

XII. APPENDIX IV

ANALYTICAL METHOD FOR REFINED PETROLEUM SOLVENTS

The following analytical method is adapted from those described by White et al [160] and from Method Nos. s382 and s380 of the Physical and Chemical Analysis Branch of NIOSH [103,104]. This analytical method will yield adequate results for refined petroleum solvents with boiling ranges from 120-200 C, eg, varnish makers' and painters' naphtha, mineral spirits, and Stoddard solvents. By collecting two samples of rubber solvent and desorbing one with carbon disulfide and the other with toluene, this method should provide adequate results for rubber solvent. To obtain the best results for kerosene, the gas-chromatographic conditions should be changed from isothermal to a temperature programmed mode of operation. The gas-chromatographic conditions and columns stated in this Appendix have not been tested for all refined petroleum solvents and some modifications may be required for adequate results.

Principle of the Method

Refined petroleum solvent vapor trapped on an activated charcoal from a known volume of air is desorbed with carbon disulfide, except petroleum ether or other solvents with boiling points below 60 C, which should be desorbed with toluene. An aliquot of the desorbed sample is injected into a gas chromatograph. The area of the resulting peak is determined and compared with those obtained from injection of standards.

Range and Sensitivity

This method was developed to analyze Stoddard solvents over the range of 1,417-5,940 mg/cu m at an atmospheric temperature and pressure of 24 C and 749 mmHg [103]. For a 3-liter sample, the useful range of this method was 295-8,850 mg/cu m at a detector sensitivity that gives nearly full deflection on the strip chart recorder for a 26.6-mg sample. By increasing the air sample size, it should be possible to detect airborne solvent concentrations below 195 mg/cu m provided the desorption efficiency is adequate. Desorption efficiency must be determined over the range used.

The upper limit of the range of the method is dependent on the absorptive capacity of the charcoal tube. This capacity varies with the concentrations of the Stoddard or other refined petroleum solvents and other substances in the air. The first section of the charcoal tube held 26.3 mg of Stoddard solvent when a test atmosphere containing 6,026 mg/cu m of Stoddard solvent in air was sampled at 0.19 liter/minute for 23 minutes; at that time, the concentration of Stoddard solvent in the effluent was less than 5% of that in the influent.

Interferences

Any compound which has about the same retention time as Stoddard, or other refined petroleum solvents, under the gas-chromatographic conditions for this method, given below, will interfere with the analysis. This type of interference can be overcome by changing the operating conditions of the instrument, usually the column, the column temperature, or both. When the humidity is so great that condensation occurs in the sampling tube, organic vapors will not be trapped efficiently.

Precision and Accuracy

The coefficient of variation for the total analytical and sampling method for Stoddard solvents in the range of 1,417-5,940 mg/cu m was 0.052, which represents a standard deviation of 153.4 mg/cu m at the OSHA standard level. The average values obtained using the overall sampling and analytical methods were 4.7% lower than the "true" value at the OSHA standard level. The coefficient of variation for the total analytical and sampling method for petroleum distillates (varnish makers' and painters' naphtha) in the range of 937-3,930 mg/cu m was 0.052, which represents a standard deviation of 104 mg/cu m at the OSHA standard level. The data were based on validation experiments using the internal standard method. Precision and accuracy data are not available for rubber solvent and kerosene. The data for mineral spirits are assumed to be similar as that for Stoddard solvents.

Advantages and Disadvantages

(a) The sampling device is small, portable, and does not contain liquids. Interferences are minimal and most of those that do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by an instrumental method, which by changing the gas-chromatographic conditions or columns, is capable of qualitating and quantitating complex mixtures such as refined petroleum solvents.

(b) The amount of sample that can be taken is limited by the number of milligrams that the tube will hold before loading. The possibility of sample loss exists when the sample value obtained for the backup section of the charcoal tube exceeds 25% of that found on the front

section. Furthermore, the precision of the method is limited by 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 only one tube.

