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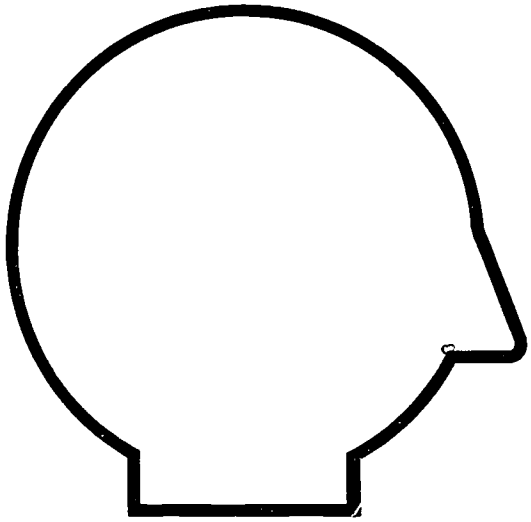
ABSTRACT

This module, one of 25 on vocational education training for careers in environmental health occupations, contains self-instructional materials on operating gas-absorbing equipment. Following guidelines for students and instructors and an introduction that explains what the student will learn are three lessons: (1) identifying parts and functions of each component in a gas-absorbing sampling train; (2) cleaning and calibrating a gas-absorbing sampling train; and (3) operating a gas-absorbing sampling train to obtain an enclosed area sample for analysis of sulfur dioxide. Each lesson contains objectives, recommended methods and location for practice, performance criteria, equipment and supplies to perform a task, detailed step-by-step instructions for learning a task, and performance exercises. Performance tests cover the subject matter of each lesson. (CT)



Operating Gas-Absorbing Equipment

Module 21

U.S. DEPARTMENT OF EDUCATION, Office of Vocational and Adult Education

FOREWORD

The Curriculum and Instruction Branch of the Office of Vocational and Adult Education, U.S. Department of Education, identified a need to improve the training opportunities for vocational education students interested in pursuing careers in environmental health. To fulfill that need, Consumer Dynamics, Inc., a Rockville, Maryland, based company, was awarded the contract to develop performance-oriented, competency-based modules in the environmental health sciences.

OPERATING GAS-ABSORBING EQUIPMENT is one of the modules in the series, "Vocational Education Training in Environmental Health Sciences." The module content is based on selected materials in the environmental health field. The module is intended to supplement existing course materials.

CONTENTS

USING THESE SELF-INSTRUCTION MATERIALS

This self-instruction learning package or module is designed to allow both students and instructors flexibility of use. Although primarily intended for use in existing training programs, the module can be used by anyone interested in learning new skills or picking up old ones. Therefore, two sets of guidelines are presented--one set addressed to students and the other set addressed to instructors. First, find out how you, the student, should use the materials in this book.

GUIDELINES FOR STUDENTS

Take the Performance Test as a pretest.

When you pick up this book and work through it, your goal will not be a letter grade or a high score on an exam. Instead, you will work to develop skills that you can measure. You will not have to worry about how well someone else is doing. Before entering training in this module, you should have gained experience and skill in (1) using a primary calibration standard, such as the bubble meter, to calibrate personal sampling pumps and devices; calibrating and using precision rotameters; and using such sampling trains to measure occupational exposures; and (2) in calibrating and using other portable pumps, including gasoline-operated or AC-operated (semi-portable) pumps. You also must have gained basic chemical laboratory skills, including use of volumetric glassware, learned in a high school chemistry course or through on-the-job training. Before you begin work on the steps and exercises in this module, first, find out if you have sufficient skills to start training by reading through the section called PERFORMANCE TEST. If you think you can perform each item as specified, ask your instructor to make available the necessary equipment and supplies so that you can demonstrate your skill level.

Work on parts you need to practice.

If you do everything well, according to the criteria in the Performance Test guidelines, you will not need to spend time working on this module. If after taking the Performance Test you discover there are parts you need to practice, follow the key to each item in FOR FURTHER STUDY.

USING THESE SELF-INSTRUCTION MATERIALS

Work straight through each lesson in the order presented.

Should you decide to completely work through this module, begin with the INTRODUCTION and go straight through each of the three lessons. The lesson begins with the OBJECTIVE of the training. Follow the instruction for each part in the order presented. Practice each step in a lesson until you can do it according to the criteria stated for the step. At the end of a lesson, do the EXERCISES. When there are audiovisuals listed at the end of a lesson, ask your instructor for help in obtaining them.

Take the Performance Test as a posttest.

Finally, after you have mastered the exercises, ask your instructor to watch you clean and calibrate a gas-absorbing sampling train and to operate the equipment to obtain air samples for analysis of a specific gas or vapor. The guidelines in the Performance Test can be used as a posttest to evaluate the quality of your performance. Turn now to the Performance Test.

GUIDELINES FOR INSTRUCTORS

Approach

The approach of these materials is to provide the student with (1) nomenclature and functions of the gas-absorbing sampling train; (2) procedures for cleaning and calibrating a gas-absorbing sampling train; and (3) procedures for operating a sampling train. The lessons are sequential in that the information presented in the previous lesson serves as a basis of skill development in a later lesson. Exercises are provided to guide the student's practice of the procedures in GETTING THERE--STEPS.

Use of the Performance Test

A Performance Test is provided to serve as a guide to the skill development progress. If a student is able to demonstrate skill development by meeting the criteria for performance given in each test item, further study is not needed. Therefore, the student should be given the option of entering training at any point. To determine at what point to start, the student should take the Performance Test as a pretest. At any time during the course of study, the student also should be allowed to test out of the remaining portions of training.

Also, the student's capability to accurately complete the entire task in a timely manner can be evaluated by using the Performance Test as a posttest. The items listed in the test can serve as a basis for developing other sets of procedures to operate different configurations of sampling trains for obtaining samples of environmental pollutants.

Independent Study

This module is designed to enable the student to work independently under whatever time constraints you deem reasonable. However, depending on the skill level of the students with whom you are working, you may find it desirable to start a group together at the same time with a demonstration and informal presentation on the contents of the module. Alternatively, you may choose to use this module as a laboratory workbook in a structured laboratory session. With this option, you allow students greater access to your assistance.

