JOHNS HOPKINS
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Air Sampling for Gases and Vapors

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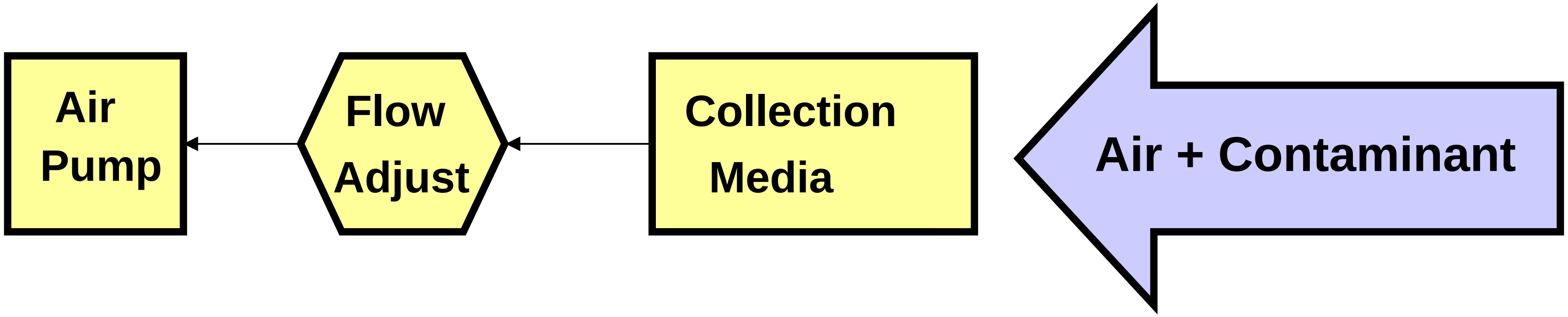
Section A

Introduction

Exposure Assessment Methods

- General air-sampling methodology



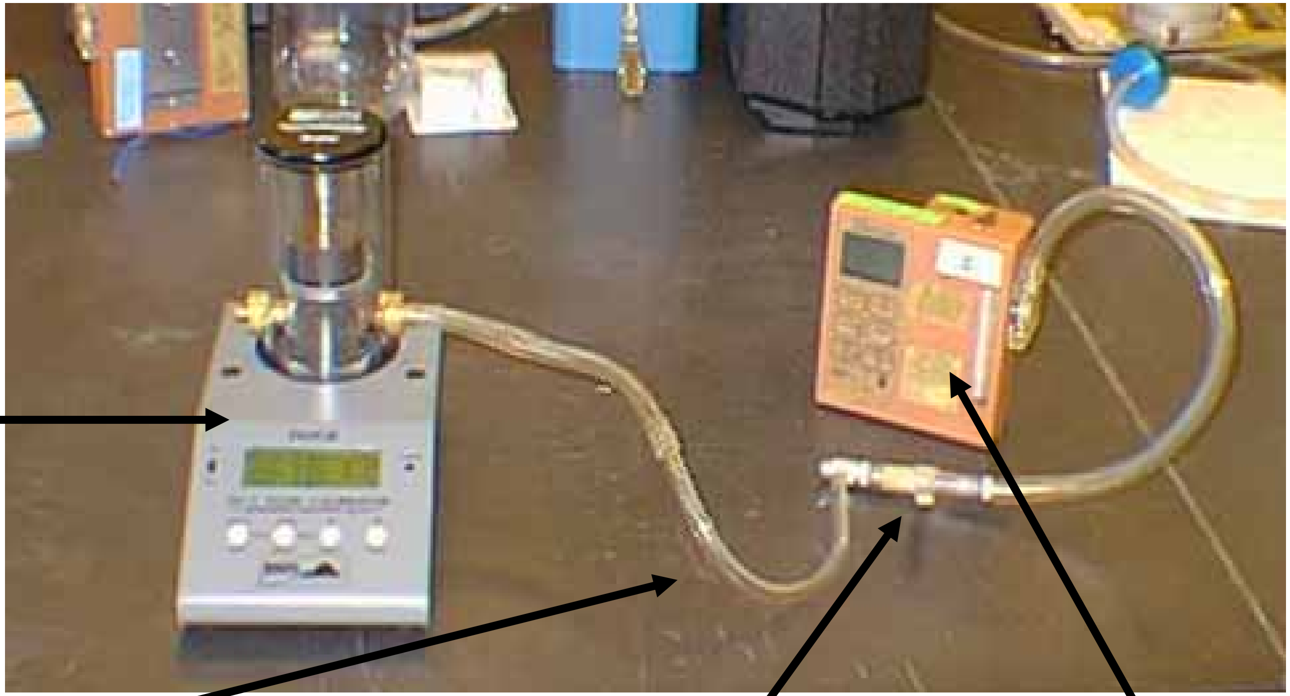
Concentration

$$\text{Concentration} = \frac{\text{Mass}_{\text{contaminant}}}{\text{Volume}_{\text{air}}}$$

