WDMCS.

(e) Electronic integrator or some other suitable method for measuring peak areas.

(f) Sample containers: 2-ml, with glass stoppers or Teflon-lined caps.

(g) Microliter syringes: 10- μ l and other convenient sizes for making standards.

(h) Pipets: 1.0-ml delivery pipets.

(i) Volumetric flasks: 10-ml or convenient sizes for making standard solutions.

Reagents

- (a) Chromatographic quality carbon disulfide.
- (b) Tetramethylsuccinonitrile, reagent grade.
- (c) Hexane, reagent grade.
- (d) Acetone, reagent grade.
- (e) Purified nitrogen.
- (f) Prepurified hydrogen.
- (g) Filtered compressed air.

Procedure

(a) Detergent wash and thoroughly rinse with tapwater and distilled water all glassware used for the laboratory analysis.

(b) Calibrate each personal pump with a representative charcoal tube in the line. This minimizes errors associated with uncertainties in the sample volume collected.

Collection and Shipment of Samples

(a) Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

(b) Use the smaller section of charcoal as a backup and position nearest the sampling pump.

(c) Place the charcoal tube in a vertical direction during sampling to minimize channeling through the charcoal.

(d) Do not pass air being sampled through any hose or tubing before it enters the charcoal tube.

(e) A sample size of 50 liters is recommended. Sample at a flow of 1.0 liter/minute or less. The flowrate should be known with an accuracy of at least $\pm 5\%$.

(f) Record the temperature and pressure of the atmosphere being sampled. If pressure reading is not available, record the elevation.

(g) Cap the charcoal tubes with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

(h) With each batch of 10 samples, submit 1 tube from the same lot of tubes that is used for sample collection and is handled exactly the same as the samples except that no air is drawn through it. Label this as a blank.

(i) To minimize tube breakage during shipping, tightly pack and pad capped tubes before shipping.

Analysis of Samples

(a) Preparation of Samples

In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

(b) Desorption of Samples

Prior to analysis, 1.0 ml of carbon disulfide is pipetted into each sample container. (All work with carbon disulfide should be performed in a hood because of its high toxicity.) Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period.

(c) Gas Chromatographic Conditions

The typical operating conditions for the gas chromatograph are:

- (1) 50 ml/minute (60 psig) nitrogen carrier gas flow.
- (2) 65 ml/minute (24 psig) hydrogen gas flow to detector.
- (3) 500 ml/minute (50 psig) airflow to detector.
- (4) 230 C injector temperature.
- (5) 255 C manifold temperature (detector).
- (6) 90 C column temperature.

(d) Injection

The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, the solvent flush injection technique should be used. The 10- μ l syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 μ l to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5- μ l aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 μ l to minimize evaporation of the sample from the tip of the needle. (Observe that the sample occupies 4.9-5.0 μ l in the barrel of the syringe.) Duplicate injections of each sample and standard should be made. No more than a 3% difference in area is to be expected.

(e) Measurement of Area

The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed in the following sections.

Determination of Desorption Efficiency

(a) Importance

The DE of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

(b) Procedure

Activated charcoal equivalent to the amount in the first section of the sampling tube (100 mg) is measured into a 2.5-inch, 4-mm ID glass tube, flame sealed at one end. This charcoal must be from the same batch as that used in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm (or equivalent). A known amount of a 20% (V/V) acetone-hexane solution of tetramethylsuccinonitrile containing 34.75 mg/ml is injected directly into the activated charcoal with a microliter syringe, and the tube is capped with more Parafilm. The amount injected is equivalent to that present in a 50-liter air sample at the selected level.

Six tubes at each of three levels (50%, 100%, and 200% of the standard) are prepared in this manner and allowed to stand, at least overnight, to assure complete adsorption of the analyte onto the charcoal. These tubes are referred to as the samples. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube.

Two or three standards are prepared by injecting the same volume of compound into 1.0 ml of carbon disulfide with the same syringe used in the preparation of the samples. These are analyzed with the samples.

The DE equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

$$DE = \frac{\text{average weight recovered (mg)}}{\text{weight added (mg)}}$$

The DE is dependent on the amount of analyte collected on the charcoal. Plot the DE vs weight of analyte found. This curve is used to correct for adsorption losses.