General Instructions

Read through each lesson to anticipate what equipment and supplies you will need to make available for students to use. Also, order any audiovisuals or reading materials you think may present a complementary perspective to the training in this module.

Specific Instructions

The exercises in Lesson Three require that actual samples of sulfur dioxide (SO_2) be collected and analyzed; therefore, these exercises may be beyond the capability of some students using this module. If this is the case, have each student calibrate and prepare a sampling train as if a sample were being collected. Observe their performance and rate them on their technique.

BACKGROUND

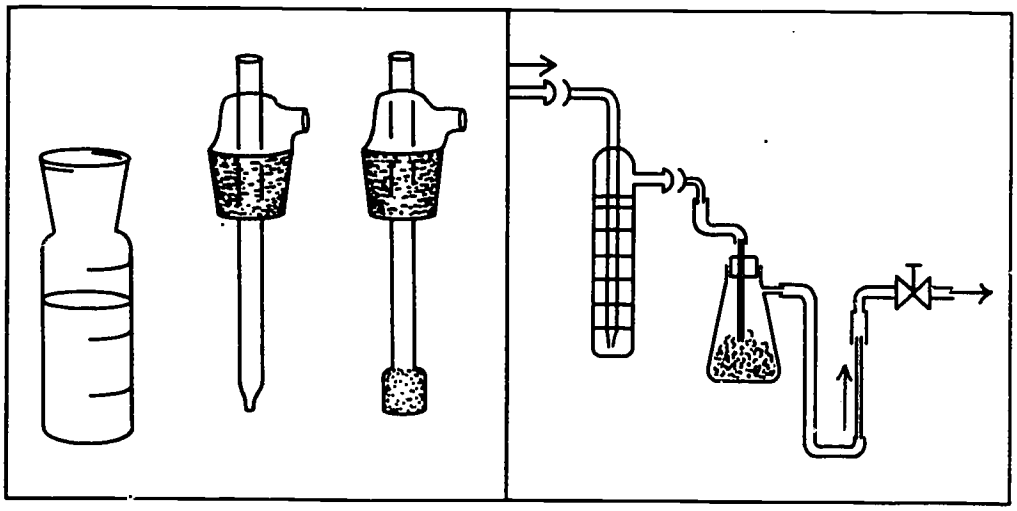
Samples of airborne contaminants are collected using several types of equipment depending on whether environmental or workplace conditions are being monitored. For sampling occupational exposures to airborne vapors, mists, gases, or particulates, the sample frequently is collected on dry media, such as a charcoal tube or filter, at low airflow rates (1-5 liters per minute). To monitor the level of airborne pollutants outside of the workplace, higher airflow rates are used to draw air into sample collecting devices. Many of the gases or vapors that are sampled from outside air are drawn into containers holding an absorbing solution or reagent. These containers, called bubblers and impingers, are used to prevent loss of the sample through rapid chemical changes. When bubbled through a solution, the sample is stabilized--it combines with water or a chemical in solution until other chemicals are added during analysis to free the sample.

Most routine sampling with gas-absorbing equipment is performed with the use of midget impingers, fritted glass absorbers, or a combination of the two. These devices are designed to hold 30 ml or less volume. A gas collection train of pumps, filters, and impingers is operated in a work area for a given length of time. After sampling the air, the stoppered collection device is returned to the laboratory for analysis.

Those who may be required to operate gas-absorbing equipment include employees of electric utility companies; petrochemical companies; pharmaceutical companies; chemical testing laboratories; various manufacturers; or employees of any of the Federal, State, or local agencies charged with enforcement of government air standards. Performing gas-absorbing tests is an important task. The health and well-being of the public and workers ultimately depend on the accurate determination of hazardous levels of airborne contaminants.

WHAT YOU WILL LEARN

When you finish working through the steps and exercises in this module, you will be able to use a calibrated gas-absorbing sampling train to obtain air samples for analysis of a specific gas or vapor.



You will learn how to operate gas-absorbing equipment in three lessons:

- o Lesson One

  You will be able to identify parts and functions of each component in a gas-absorbing sampling train.

- o Lesson Two

  You will be able to clean and calibrate a gas-absorbing sampling train.

- o Lesson Three

  You will be able to operate a gas-absorbing sampling train to obtain an enclosed area sample for analysis of sulfur dioxide.

OBJECTIVE

You will be able to identify parts and functions of each component in a gas-absorbing sampling train.

WHERE AND HOW TO PRACTICE

You should practice this lesson in a laboratory or equipment breakout area. Read through each step and refer to the equipment as you identify specific parts or features of a component. If you do not understand an instruction, ask your instructor for help.

HOW WELL YOU MUST DO

You must be able to identify all parts and explain their functions well enough to indicate that you can properly use the sampling train.

THINGS YOU NEED*

You will need the following equipment and supplies:

- o portable sampling pump, high flow (1-4 liters) accurate to within 10 percent; such pumps are manufactured by the duPont Company, Mine Safety Appliances, or others that pump at 1 or more liters per minute (lpm)
- o manufacturer's instruction booklet for the portable sampling pump
- o flow meter that can indicate airflows as low as 1.0 lpm or precision rotameter that measures airflows in the range of 1-10 lpm
- o filter cassette with membrane filter, 0.8-μm pore size
- o impinger, midget
- o impinger, midget, modified with threaded top and threaded side arms
- o bubbler, fritted-glass, midget
- o bubbler, smog

*Presentation of specific brands or models of equipment should not be construed as an endorsement of the equipment by the U.S. Department of Education.

THINGS YOU NEED (cont'd)

- o probe to direct airflow into the sampling train
- o plastic tubing to connect sampling train components.

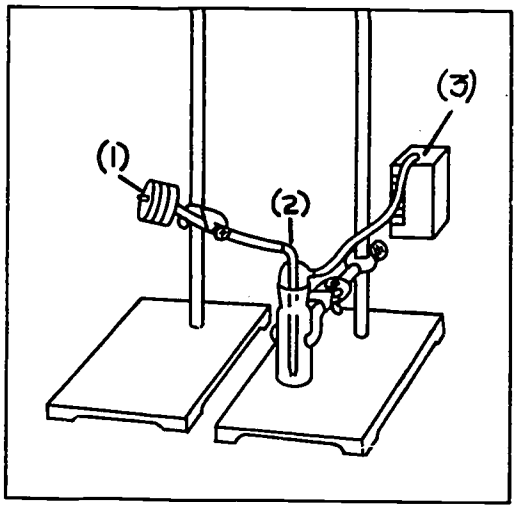
Instructions: Now turn to the next page and begin work on Lesson One, "Getting There--Steps."