Apparatus

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

(b) The following is a list of gas-chromatographic columns that can be used in the analysis of all refined petroleum solvents with the exception of petroleum ether. Columns (3) and (4) may be used where it is desirable to separate aromatics from aliphatics.

(1) Stainless steel column (6 feet x 1/8 inch) packed with 1.5% OV-101 on 100/120 mesh Chromosorb W (recommended for mineral spirits, Stoddard solvents, and kerosene).

(2) Stainless steel column packed with 10% OV-101 on 100/120 mesh Supelcoport (recommended for rubber solvent and varnish makers' and painters' naphtha).

(3) Stainless steel column (8 feet x 1/8 inch) packed with 10% TCEP on 100/120 mesh Chromosorb PAW.

(4) Stainless steel column (8 feet x 1/8 inch) packed with 7% tetracyanoethylated pentacrythrilol (Penta) on 100/120 mesh Chromosorb PAW.

(5) Stainless steel column (20 feet x 1/8 inch) packed with 10% FFAP on 80/100 Chromosorb W AW DMCS.

(6) Stainless steel column (10 feet x 1/8 inch) packed with 10% SP-2100 on 100/120 Supelcoport.

(c) A mechanical or electronic integrator or a recorder for determining peak area.

(d) Small (2-ml) glass test tubes or equivalent with glass- or polymer-lined stoppers.

(e) A 10- μ l syringe and other conveniently sized syringes for preparation of the standards.

(f) Delivery pipets, 1.0-ml type graduated in 0.1-ml increments.

(g) Volumetric flasks, about 10-ml.

Reagents

(a) Carbon disulfide or toluene chromatographic quality.

(b) The refined petroleum solvent bulk sample.

(c) Undecane, or other suitable internal standard.

(d) Hydrogen, purified.

(e) Helium, purified.

(f) Compressed air, filtered.

Analysis of Samples

All glassware used for the laboratory analysis should be washed in detergent and rinsed with tap and distilled water.

(a) Preparation: Score each charcoal tube, including the blank from field samples, with a file and break open in front of the first section of charcoal. Remove and discard the glass wool. Transfer the charcoal in the first (larger) section to a small stoppered test tube. Remove and discard the foam separating sections and transfer the second

section of charcoal to another test tube. Analyze the two charcoal sections separately.

(b) Desorption: Prior to analysis, pipet 1.0 ml of carbon disulfide into each test tube to desorb the Stoddard or other refined petroleum solvents from the charcoal. Desorption is complete in 30 minutes if the sample is stirred occasionally. For some solvent solutions with a boiling range below 160 C, it may be necessary to take two samples. One should be desorbed with carbon disulfide to analyze for the high-boiling components and the other sample desorbed with toluene to analyze for the low-boiling components.

If an automatic sample injector is used, the sample vials should be capped as soon as the carbon disulfide is added to minimize volatilization. For the internal standard method, desorb using 1.0 ml of carbon disulfide containing a known amount of the chosen internal standard.

EXTREME CAUTION MUST BE EXERCISED AT ALL TIMES WHEN USING CARBON DISULFIDE BECAUSE OF ITS HIGH TOXICITY AND FIRE AND EXPLOSION HAZARDS. IT CAN BE IGNITED BY HOT STEAM PIPES. ALL WORK WITH CARBON DISULFIDE MUST BE PERFORMED UNDER AN EXHAUST HOOD.

(c) Typical gas-chromatographic operating conditions are:

- (1) 30 ml/minute (60 psig) helium flowrate.
- (2) 35 ml/minute (25 psig) hydrogen flowrate.
- (3) 400 ml/minute (60 psig) air flowrate.
- (4) 225 C injector temperature.
- (5) 250 C manifold temperature (detector).

(6) 75 C column temperature (recommended for mineral spirits, Stoddard solvents and kerosene).

(7) 85 C column temperature (recommended for rubber solvent and varnish makers' and painters' naphtha).