- Contaminant mass from laboratory analysis
- Air volume from product of calibrated air flow rate and sampling time

Source: U. S. Government

Charcoal Tube Calibration



Calibrator

Tubing

Charcoal tube Holder

Sampling Pump

Source: Patrick Breysse

Personal Sampling Pumps

Source: Patrick Breysse

Section B

Sample Collection Methods

Sampling for Gases and Vapors

- Absorptive methods
  - *Absorption* is a molecular process by which molecules are homogeneously dispersed in another substance
  - Forming a solution (i.e., requires a liquid sampling medium)
- Methods now mostly obsolete

Continued

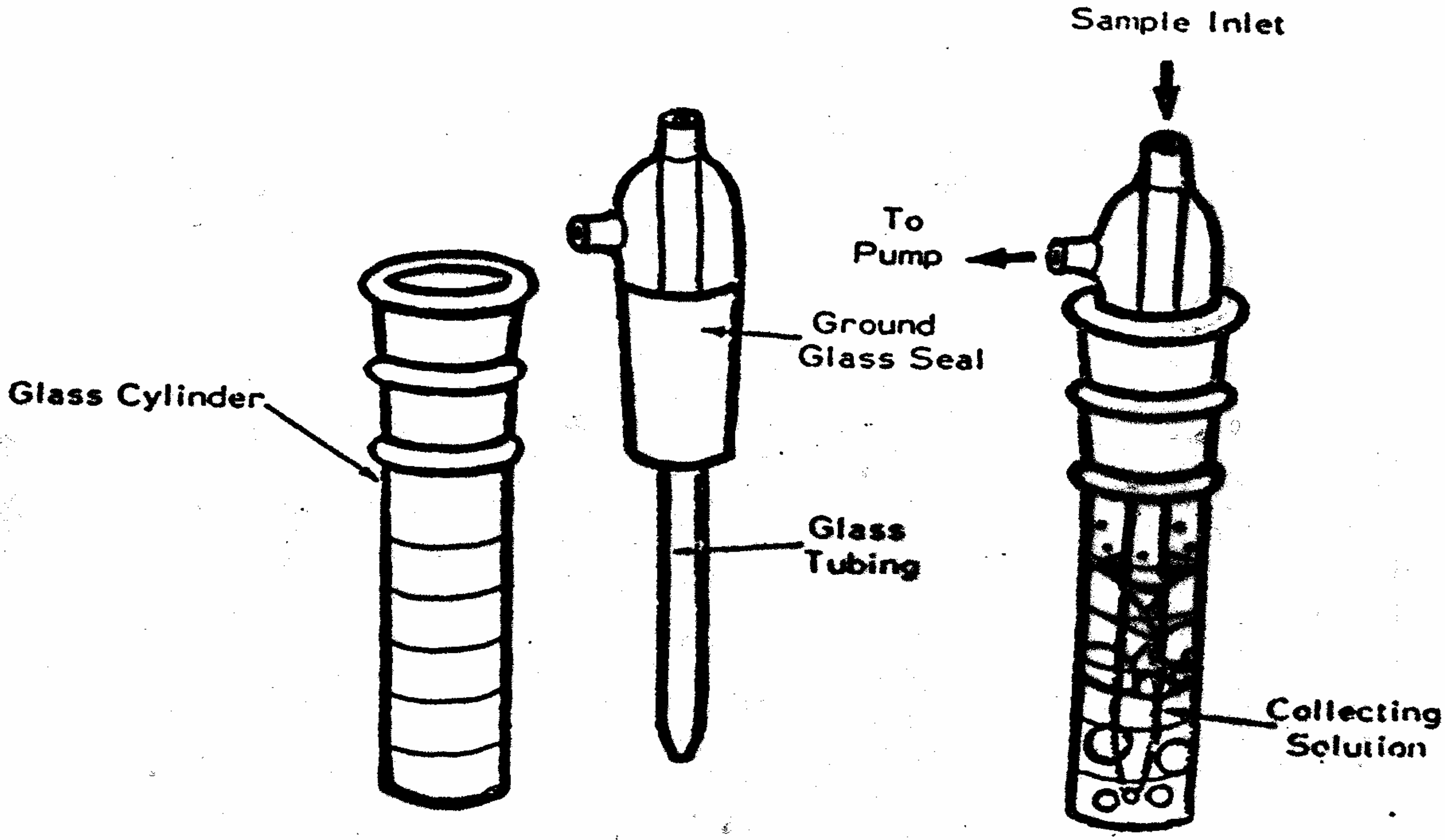
Sampling for Gases and Vapors

- Adsorptive methods
  - *Adsorption* is a molecular process by which molecules are reversibly bound to a surface
  - Bound by intermolecular or van der Waals forces
  - Uses solids as sampling medium
- Most current gas and vapor methods are adsorptive