GETTING THERE--STEPS

STEP 1

A gas-absorbing sampling train consists of a filter cassette (1) with filter to prevent dissolvable contaminants from entering the impinger; one or more impingers (2) to trap gases and vapors in an absorbing reagent; and a sampling pump (3) to pull air into the sampling train at a predetermined flow rate.

KEY POINT 1

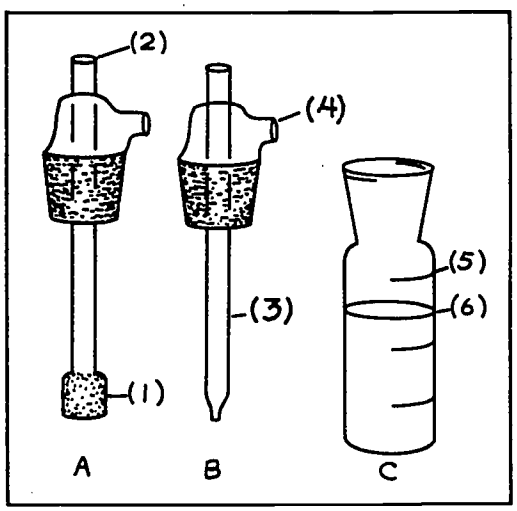


The sampling train consists of three major components: a filter, a trap, and a pump.

STEP 2

Pick up a midget impinger and a midget bubbler. The bubbler is recognized by the "frit" (1)--a porous piece of glass at the end of the inlet tube (2) as shown in "A." The impinger stem (3) is a straight tube with a tapered end as shown in "B." Remove the tube from either the impinger or bubbler bottle "C" by simply grasping the bottle with one hand and turning and lifting the ground-glass tube and outlet arm (4) with the other hand. The bottle, which has a capacity of 30 ml, may or may not have volume markings (5). Before the sampling train is calibrated or used, add absorbing reagent to the bottle up to the desired volume.

KEY POINT 2



The bubbler is identified by its frit--a porous piece of glass at the end of the inlet tube.

STEP 3

Pick up the smog bubbler. It is similar to the midget impinger/bubbler except that it has an expanded mixing chamber to ensure complete mixing of the particulate-containing smog sample and the absorbing reagent. The parts include:

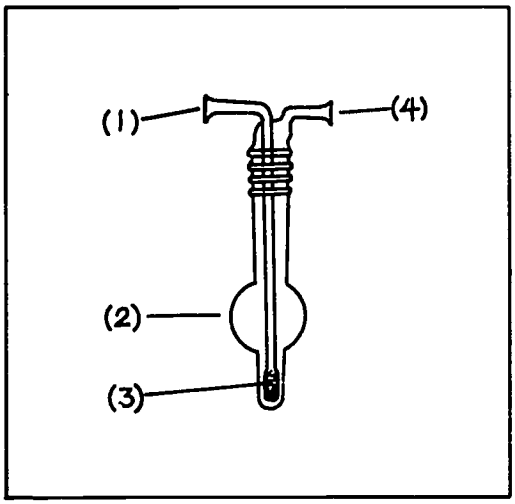
(1) inlet tube

(2) mixing chamber

(3) frit

(4) outlet fitting

KEY POINT 3



The smog bubbler has a large mixing chamber to ensure complete mixing between smog particulates and the absorbing reagent.

STEP 4

Locate the portable sampling pump and the manufacturer's instruction booklet. Make sure the batteries are fully charged before you calibrate it or use it for sampling. Turn on the pump. If it has a built-in rotameter, turn the pump adjustment knob and watch the rotameter ball move up and down in the cylinder. If at least an 80 percent full-scale adjustment is not possible, recharge the batteries. When fully charged, check the pump again. If adjustment is still not possible, tell your instructor, who should have the pump repaired.

KEY POINT 4

Check the adjustment of flow to determine if the batteries are fully charged or, if they are, if the pump needs to be repaired.

STEP 5

If the pump you use does not have a built-in rotameter, obtain a variable area flow meter, better known as a rotameter. Pick up the rotameter and locate the following parts by referring to the illustration in the Key Point:

(1) outlet fitting

(2) outlet connection

(3) outlet float stop

(4) tapered glass metering tube and scales

(5) metering float

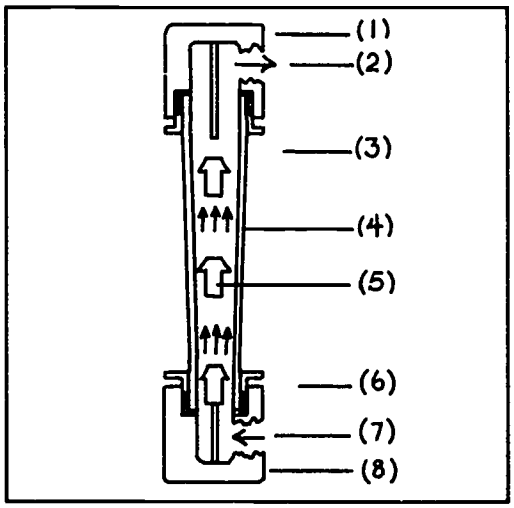
(6) inlet float stop

(7) inlet connection

(8) inlet fitting

When sampling with impingers, attach a 6- to 8-inch piece of tubing between the outlet fitting on the rotameter and the inlet fitting on the pump. Now attach the tubing and set the assembly aside.

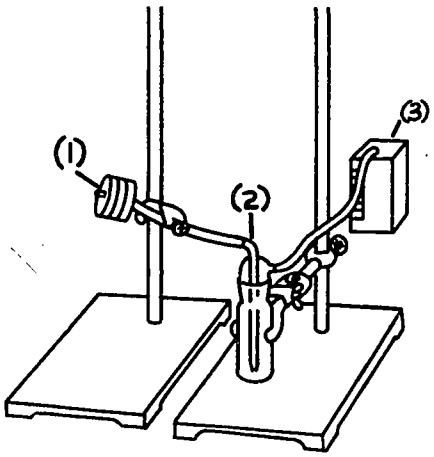
KEY POINT 5



Use a precision rotameter if the pump you use does not have a flow meter built in.