The gas-chromatographic conditions have been chosen such that the solvent-related peaks elute as a cluster of unresolved peaks. Observe distinctive patterns in searching for interferences and adjust the gas-chromatographic conditions accordingly. These conditions were specifically chosen for Stoddard or other refined petroleum solvents. Some alteration in these conditions may be necessary for other refined petroleum solvents.

One method that would reduce the number of peaks needed to quantitate a refined petroleum solvent air sample is the use of head-space samples. Using the supplied liquid bulk sample, head-space volatiles are prepared and sampled with a charcoal tube. This tube is then desorbed with carbon disulfide and analyzed using a gas chromatograph. A portion of the bulk sample is then diluted with carbon disulfide and analyzed in the same manner as the head-space sample. Comparing the two chromatograms should show three or four peaks that have the same relative area for both samples. These three or four peaks can then be used to quantitate the solvent. This method is particularly useful for multiple exposure samples. The bulk air sample referred to in Appendix III could be used instead of the head-space sample of this purpose.

(d) Injection: The first step in the analysis is the injection of the sample into the gas chromatograph. Employ the solvent flush injection technique. This eliminates difficulties arising from blowback or distillation within the syringe needle, thus increasing the accuracy and

reproducibility of the injected sample volume. First, flush the 10.0- μ l syringe with carbon disulfide several times to wet the barrel and plunger, then draw 3.0- μ l of carbon disulfide into the syringe. Next, remove the needle from the carbon disulfide and pull the plunger back about 0.2- μ l to separate the solvent flush from the sample with an air pocket to be used as a marker. Immerse the needle in the sample and withdraw a 1- to 2- μ l portion, 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 in the gas chromatograph, pull the plunger back a short distance to minimize sample evaporation from the tip. Make duplicate injections of each sample and of the standard. No more than a 3% difference between the peak areas of the similar samples should be accepted as a valid result.

(e) Measurement of area: The areas of the sample peaks are measured by electronic integration or some other suitable method of area measurement. Preliminary sample results are read from a standard curve prepared as outlined below.

Determination of Desorption Efficiency

The desorption efficiency 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 Stoddard or other refined petroleum solvents that is removed in the desorption process. Repeat this procedure for each new batch of charcoal in use.

Place the same amount of activated charcoal as in the first section of the sampling tube (100 mg) 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 sampling and can be obtained from unused charcoal tubes. Cap the open end with Parafilm or equivalent. Inject a known amount of solvent directly into the activated charcoal with a microliter syringe and cap the tube with more Parafilm or equivalent.

Prepare six tubes at each of three concentrations (0.5x, 1x, and 2x of the standard) by adding an amount of analyte equivalent to that present in a 10-liter sample at the selected level. Allow the tubes to stand overnight to assure complete adsorption of the solvent onto the charcoal. These six tubes are referred to as the samples. Treat a parallel blank tube in the same manner, except add no solvent to it. Desorb and analyze the sample and blank tubes in exactly the same manner as the sampling tube described for unknown air samples.

Prepare two or three standards by injecting the same volume of the solvent or into 1.0 ml of carbon disulfide with the same syringe used in the preparation of the sample. These are analyzed with the samples.

If the internal standard method is used, prepare a calibration standard by using 1.0 ml of carbon disulfide containing a known amount of the internal standard.

The desorption efficiency equals the difference between the average peak area of the samples and that of the blank divided by the average peak area of the standards, or:

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

Calibration and Standards

The bulk samples of the analyte should be used for the calibration. It is convenient to express the concentration of standards in terms of mg/ml of carbon disulfide because samples are desorbed in 1 ml of carbon disulfide. Use the density of the solvent tested to convert milligrams into microliters for easy measurement with a microliter syringe. Prepare a series of standards varying in concentration over the range of interest and then analyze under the same gas-chromatographic conditions and during the same time period as the unknown samples. Prepare standard curves by plotting concentration in mg/ml versus peak area.

For the internal standard method, use carbon disulfide containing a predetermined amount of internal standard. The analyte concentration in mg/ml is plotted versus the area ratio of the solvent peaks to that of the internal standard.