Absorptive Methods: Impingers

- Contaminant bubbled through absorbent solution
- Solution changes according to analyte
- Analyzed by wet chemical methods
- Messy and unstable; not suited to personal sampling
- Used for gases (NO_2)

Impingers



Source: U. S. Government

Adsorptive Methods

- Gas and vapor molecules “stick” to solid surface
- Highly efficient reversible process
- Contaminant stable for transport
- Many different adsorbents available
- Can be affected by high humidity
- Subject to overload

Continued

Adsorptive Methods

- Some common adsorbent media
  - Activated charcoal: Polar solvents (many hydrocarbons)
  - Silica gel: Non-polar solvents (alcohols and aldehydes)
  - Treated diatomaceous earth
  - Gas chromatographic supports

Adsorbent Tubes

Source: Patrick Breysse

Adsorptive Methods: Charcoal

- Sampling
  - 20–200 ml/min drawn through tube
- Analysis
  - Analyte(s) desorbed (CS_2, or thermally)
  - Typically analyzed using gas chromatography

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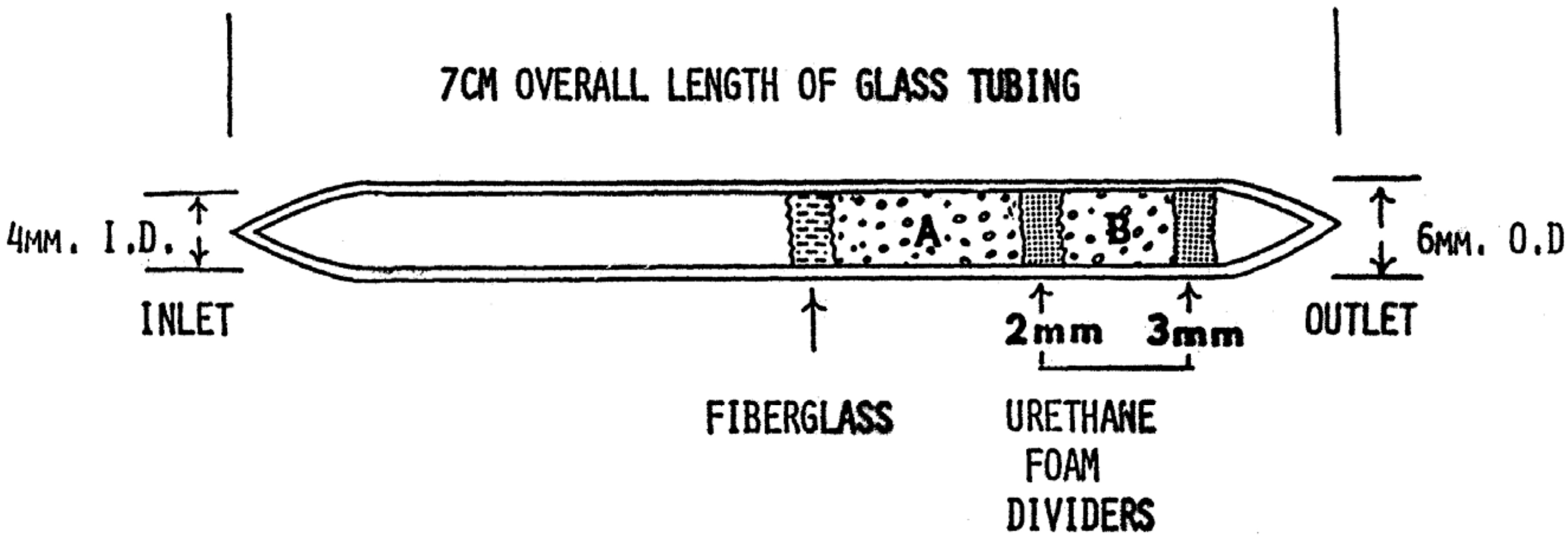
Adsorptive Methods: Charcoal

- Overload
  - >25% on “B” section indicates breakthrough (loss)
  - Discard sample or report as underestimate