EXERCISES

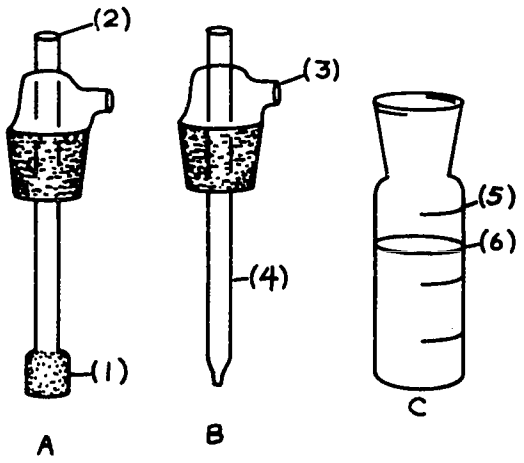
Instruction 1: Referring to the equipment and/or drawings in the lesson, label the following drawings. You must be able to name each part in the drawing and tell how it functions or is used. You should be able to do this in 5 minutes or less.



(1) _____

(2) _____

(3) _____



A _____

(1) _____

(2) _____

B _____

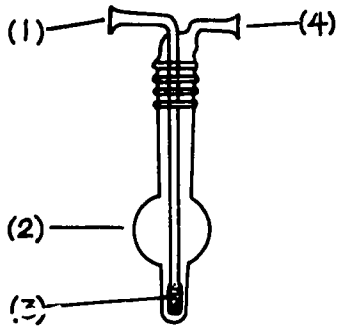
(3) _____

(4) _____

C _____

(5) _____

(6) _____

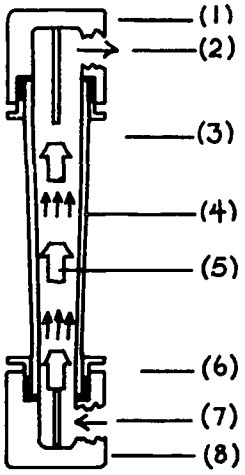


(1) _____

(2) _____

(3) _____

(4) _____



(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

(7) _____

(8) _____

Instruction 2: When you can do the exercises in this lesson within the time stated, you are ready to begin work on Lesson Two.

OTHER READING

U.S. EPA, Title 40, Subpart 50, Code of Federal Regulations.

LESSON TWO

OBJECTIVE

You will be able to clean and calibrate a gas-absorbing sampling train.

WHERE AND HOW TO PRACTICE

In this lesson, you should practice the steps in a laboratory. Since you may be handling caustic and/or toxic materials in cleaning and assembling the apparatus, exercise extreme caution. Should liquid materials contact your skin, wash them off with plenty of water. Inform your instructor or laboratory supervisor as soon as possible. Never work in the laboratory alone. Follow each step in "Getting There--Steps" and go over each as many times as it takes to do the step correctly.

HOW WELL YOU MUST DO

You must be able to clean the impinger and probe so that all surfaces are free from chemical or organic residues, and also to clean the frit in a bubbler. You must be able to clean and dry necessary glassware components in 20 minutes. You must be able to assemble the sampling train so that air flows in the intended direction; that is, into the impingers through the inlet tubes and out through the outlet arms toward the pump. Practice setting up the train so you can completely assemble a functioning train in 10 minutes or less. Using a 100-ml buret to calibrate air flowing through the system, your timing accuracy must be 6 $\pm$ 1 seconds.

THINGS YOU NEED

In addition to the equipment and supplies needed in Lesson One, you will need the following:

- soap solution
- petri dish or shallow dish
- buret, 100-ml
- beaker brush, small
- gas-absorption bottles

THINGS YOU NEED (cont'd)

- acid cleaning solution in a squeeze bottle
- acetone
- distilled water
- filter cassette, particulate
- squeeze bulb with air vent
- pipet, 25-ml
- impinger holders
- glass tubing, 1-inch piece
- ringstands (2), extension clamp, regular holder clamp, and buret clamp
- fullface shield
- paper towels
- detergent (phosphate-free), laboratory glassware
- rubber gloves (acid-resistant)
- safety glasses with side shields or safety goggles
- waste container (corrosion-resistant)
- drying rack
- paper towels.

CAUTION: When working with acids, bases, and other caustic and corrosive or other toxic chemicals, wear a fullface shield made of corrosion-resistant plastic. You should wear safety glasses with side shields at all other times when working in a laboratory. Toxic materials that generate vapors should be handled in a laboratory hood vented to the outside.

Instructions: Now turn to the next page and begin work on Lesson Two, "Getting There--Steps." Read through each step carefully before handling any equipment or supplies.

GETTING THERE--STEPS

STEP	KEY POINT
STEP 1 Clean a midget impinger and probe. First, put on safety protection equipment--gloves, fullface shield, and apron--while handling corrosive materials. Clean the equipment with detergent, using the brush to remove adhering substances. Rinse with acid cleaning solution. Rinse with tapwater. If water does not bead on the inside surfaces, rinse each piece of glassware with distilled water. Set the bottle and insert off to the side on a clean drainboard.	KEY POINT 1 Chemically clean a midget impinger, including the bottle and the insert.
STEP 2 Clean a midget bubbler. Clean the bottle first as in Step 1. Examine the frit. If it appears clogged, you will need to clean it with the appropriate solvent.* Add the solvent to the bottle and put the inlet tube back into the bottle. Attach one end of a 1- to 2-foot piece of tubing to the inlet tube and the other end to a short piece of glass tubing; insert this into a squeeze bulb. Surge (rapid uptake and outflow) the solvent through the frit by squeezing the bulb. Drain the solvent out of the bubbler into a waste solvent container. Rinse the bubbler by surging tapwater through the frit. Rinse all glassware with distilled water. Set the cleaned glassware next to the impinger on the drainboard.	KEY POINT 2 Chemically clean a midget bubbler.