Calculations

Read the weight in milligrams corresponding to the total peak area from the standard curve. No volume corrections are needed because the standard curve is based on mg/ml of carbon disulfide and the volume of sample injected is identical to the volume of the standards injected.

Make corrections for the blank from the field sampling for each sample by subtracting the amounts of Stoddard or other refined petroleum solvents found on the front and back sections of the blank from the amounts found in the respective sections of the sample:

$$\text{corrected amount} = \text{amount on sample} - \text{amount on blank}$$

Add the corrected amounts present in the front and in the backup sections of the same sample tube to determine the total amount of Stoddard or other refined petroleum solvents in the sample. Divide this total amount by the desorption efficiency to obtain the adjusted total amount of Stoddard or other refined petroleum solvents in the sample:

$$\text{adjusted total amount} = \frac{\text{total amount}}{\text{desorption efficiency}}$$

The concentration of Stoddard or other refined petroleum solvents in the air sampled, expressed in mg/cu m, is given by the quotient of the adjusted amount, in mg, divided by the volume of air sampled, in cu m:

$$\text{concentration (mg/cu m)} = \frac{\text{adjusted amount (mg)}}{\text{volume of air sampled (cu m)}}$$

Another method of expressing concentration is ppm:

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

where:

24.45 = molar volume (liter/mole) at 25 C (78 F) and 760 mmHg

760 = standard pressure

P = pressure (mmHg) of air sampled

T = temperature (degrees C) of air sampled

MW = molecular weight of Stoddard solvent (or other refined petroleum solvents (g/mole)

298 = standard temperature (degrees K)

XIII. APPENDIX V
MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material shall be provided in the appropriate block of the Material Safety Data Sheet (MSDS).

The product designation is inserted in the block in the upper left corner of the first page to facilitate filing and retrieval. Print in upper case letters as large as possible. It should be printed to read upright with the sheet turned sideways. The product designation is that name or code designation which appears on the label, or by which the product is sold or known by employees. The relative numerical hazard ratings and key statements are those determined by the rules in Chapter V, Part B, of the NIOSH publication, An Identification System for Occupationally Hazardous Materials. The company identification may be printed in the upper right corner if desired.

(a) Section I. Product Identification

The manufacturer's name, address, and regular and emergency telephone numbers (including area code) are inserted in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially formal chemical nomenclature. Every known chemical designation or

competitor's trade name need not be listed.

(b) Section II. Hazardous Ingredients

The "materials" listed in Section II shall be those substances which are part of the hazardous product covered by the MSDS and individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, while a third component could be included both for its toxicity and its reactivity. Note that a MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

Chemical substances should be listed according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such as "aromatic amine," "safety solvent," or "aliphatic hydrocarbon" when the specific name is known.

The "%" may be the approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount, ie, "10-40% vol" or "10% max wt" to avoid disclosure of trade secrets.

Toxic hazard data shall be stated in terms of concentration, mode of exposure or test, and animal used, eg, "100 ppm LC50-rat," "25 mg/kg LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.1000," or, if not available, from other sources of publications such as the American Conference of Governmental Industrial Hygienists or the American National Standards Institute Inc. Flashpoint, shock sensitivity

or similar descriptive data may be used to indicate flammability, reactivity, or similar hazardous properties of the material.

(c) Section III. Physical Data

The data in Section III should be for the total mixture and should include the boiling point and melting point in degrees Fahrenheit (Celsius in parentheses); vapor pressure, in conventional millimeters of mercury (mmHg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicated if by weight or volume) at 70 degrees Fahrenheit (21.1 degrees Celsius); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for design and deployment of adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers, or when spilled.

(d) Section IV. Fire and Explosion Data

Section IV should contain complete fire and explosion data for the product, including flashpoint and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special firefighting procedures; and unusual fire and explosion hazard information. If the product presents no fire hazard, insert "NO FIRE HAZARD" on the line labeled "Extinguishing Media."

(e) Section V. Health Hazard Information

The "Health Hazard Data" should be a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable standard. Other data are acceptable, such as lowest LD50 if multiple components are involved.