Calibration and Standards

It is convenient to express concentration of standards in terms of mg/1.0 ml carbon disulfide because samples are desorbed in this amount of carbon disulfide. The density of the analyte is used to convert milligrams into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same gas chromatographic conditions and during the same time period as the unknown samples. Curves are established by plotting concentration in mg/1.0 ml vs peak area.

Note: Since no internal standard is used in this method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the flame-ionization detector response.

Calculations

Read the weight, in mg, corresponding to each peak area from the standard curve. No volume corrections are needed because the standard

curve is based on mg/1.0 ml carbon disulfide, and the volume of sample injected is identical to the volume of the standards injected.

Corrections for the blank must be made for each sample.

$$\text{mg} = \text{mg sample} - \text{mg blank}$$

where:

mg sample = mg found in front section of sample tube

mg blank = mg found in front section of blank tube

A similar procedure is followed for the backup sections.

Add the weights found in the front and backup sections to get the total weight in the sample.

Read the DE from the curve for the amount found in the front section. Divide the total weight by this DE to obtain the corrected mg/sample.

$$\text{corrected mg/sample} = \frac{\text{total weight}}{\text{DE}}$$

The concentration of the analyte in the air sampled can be expressed in mg/cu m.

$$\text{mg/cu m} = \frac{\text{corrected mg} \times 1,000 \text{ (liter/cu m)}}{\text{air volume sampled (liter)}}$$

Another method of expressing concentration is in ppm.

$$\text{ppm} = \text{mg/cu m} \times \frac{24.45}{\text{MW}} \times \frac{760}{\text{P}} \times \frac{\text{T} + 273}{298}$$

where:

P = pressure (mmHg) of air sampled

T = Temperature (C) of air sampled

24.45 = molar volume (liter/mole) at 25 C and 760 mmHg

MW = molecular weight (g/mole) of analyte

760 = standard pressure (mmHg)
298 = standard temperature (K)

ADIPONITRILE, MALONONITRILE, AND SUCCINONITRILE

These other dinitriles may be analyzed by gas chromatography [104]. Adiponitrile is monitored in industry by collection on charcoal and analyzed by gas chromatography with a flame-ionization detector using an SP1000 column at 220 C [4]. When these compounds are released as particulates, filter sampling should be considered. NIOSH has not tested or validated methods for these compounds, but the relatively similar physical and chemical properties of the dinitriles (Table XII-2) suggest that the recommended method for tetramethylsuccinonitrile can be adapted for use in the determination of concentrations of airborne adiponitrile, malononitrile, and succinonitrile.

ACETONITRILE

Principle of the Method

- (a) A known volume of air is drawn through a large charcoal tube to trap the organic vapors present.
- (b) The charcoal in the tube is transferred to a small, stoppered sample container, and the analyte is desorbed with toluene.
- (c) An aliquot of the desorbed sample is injected into a gas chromatograph.
- (d) The area of the resulting peak is determined and compared with areas obtained from the injection of standards.

Range and Sensitivity

This method was validated over the range of 31.4-140.2 mg/cu m at an atmospheric temperature and pressure of 22 C and 760 mmHg, using a 10-liter sample. Under the conditions of sample size (10 liters), the probable useful range of this method is 10-210 mg/cu m at a detector sensitivity that gives nearly full deflection on the strip chart recorder for a 2.1-mg sample. The method is capable of measuring much smaller amounts if the DE is adequate. The DE must be determined over the range used.

The upper limit of the range of the method depends on the adsorptive capacity of the charcoal tube. This capacity varies with the

concentrations of acetonitrile and other substances in the air. The first section of the charcoal tube held 5.2 mg of acetonitrile when a test atmosphere containing 140 mg/cu m of acetonitrile in air was sampled at 0.196 liter/minute for 190 minutes; breakthrough was observed at this time, ie, the concentration of acetonitrile in the effluent was 5% of that in the influent. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam.)

If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

Interference

When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.

When two or more substances are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample. When the desorbing solvent is present as a contaminant in the occupational environment, it cannot be effectively analyzed in the sample. If it is suspected that toluene is present, a separate sample should be collected for toluene analysis.

Any compound that has the same retention time as a nitrile of interest under the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered proof of chemical identity.

When there is possible interference, separation conditions (column packing, temperature, etc) must be changed to circumvent the problem.

Precision and Accuracy

The coefficient of variation for the total analytical and sampling method in the range of 31.4-140.2 mg/cu m was 0.072. This value corresponds to a standard deviation of 5.0 mg/cu m at 70 mg/cu m.