20

STEP 3

Rinse each piece of glassware with acetone, and discard the acetone in a waste solvent container. To dry, stand the inlet/outlet pieces vertically in a drying rack and place the bottles upside down on paper towels.

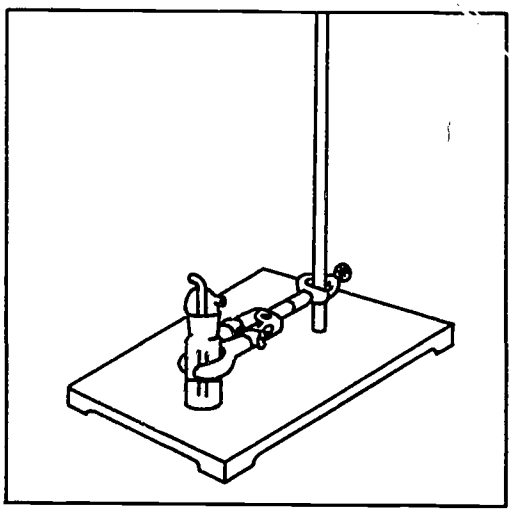
KEY POINT 3

Rinse and dry each piece of glassware.

STEP 4

The first step in assembling the sampling train for calibration is to add absorbing reagent to the impinger/bubbler bottles. To practice this lesson, use distilled water. Using a graduated pipet, add 15 ± 0.5 ml distilled water to the impinger bottle. Before reinserting the inlet/outlet tube, spread a thin layer of silicon stopcock grease on the tapered, ground-glass sides. To ensure that there is an airtight seal between the ground-glass edges, twist the tube as you reinsert it into the bottle. Clamp the impinger with an extension clamp attached to a ringstand. Fasten the hold-down springs if they are supplied.

KEY POINT 4



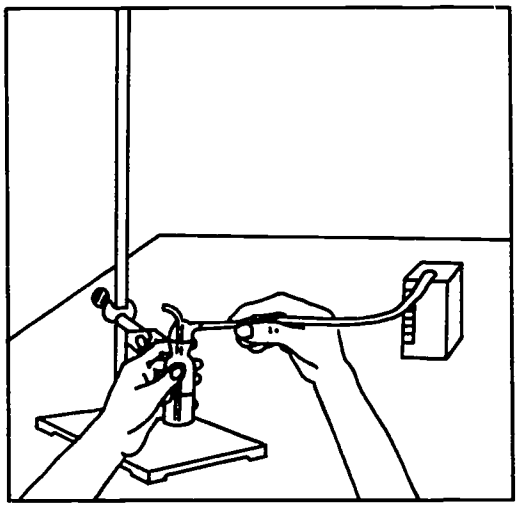
Add distilled water to the impinger bottle, grease the ground-glass surfaces, and clamp the impinger.

*Solvent may include hot hydrochloric acid for dirt, and hot concentrated sulfuric acid containing sodium nitrate for organic matter.

STEP 5

Attach a 1-foot piece of tubing to the inlet fitting of the pump. To prevent spilling the absorbing reagent (distilled water in this lesson) while attaching the other end of the tubing to the impinger outlet, steady the clamped impinger bottle with one hand and twist the tubing onto the fitting with the other hand as shown in the Key Point.

KEY POINT 5

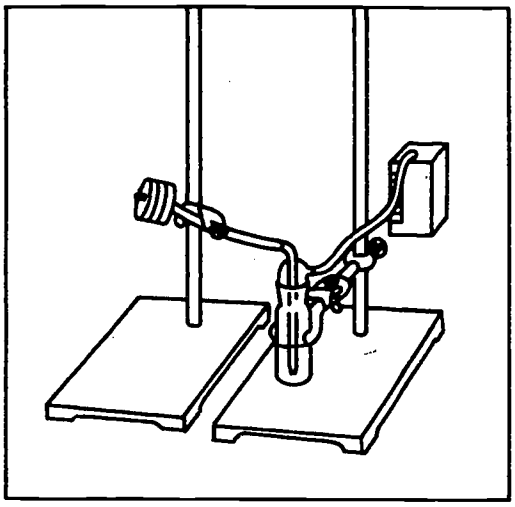


Do not spill the absorbing reagent while attaching the tubing.

STEP 6

Because the probe and filter will have to be supported, obtain a ringstand and shaft clamp. Attach the clamp to the ringstand shaft and place the probe in the clamp. Fasten the clamp so it holds the probe firmly but not too tightly. Connect a 6-inch piece of tubing between the outlet of the filter and the inlet of the impinger in the manner shown in Key Point 5.

KEY POINT 6

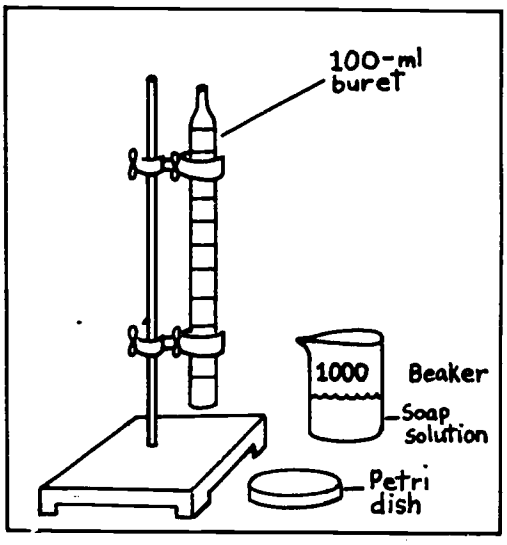


Hold the filter assembly with a ringstand and shaft clamp. Do not tighten the clamp on the tubing; just rest the tubing in the clamp.

STEP 7

Turn on the sampling pump and let it run for about 5 minutes. While it is running, set up the bubble meter for calibrating the sampling train. Rinse the buret with soap solution before placing in on a buret stand. Connect a 30-inch piece of tubing between the buret and the probe.

KEY POINT 7



While the pump is warming up, prepare the bubble meter for use.

STEP 8

Check the tubing to make sure it is not kinked. Check the tubing size and push the tubing further onto the fittings.