Under "Routes of Exposure," comments in each category should reflect the potential hazard from absorption by the route in question. Comments should indicate the severity of the effect and the basis for the statement if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as "yes" or "possible" are not helpful. Typical comments might be:

Skin Contact--single short contact, no adverse effects likely; prolonged or repeated contact, possibly mild irritation.

Eye Contact--some pain and mild transient irritation; no corneal scarring.

"Emergency and First Aid Procedures" should be written in lay language and should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Information in the "Notes to Physician" section should include any special medical information which would be of assistance to an attending physician including required or recommended preplacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed employees.

(f) Section VI. Reactivity Data

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. It is particularly important to highlight instability or incompatibility to common substances or circumstances, such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. "Hazardous Decomposition Products" shall include those products released under fire conditions. It must also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, shelf life should also be indicated.

(g) Section VII. Spill or Leak Procedures

Detailed procedures for cleanup and disposal should be listed with emphasis on precautions to be taken to protect employees assigned to cleanup detail. Specific neutralizing chemicals or procedures should be described in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as "sanitary landfill," or "incineration." Warnings such as "comply with local, state, and federal antipollution ordinances" are proper but not sufficient. Specific procedures shall be identified.

(h) Section VIII. Special Protection Information

Section VIII requires specific information. Statements such as "Yes," "No," or "If necessary" are not informative. Ventilation requirements should be specific as to type and preferred methods. Respirators shall be specified as to type and NIOSH or US Bureau of Mines approval class, ie, "Supplied air," "Organic vapor canister," etc. Protective equipment must be specified as to type and materials of construction.

(i) Section IX. Special Precautions

"Precautionary Statements" shall consist of the label statements selected for use on the container or placard. Additional information on any aspect of safety or health not covered in other sections should be inserted in Section IX. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

(j) Signature and Filing

Finally, the name and address of the responsible person who completed the MSDS and the date of completion are entered. This will facilitate correction of errors and identify a source of additional information.

The MSDS shall be filed in a location readily accessible to employees exposed to the hazardous substance. The MSDS can be used as a training aid and basis for discussion during safety meetings and training of new employees. It should assist management by directing attention to the need for specific control engineering, work practices, and protective measures to ensure safe handling and use of the material. It will aid the safety and health staff in planning a safe and healthful work environment and in suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of employees.

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MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION		
MANUFACTURER'S NAME	REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.	
ADDRESS		
TRADE NAME		
SYNONYMS		
II HAZARDOUS INGREDIENTS		
MATERIAL OR COMPONENT	%	HAZARD DATA
III PHYSICAL DATA		
BOILING POINT, 760 MM HG		MELTING POINT
SPECIFIC GRAVITY (H ₂ O=1)		VAPOR PRESSURE
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H ₂ O, % BY WT
% VOLATILES BY VOL		EVAPORATION RATE (BUTYL ACETATE 1)
APPEARANCE AND ODOR		

IV FIRE AND EXPLOSION DATA				
FLASH POINT (TEST METHOD)			AUTOIGNITION TEMPERATURE	
FLAMMABLE LIMITS IN AIR, % BY VOL.		LOWER		UPPER
EXTINGUISHING MEDIA				
SPECIAL FIRE FIGHTING PROCEDURES				
UNUSUAL FIRE AND EXPLOSION HAZARD				
V HEALTH HAZARD INFORMATION				
HEALTH HAZARD DATA				
ROUTES OF EXPOSURE				
INHALATION				
SKIN CONTACT				
SKIN ABSORPTION				
EYE CONTACT				
INGESTION				
EFFECTS OF OVEREXPOSURE				
ACUTE OVEREXPOSURE				
CHRONIC OVEREXPOSURE				
EMERGENCY AND FIRST AID PROCEDURES				
EYES				
SKIN				
INHALATION				
INGESTION				
NOTES TO PHYSICIAN				