On the average, the concentrations obtained at 70 mg/cu m using the overall sampling and analytical method were 5.3% higher than the "true" concentrations for a limited number of laboratory experiments. Any difference between the "found" and "true" concentrations may not represent a bias in the sampling and analytical method but rather a random variation from the experimentally determined "true" concentration. Therefore, no recovery correction should be applied to the final result.

Advantages and Disadvantages of the Method

The sampling device is small and portable and involves no liquids. Interferences are minimal, and most of those that do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick instrumental method. The method can also be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions from isothermal to a temperature-programmed mode of operation.

One disadvantage of the method is that the amount of sample that can be collected is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25% of that found on the front section, the possibility of sample loss exists.

Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flowrate and cause the volume to be imprecise because the pump is usually calibrated for one tube only.

Apparatus

(a) A calibrated personal sampling pump with a flowrate that can be accurately determined within $\pm 5\%$ at the recommended rate.

(b) Charcoal tubes: glass tube with both ends flame sealed, 9 cm long with an 8-mm OD and a 6-mm ID, containing two sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoal is prepared from coconut shells and fired at 600 C prior to packing. The adsorbing section contains 400 mg of charcoal, the backup section 200 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silylated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flowrate of 1 liter/minute.

(c) Gas chromatograph equipped with a flame-ionization detector.

(d) Column (4-feet x 1/4-inch stainless steel) packed with 50/80 mesh Porapak, Type Q.

(e) An electronic integrator or some other suitable method for measuring peak areas.

(f) Volumetric flasks: 10-ml or convenient sizes for making standard solutions and for desorbing the samples. If an automatic sample injector is used, aliquots of the samples may be transferred to the associated vials.

(g) Microliter syringes: 10- μ l for injection of samples into the gas chromatograph.

(h) Pipets: 5-ml delivery pipets.

Reagents

(a) Chromatographic quality toluene.

(b) Acetonitrile, reagent grade.

(c) Purified nitrogen.

(d) Prepurified hydrogen.

(e) Filtered compressed air.

Procedure

(a) Detergent wash and thoroughly rinse with tap water and distilled water all glassware used for the laboratory analysis.

(b) Calibrate each personal pump with a representative charcoal tube in the line. This will minimize errors associated with uncertainties in the sample volume collected.

Collection and Shipment of Samples

(a) Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube.

(b) Use the smaller section of charcoal as a backup and position it nearest the sampling pump.

(c) Place the charcoal tube in a vertical direction during sampling to minimize channeling through the charcoal.

(d) Do not pass air being sampled through any hose or tubing before it enters the charcoal tube.

(e) A sample size of 10 liters is recommended. Sample at a flow of 0.20 liter/minute or less. The flowrate should be known with an accuracy of at least $\pm 5\%$.

(f) Record the temperature and pressure of the atmosphere being sampled. If pressure reading is not available, record the elevation.

(g) Cap the charcoal tubes with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

(h) One tube should be handled in the same manner as the sample tube (break, seal, and transport) except that no air is sampled through this tube. Label this tube as a blank.

(i) To minimize tube breakage during shipping, tightly pack and pad capped tubes before shipping.

(j) Submit a sample of the bulk material to the laboratory in a glass container with a Teflon-lined cap. Do not transport this sample in the same container as the charcoal tubes.

Analysis of Samples

(a) Preparation of Samples

In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 10-ml stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

(b) Desorption of Samples

Prior to analysis, 5 ml of toluene are pipetted into each sample container. (All work with toluene should be performed in a hood.) Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period. If an automatic sample injector is used, an appropriate amount of the sample should be transferred to the automatic sample injector vials after desorption is complete. To minimize volatilization, the sample vials should be capped as soon as the sample is added.

(c) Gas Chromatographic Conditions

The typical operating conditions for the gas chromatograph are:

- (1) 50 ml/minute (60 psig) nitrogen carrier gas flow.
- (2) 65 ml/minute (24 psig) hydrogen gas flow to detector.
- (3) 500 ml/minute (50 psig) airflow to detector.

- (4) 270 C injector temperature.
- (5) 285 C manifold temperature (detector).
- (6) 180 C column temperature.