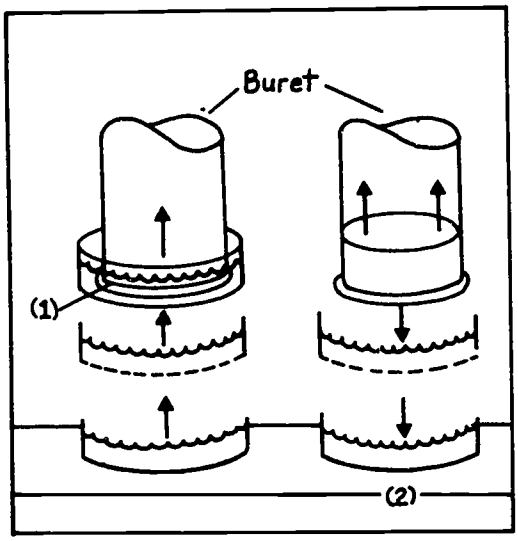
KEY POINT 8

Check the tubing and connections for kinking and leaks.

STEP 9

Make sure the soap solution container is filled. Form a bubble in the buret by raising the soap solution dish until the buret mouth is just below the surface of the solution (1). Quickly lower the dish (2). A bubble should have formed and begun to rise in the buret through the sucking action of the pump. Draw two or three bubbles up the buret to make sure that at least one bubble makes it to the 100-ml mark.

KEY POINT 9



Submerge the buret mouth only briefly in the soap solution.

STEP 10

If you cannot get a bubble to rise to the 100-ml mark, wet the buret walls with soap solution. A stronger soap solution may also be needed. Try these remedies and repeat Step 9 until you can get two or three bubbles to rise to the 100-ml mark each time you try.

KEY POINT 10

If the bubbles do not rise, wet the buret with soap solution and/or make the solution stronger.

STEP 11

Adjust the airflow of the pump so the rotameter ball is in line with an index mark on the rotameter scale you believe may correspond to an airflow of approximately 1 lpm. Since the object of calibrating the sampling train with the bubble meter is to find what marking on the rotameter scale corresponds to air flowing through the system, this initial alignment is only temporary.

KEY POINT 11

Before starting to calibrate the sampling train, coarsely adjust the pump to get air flowing through the system at approximately 1 lpm.

STEP 12

Measure the rise of the soap-bubble at least three times in a row. It should take the bubble about 6 seconds to rise 100 ml in the buret. Record each timing here:

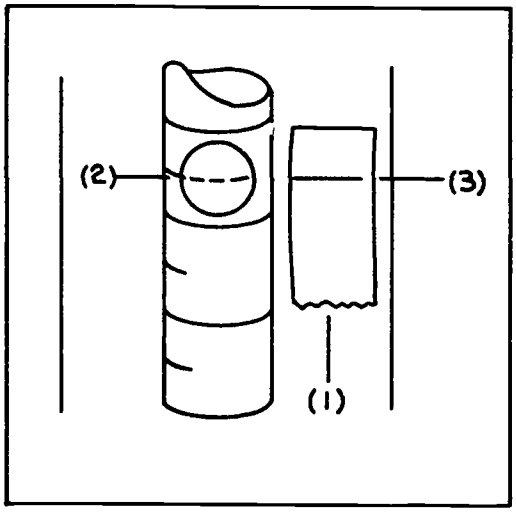
(a) _____ sec

(b) _____ sec

(c) _____ sec

If the average of these timings is 6 ± 1 seconds, place a small piece of tape (1) on the rotameter scale across from the point at which the rotameter ball (2) is floating. Draw a line (3) across from the center of the ball as shown in the Key Point.

KEY POINT 12



Make a mark on the tape to show where the center of the rotameter ball should be when the pump is drawing the desired flow rate.

EXERCISES

Instruction 1: Practice cleaning and setting up a gas-absorbing sampling train. Work toward cleaning and drying the glassware components in 20 minutes or less. Add absorbing reagent to the impinger, run the pump for 5 minutes, and connect and check the fittings for air leaks within 10 minutes.

Instruction 2: Disconnect the tubing from the impinger outlet. Attach the tubing to the outlet of the precision rotameter. Attach one end of another 6-inch piece of tubing to the inlet of the rotameter. Attach the other end of the same tube to the outlet of the impinger. Remember to follow Step 5 when you do this operation. Turn on the pump without adjusting flow. How does the flow compare with the calibrated setting you arrived at using the bubble meter? Write your observation here:

Instruction 3: Remove the rotameter from the sampling train. Place another impinger in line. Connect the tubing from the outlet of impinger 1 to the inlet of impinger 2, and connect the outlet of impinger 2 to the pump. How does the flow compare with the calibration setting? Write your observation here:

Instruction 4: Disconnect both impingers and replace them with one bubbler. How does the flow compare with the calibration setting? Write your observation here:

Instruction 5: Repeat instruction 2 through 4 and calibrate each sampling train for a flow of 1.5 lpm.

Instruction 6: Obtain a small gasoline-operated or electric pump. Set up and calibrate a calibrating train that includes the pump, a rotameter, one midget impinger, a 0.8-μm pore size membrane filter/cassette, and a probe.

LESSON THREE

OBJECTIVE

You will be able to operate a gas-absorbing sampling train to obtain an enclosed area sample for analysis of sulfur dioxide.

WHERE AND HOW TO PRACTICE

In this lesson you will again do all your work in the laboratory. As in Lesson Two you should work with at least one other person during preparation of gas-absorbing glassware; if an accident should occur, you will have help. When cleaning glassware, wear personal protective equipment, including acid-resistant rubber gloves, apron, and fullface shield. Wear safety glasses with side shields or safety goggles when handling absorbing solution. Pipet solutions in a laboratory hood that is vented to the outside. Use commercially prepared standardized solutions, if available; otherwise, your instructor will have to prepare the standardized solutions in advance.

HOW WELL YOU MUST DO

You must be able to operate the gas-absorbing apparatus so that the absorbing reagent does not fall below one-half of the level to which the absorbing reagent is initially added, and so that the flow rate is kept at the calibration rate. You also must record all necessary information about the sampling conditions, sampling area, sampling train, and the collector.