VI REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

INCOMPATIBILITY

HAZARDOUS DECOMPOSITION PRODUCTS

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

NEUTRALIZING CHEMICALS

WASTE DISPOSAL METHOD

VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY (SPECIFY IN DETAIL)

EYE

GLOVES

OTHER CLOTHING AND EQUIPMENT

IX SPECIAL PRECAUTIONS

PRECAUTIONARY
STATEMENTS

OTHER HANDLING AND
STORAGE REQUIREMENTS

PREPARED BY _____

ADDRESS _____

DATE _____

XIV. TABLES AND FIGURE

TABLE XIV-1

CHEMICAL AND PHYSICAL PROPERTIES OF SOME REFINED PETROLEUM SOLVENTS

<u>Petroleum Ether (a)</u>	
Boiling range	30-60 C (86-140 F)
Predominant molecular species	C5-C6
Molecular weight	Average 74.96
Appearance and odor	Clear water-white liquid; sweet ethereal odor
Specific gravity (60 F)	0.630-0.660
Vapor pressure (mmHg) at 12.6 C	100
Vapor density (air=1)	2.5
Solubility	Insoluble in water; readily soluble in most organic solvents
Evaporation rate (ethyl ether=1)	1.1
Autoignition point	246 C (475 F)
Flashpoint range (closed)	-57 to -46 C (-70 to -50 F)
Flammable limits (in air)	1.1-8.0 %
Flammability category (OSHA)	Class IB
Extinguishing media	Foam, carbon dioxide, dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 75)	1 ppm = 3.07 mg/cu m 1 mg/cu m = 0.326 ppm
<u>Rubber Solvent (b)</u>	
Boiling range	45-125 C (113-257 F)
Predominant molecular species	C5-C8
Molecular weight	Approximately 97
Appearance and odor	Clear water-white liquid; pleasant aromatic odor
Specific gravity (60 F)	0.674-0.850
Vapor pressure (mmHg)	Unknown
Vapor density (air=1)	Approximately 3.4
Solubility	Insoluble in water; readily soluble in most organic solvents
Evaporation rate (butyl acetate=1)	Approximately 4
Autoignition point	Minimum 260 C (500 F)
Flashpoint range (closed)	-46 to -13 C (-50 to 9 F)
Flammable limits (in air)	1.1-6.5 %
Flammability category (OSHA)	Class IB

TABLE XIV-1 (CONTINUED)

CHEMICAL AND PHYSICAL PROPERTIES OF SOME REFINED PETROLEUM SOLVENTS

Rubber Solvent (continued)

Extinguishing media	Foam, carbon dioxide, dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 97)	1 ppm = 3.97 mg/cu m 1 mg/cu m = 0.252 ppm

Varnish Makers' and Painters' Naphtha (c)

Boiling range	95-160 C (203-320 F)
Predominant molecular species	C7-C11
Molecular weight	Approximately 87-114
Appearance and odor	Clear water-white to yellow liquid; pleasant aromatic odor
Specific gravity (60/60 F)	0.7275-0.7603
Vapor pressure (mmHg) at 20 C	2-20
Vapor density (air=1)	Approximately 3.0
Solubility	Insoluble in water; readily soluble in most organic solvents
Evaporation rate (butyl acetate=1)	0.3-1.7
Autoignition point	232 C (450 F)
Flashpoint range (closed)	-6.7 to 12.8 C (20 to 55 F)
Flammable limits (in air)	0.90-6.0 %
Flammability category (OSHA)	Class IB
Extinguishing media	Foam, carbon dioxide, dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 114)	1 ppm = 4.66 mg/cu m 1 mg/cu m = 0.215 ppm

Mineral Spirits (d)

Boiling range	150-200 C (302-392 F)
Predominant molecular species	C9-C12
Molecular weight	Approximately 144-169
Appearance and odor	Clear, water-white; pleasant sweet odor
Specific gravity	0.77-0.81
Vapor pressure (mmHg) at 20 C	0.8
Vapor density (air = 1)	Approximately 5
Solubility	Insoluble in water
Evaporation rate (butyl acetate=1)	Approximately 0.1
Autoignition point	Unknown
Flashpoint range (closed)	30.2-40.5 C (86-105 F)