(d) Injection

The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, the solvent flush injection technique should be used. The 10- μ l syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 μ l to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5- μ l aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 μ l to minimize evaporation of the sample from the tip of the needle. (Observe that the sample occupies 4.9-5.0 μ l in the barrel of the syringe.) Duplicate injections of each sample and standard should be made. No more than a 3% difference in area is to be expected. An automatic sample injector can be used if it is shown to give reproducibility at least as good as the solvent flush method.

(e) Measurement of Area

The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

Determination of Desorption Efficiency

(a) Importance

The DE of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

(b) Procedure

Activated charcoal equivalent to the amount in the first section of the sampling tube (400 mg) is measured into a 9-cm x 6-mm ID glass tube, flame sealed at one end. This charcoal must be from the same batch as that used

in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm.

A known amount of acetonitrile in toluene containing 157 mg/ml is injected directly into the activated charcoal with a microliter syringe, and the tube is capped with more Parafilm.

The amount injected is equivalent to that present in a 10-liter air sample at the selected level. Six tubes at each of three levels (50%, 100%, and 200% of the standard) are prepared in this manner and allowed to stand for at least overnight to assure complete adsorption of the analyte onto the charcoal. These tubes are referred to as the samples. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube.

Two or three standards are prepared by injecting the same volume of compound into 5.0 ml of toluene contained in a 10-ml volumetric flask. These are analyzed with the samples.

The DE equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

$$DE = \frac{\text{average weight recovered (mg)}}{\text{weight added (mg)}}$$

The DE is dependent on the amount of analyte collected on the charcoal. Plot the DE vs weight of analyte found. This curve is used to correct for adsorption losses.

Calibration and Standards

It is convenient to express concentration of standards in terms of mg/5 ml toluene because samples are desorbed in this amount of toluene. The density of the analyte is used to convert mg into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same gas chromatographic conditions and during the same time period as the unknown samples. Curves are established by plotting concentration in mg/5.0 ml vs peak area.

Note: Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the flame-ionization detector response.

Calculations

Read the weight, in mg, corresponding to each peak area from the standard curve. No volume corrections are needed because the standard curve is based on mg/5.0 ml toluene, and the volume of sample injected is identical to the volume of the standards injected.

Corrections for the blank must be made for each sample.

$$\text{mg} = \text{mg sample} - \text{mg blank}$$

where:

$$\begin{aligned} \text{mg sample} &= \text{mg found in front section of sample tube} \\ \text{mg blank} &= \text{mg found in front section of blank tube} \end{aligned}$$

A similar procedure is followed for the backup sections.

Add the weights found in the front and backup sections to get the total weight in the sample.

Read the DE from the curve for the amount found in the front section. Divide the total weight by this DE to obtain the corrected mg/sample.

$$\text{corrected mg/sample} = \frac{\text{total weight}}{\text{DE}}$$

The concentration of the nitrile in the air sampled can be expressed in mg/cu m.

$$\text{mg/cu m} = \frac{\text{corrected mg} \times 1,000 \text{ (liter/cu m)}}{\text{air volume sampled (liter)}}$$

Another method of expressing concentration is in ppm.

$$\text{ppm} = \text{mg/cu m} \times \frac{24.45}{\text{MW}} \times \frac{760}{\text{P}} \times \frac{\text{T} + 273}{298}$$

where:

$$\begin{aligned} \text{P} &= \text{pressure (mmHg) of air sampled} \\ \text{T} &= \text{temperature (C) of air sampled} \end{aligned}$$

24.45 = molar volume (liter/mole) at 25 C and 760 mmHg
MW = molecular weight (g/mole) of analyte
760 = standard pressure (mmHg)
298 = standard temperature (K)

n-BUTYRONITRILE, ISOBUTYRONITRILE, AND PROPIONITRILE

These other mononitriles may be analyzed by gas chromatography [103,104]. Evidence available for propionitrile indicates that it can be separated from other nitriles after collection on charcoal and analyzed at a column temperature of 80 C [4]. NIOSH has not tested or validated methods for n-butyronitrile, isobutyronitrile, and propionitrile, but the relatively similar physical and chemical properties of the mononitriles (Table XII-2) suggest that the recommended method for acetonitrile can be adapted for use in the determination of concentrations of airborne n-butyronitrile, isobutyronitrile, and propionitrile.

ACETONE CYANOHYDRIN AND GLYCOLONITRILE

There is no recommended method available to collect and determine concentrations of airborne acetone cyanohydrin and glycolonitrile.