THINGS YOU NEED

In addition to the equipment and supplies you used in the previous two lessons, you will need the following:

- 0.3 N hydrogen peroxide absorbing solution
- wash bottle containing unused absorbing solution
- plastic caps or ground-glass stoppers with springs for shipping
- shipping container
- plastic tape
- barometer, such as a marine barometer, with pressure, temperature, and humidity gages.

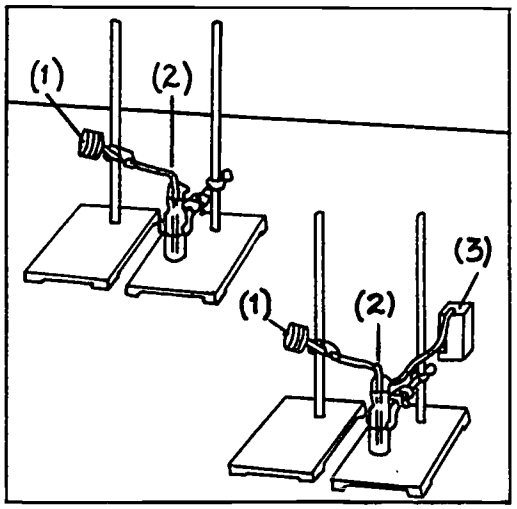
Instructions: Now turn to the next page and begin work on Lesson Three, "Getting There--Steps."

GETTING THERE--STEPS

STEP 1

Set up a sampling train to obtain an area sample of sulfur dioxide. Include a membrane filter cassette (1), one midget impinger (2), and the sampling pump (3). Check the system for leaks and calibrate the sampling train for a flow of 1 lpm as you did in the previous lesson. Next to the calibrated sampling train, set up another impinger and filter but do not connect it to a pump; this impinger is to be used as a blank.

KEY POINT 1



Calibrate the sampling train just prior to sampling with it. Set up another impinger and filter as a blank.

STEP 2

Using a pipet, fill both impingers with 15 ml* of 0.3 N hydrogen peroxide absorbing reagent. Without connecting the pump to the sampling train, run it for 5 minutes just before you begin sampling. Change the filter before beginning to sample.

KEY POINT 2

Fill the impingers, run the pump, and change the filter before before starting the sampling.

*NIOSH Sampling Data Sheet #19.01.

STEP 3

If you were to collect an actual sample, calculate how long you must draw air through the sampling train if you must collect 100 liters of sample at a flow rate of 1 lpm. If the pump draws 1 liter in 1 minute, it takes 100 minutes to draw 100 liters. Refer to the Key Point for the arithmetic. If the concentration is expected to be greater than 100 mg/m^3, then collect a smaller volume, such as 50 or 75 liters.* Unless the sulfur dioxide concentration is this high (dangerously high), you will collect at least 100 liters.

KEY POINT 3

Divide volume to be sampled

(100 liters) by the flow rate

(1 lpm), or

100 liters 1 lpm = 100 min

Determine the sampling time by dividing the volume to be sampled by the flow rate.

*NIOSH Sampling Data Sheet #19.01.

STEP 4

For purposes of this lesson it is not necessary to collect an actual sulfur dioxide sample. However, operate the sampling equipment as if you were. Frequently check the level of absorbing reagent during sampling; do not let it splash or spill. If the sample is spilled by the worker bending over, begin sampling again. If the reagent drops to one-half of the original amount, stop the pump, remove the impinger stem, and add more absorbing reagent up to the original volume, using a Mohr pipet. Turn the pump back on as soon as possible. Check the flow rate and readjust the rotameter ball so it floats at the calibration mark. In a notebook, record the procedure and the time it took.

KEY POINT 4

Do not let the level of absorbing reagent fall to less than one-half of the starting amount.

STEP 5

At the end of the sampling period, remove both impinger stems from their bottles and rinse each directly into its respective bottle with 1-2 ml of unused absorbing reagent. Stopper each impinger bottle tightly with the plastic cap provided, or pour the contents into two separate 20-cc vials. Make sure a Teflon liner is in both vial caps. Tightly screw on the caps and seal each bottle with vinyl tape.

KEY POINT 5

Rinse the impinger stems and transfer the contents of the sample and the blank to two 20-cc vials supplied with Teflon-lined caps.

STEP 6

Measure the room temperature to the nearest 1/2° C and the barometric pressure to the nearest millimeters of mercury (mmHg). Record the elevation at your location if the pressure is unavailable. Record this and other sampling information in a letter or on a form to be mailed along with each bottle. Among the other information, include the following:

- o sample identification number (user, not laboratory number)
- o type of analysis
- o date, time, and duration of sampling
- o area sampled and type of atmosphere
- o temperature and pressure
- o amount and type of absorbing reagent used
- o when and how the sampling train was calibrated
- o flow rate at which sample was collected
- o name of the sample collector.

KEY POINT 6

In a letter or on a form, record information about the sampling conditions, the areas sampled, the sampling train, and the collector.

STEP 7

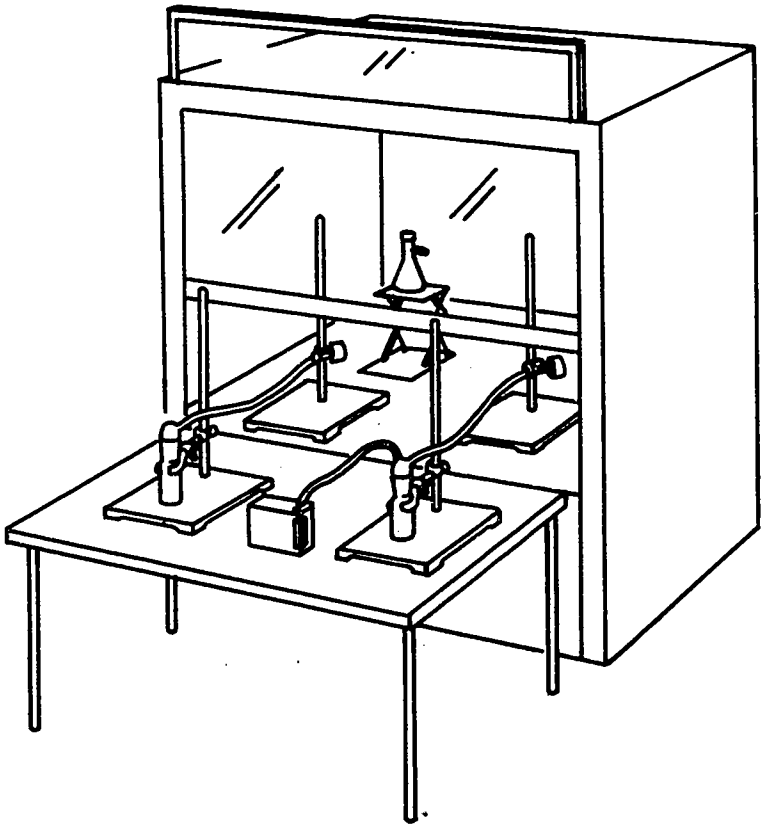
Place a label on each vial. On the label, write the sample identification number and the type of analysis. Check with the specific laboratory that does the analysis as to what other types of information you may need to include on the label. Place the vial in a rigid box for shipping along with complete information on each sample and blank. Keep another copy of the information on each vial for your files. Check postal and Department of Transportation regulations for mailing laboratory samples.