TABLE XIV-1 (CONTINUED)

CHEMICAL AND PHYSICAL PROPERTIES OF SOME REFINED PETROLEUM SOLVENTS

Mineral Spirits (continued)

Flammable limits (in air)	1.0-6.0 %
Flammability category (OSHA)	Class II
Extinguishing media	Foam, carbon dioxide dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 156)	1 ppm = 6.38 mg/cu m 1 mg/cu m = 0.157 ppm

Stoddard Solvents (e)

Boiling range	160-210 C (320-410 F)
Predominant molecular species	C9-C11
Molecular weight	Average 135-145
Appearance and odor	Colorless liquid with kerosene-like odor
Specific gravity	0.75-0.80
Vapor pressure (mmHg) at 25 C	4-4.5
Vapor density (air=1)	5
Solubility	Insoluble in water; readily soluble in most organic solvents
Evaporation rate (butyl acetate=1)	Less than 1
Autoignition point range	232-260 C (450-500 F)
Flashpoint (closed, minimum)	37.8 C (100 F) for 3 types 60 C (140 F) for 1 type
Flammable limits (in air)	0.9-6.0 %
Flammability category (OSHA)	Class II
Extinguishing media	Foam, carbon dioxide, dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 141)	1 ppm = 5.77 mg/cu m 1 mg/cu m = 0.173 ppm

Kerosene (f)

Boiling range	175-325 C (347-617 F)
Predominant molecular species	C9-C16
Molecular weight	Approximately 170
Appearance and odor	Water-white to straw colored; odorless-aromatic
Specific gravity (20/4 C)	0.8
Vapor pressure (mmHg)	Unknown
Vapor density (air=1)	4.5
Solubility	Insoluble in water
Evaporation rate	Unknown

TABLE XIV-1 (CONTINUED)

CHEMICAL AND PHYSICAL PROPERTIES OF SOME REFINED PETROLEUM SOLVENTS

<u>Kerosene</u> (continued)	
Autoignition point	229 C (444 F)
Flashpoint range (closed)	37.8-73.9 C (100-165 F)
Flammable limits (in air)	0.7-5.0 %
Flammability category (OSHA)	Class IB
Extinguishing media	Foam, carbon dioxide, dry chemical
Conversion factors (at 760 mmHg and 25 C, assuming a molecular weight of 170)	1 ppm = 6.95 mg/cu m 1 mg/cu m = 0.144 ppm

(a) Adapted from references 1,3-8,11
 (b) Adapted from references 1,9,11,14,124,129
 (c) Adapted from references 1,10,11,17,18,124,127
 (d) Adapted from references 1,3,5,12-14,18,82,124
 (e) Adapted from references 1,11,18,19,21,56,124,126
 (f) Adapted from references 4,5,18,27,67,125,128

TABLE XIV-2

OCCUPATIONS WITH POTENTIAL EXPOSURES TO SOLVENTS

Adhesive makers	Leather jappers
Ammonia synthesis workers	Metal cleaners
Asphalt coating workers	Naphtha workers
Ceramic production workers	Oil processors
Degreasers, metal	Painters
Detergent makers	Paintmakers
Drycleaners	Perfume extraction workers
Enamel makers, synthetic	Petrochemical workers
Farmers	Petroleum refinery workers
Fat and oil processors	Photographic chemical makers
Fungicide handlers	Printers
Garage workers	Resin makers
Heating fuel handlers	Rocket fuel handlers and makers
Herbicide handlers	Rubber coaters and makers
Hydrogen manufacturing workers	Stainers
Ink production workers	Stain makers
Insecticide handlers	Typesetters
Jet fuel handlers and makers	Varnish makers
Kerosene handlers	Waxmakers
Laboratory workers, chemical	Wood preservation makers
Lacquers	Wool process workers