Standard Sampling Tube



Direction of flow

Source: U.S. Government

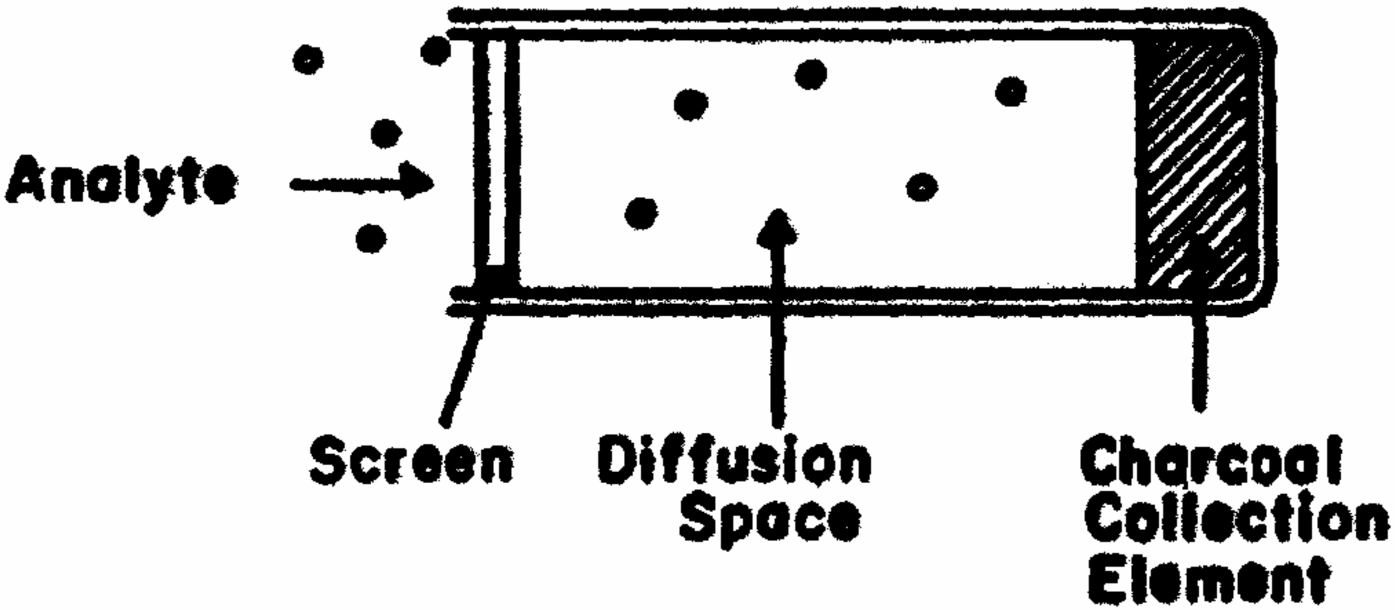
Section C

Passive Sampling Methods

Passive (Diffusive) Sampling

- Passive sampling relies on the natural diffusive energy of molecules to move them to sampling media
- Contaminant flux (mass/sampler area/unit time) is governed by Fick's Law
- Effective flow rates generally 5–30 ml/min
- A variety of designs

Example: Passive Sampler



Source: Peter Lees

Section D

Sample Analysis

Gas and Vapor Analysis

- Numerous methods
  - Spectrophotometric
  - Chromatographic
    - Gas chromatography (GC)
    - High-performance liquid chromatography (HPLC)
    - GC-Mass spectrometry (GC-MS)
  - Wet chemical

Analytical Laboratory

- Choose analytical laboratory before sampling
- Choose standard method
- Know limits of detection
  - Calculate minimum sample volume to be minimally detectable
  - Evaluate breakthrough potential
- Know interferences

Quality Control

- Blanks
  - At least 10% of samples should be blanks
- Spiked samples
  - Whenever possible, submit a "known" or spiked sample

Continued

Quality Control

- Split samples
  - If possible, submit split samples to either the same laboratory or two different laboratories

Section E

Direct-Reading Instruments

Direct-Reading Instruments

- "Real time" measurement of contaminant
- Information saved to data logger
- Subsequent data analysis (mean, min., max., etc.)
- Principle of operation varies
  - Infrared absorption
  - Ultraviolet absorption
  - Electro-chemical method

Continued

Direct-Reading Instruments

- Numerous designs and manufacturers
- Possible uses
  - Walk-through survey (preliminary hypothesis testing)
  - Leak detection
  - Over-exposure alarm
  - Personal monitoring
  - Emergency response

Continued

Direct-Reading Instruments

- Limitations
  - Specific versus non-specific response
  - Must know principal of operation
  - Must know positive and negative interference
  - Must be calibrated often
  - Subject to damage