KEY POINT 7

Label the vials with only the minimum amount of information to properly identify the sample; send the rest of the information in a letter or on a form.

EXERCISES

Instruction 1: In a chemistry laboratory, set up and prepare gas-absorbing equipment for sampling SO_2 as you did in this lesson. Place the equipment on a table set next to a laboratory fume hood as shown in the figure below:



Instruction 2: Run the pump for 5 minutes without attaching it to the sampling train.

Instruction 3: Obtain the following equipment and reagents:

- laboratory support, adjustable, with a platform for hot plates and glassware
- Pyrex/Kimax Erlenmeyer flask with sidearm, 1,000-ml capacity
- graduated cylinder, 100-ml capacity
- solid stopper, No. 8
- sodium sulfite, 25 g, powdered
- sulfuric acid, 3-5 N.

Instruction 4: Add 25 g sodium sulfite to the Erlenmeyer flask. Pour 50 ml sulfuric acid into the flask and swirl. Stopper the flask and place it on the laboratory support so the sidearm is pointed toward the filter cassette of the sampling train. The sidearm and filter cassette should be separated by a distance of about 2 feet.

Instruction 5: As soon as you see vapor escaping from the sidearm, attach the pump to the sampling train; sample for 15 minutes. At the end of the sampling period, perform Steps 5 through 7 of Lesson Three.

Instruction 6: Titrate the blank and the sample with barium perchlorate "using Thorin as an indicator."* Determine the volume sampled using the formula in Step 3, Lesson Three. Calculate the concentration of SO_2 in the sample.

Instruction 7: Repeat instructions 4 through 6 except insert another impinger in the sampling train and in the "blank" sampling train. When analyzing the samples, add them together before titrating. Compare the results you get using one impinger versus using two impingers in the sampling train.

*Frity, J.S., and S.S. Yamamura, Analytical Chemistry, pp. 27, 1461, 1955.

PERFORMANCE TEST

Instructions: Check your skill level or progress by working through each of the following items. If you can perform the item as well as required, place a check in the space provided. When all of the items are checked, you are ready to demonstrate your skills to your instructor. You will be considered trained in these skills after your instructor approves your performance of each item.

(Instructors: You may use this checklist in guiding your evaluation.)

PREPARING A GAS-ABSORBING SAMPLING TRAIN FOR CALIBRATION

You must be able to perform the following within 20 minutes:

No. 1 _____ Chemically clean a probe and impinger so that water does not bead on the inside surfaces.

No. 2 _____ Chemically clean a midget bubbler with the appropriate solvent for dirt and/or organic matter.

No. 3 _____ Rinse chemically washed equipment with distilled water and acetone.

No. 4 _____ With a pipet, fill an impinger with 15 ± 0.5 ml absorbing solution or reagent, and prepare the ground-glass surfaces of the impinger so it is airtight.

No. 5 _____ Secure the impinger so that it remains stable during calibration.

No. 6 _____ Connect the probe and filter, using ringstands and clamps, to the impinger so that air flows into the impinger through the inlet arm from the outlet of the filter.

FOR FURTHER STUDY

If you could not perform one or more of the six items above, review and practice the following lesson steps:

No. 1
Lesson Two, Step 1

No. 2
Lesson Two, Step 2

No. 3
Lesson Two, Step 3

Nos. 4 and 5
Lesson Two, Step 4

No. 6
Lesson Two, Step 6

CALIBRATING A GAS-ABSORBING SAMPLING TRAIN

No. 1 _____ Using a 100-ml buret for a bubble meter, calibrate a sampling train that includes a probe, filter, midget impinger (filled), and portable sampling pump with a built-in rotameter. Calibrate for a 1 lpm flow by obtaining an average of three consecutive timings that is 6 ± 1 seconds.

No. 2 _____ Mark the rotameter scale to indicate the calibrated flow rate.

FOR FURTHER STUDY

If you could not perform one or both of the two items above, review and practice the following lesson steps:

No. 1
Lesson Two, Steps 7 through 12

No. 2
Lesson Two, Steps 11 and 12

OPERATING A GAS-ABSORBING SAMPLING TRAIN

No. 1 _____ Set up a blank but do not connect it to a sampling train.

No. 2 _____ Calculate the time the sampling train must be operated to collect 200 liters at a flow rate of 1.5 lpm.

No. 3 _____ Check the amount of absorbing reagent to make sure it does not drop below one-half of the original amount.

No. 4 _____ Rinse the stem of the impingers with 1-2 ml of absorbing reagent after sampling.

No. 5 _____ Cap the impingers or pour the contents into vials with Teflon-lined caps.

No. 6 _____ Measure the temperature to the nearest 1/2° C, and the barometric pressure to the nearest mmHg.

No. 7 _____ Record all pertinent sampling information and label each vial with the necessary identification information.

FOR FURTHER STUDY

If you could not perform one or more of the seven items above, review and practice the following lesson steps:

No. 1
Lesson Three, Step 1

No. 2
Lesson Three, Step 3

No. 3
Lesson Three, Step 4

No. 4 and 5
Lesson Three, Step 5

No. 6
Lesson Three, Step 6

No. 7
Lesson Three, Step 7

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