Adapted from references 1,2,5,10,19,27,29-31

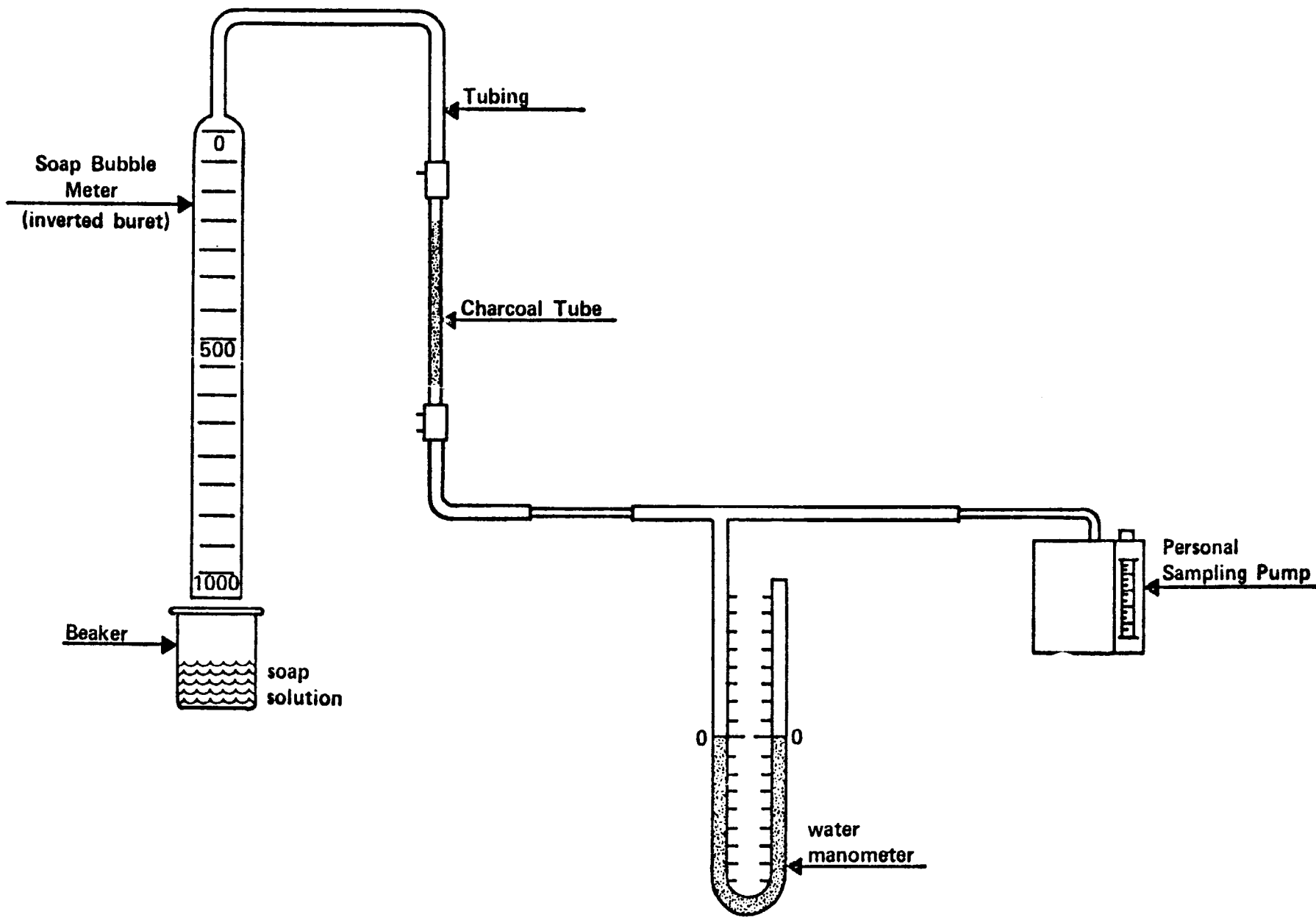


FIGURE XIV-1

CALIBRATION SETUP FOR PERSONAL SAMPLING PUMP WITH CHARCOAL TUBE

