Air Sampling - Introduction

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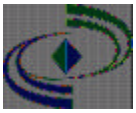
Reasons for Sampling

- Risk assessment
- Compliance testing
- Evaluating controls / plant performance
- Routine monitoring
- Research
  - epidemiology
  - method validation

Some Problems With Sampling

- Variability in exposure
- Sampler location
- Routes of exposure
- Worker behaviour
- Worker acceptability

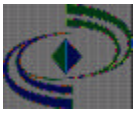


Background Survey (Anticipation)

- Familiarisation with process
  - review of literature including trade association and engineering publications
  - consultation with site management and industrial hygienists
- Review of pertinent records
  - generate a basic demographic description by reviewing personnel and industrial hygiene records at the site
- Review of toxicity of materials and products
  - relevant toxicological, medical, and industrial hygiene literature

Preliminary Survey (Recognition)

- Observation of work procedures
  - Individual work practices, methods, and workplace layout
- Preliminary measurements
  - using portable, direct-reading instruments
  - e.g. gas and vapor concentrations, noise levels
  - ventilation systems evaluated during the walk-through survey
- Study of existing controls
  - enclosures
  - local exhaust ventilation
  - personal protective equipment
  - hygiene practices

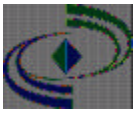


In-Depth Survey (Evaluation)

- Goal of survey
  - Regulatory, health, and other
- Selection and preparation of sampling methods
  - contaminants to be measured
  - objectives
  - location of the sampler
  - duration of the sample period
  - available analytical methods
- Design of survey
  - why the survey is being conducted (compliance or routine)
  - who to sample
  - how long to sample (from minutes up to full-shift)
  - how many samples need to be collected

In-Depth Survey (Evaluation) *(continued)*

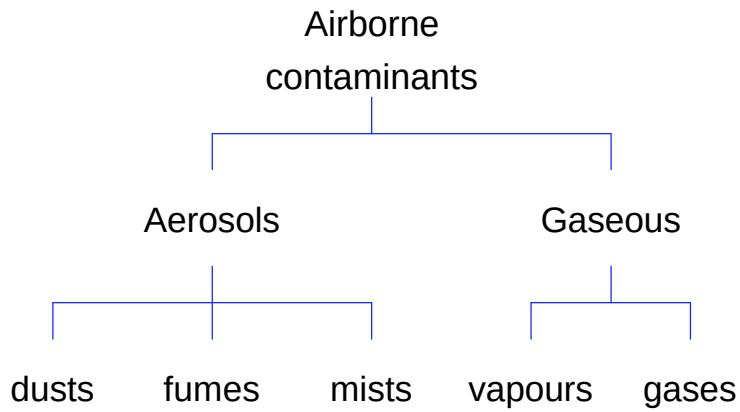
- Conduct of survey
  - preparation of sampling equipment and media before the beginning of the work shift
  - placing samplers on workers or stationary locations
  - observing the work site during the sampling period
  - collection of samplers and preparation of samples for analysis
- Analysis of samples
  - must be properly sealed and protected during transportation to the analytical laboratory
- Interpretation of data
  - measurement results
  - available limits
  - observations
  - guidance / good practice



Sampling train

- Sampling medium
  - captures contaminant
  - filter, adsorbent, solution
- Holder
  - determines what is captured
- Pump
- Flow measurement device
  - external
  - measure flow before sampling medium

Physical Forms of Airborne Contaminants

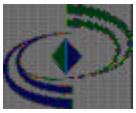


Sampling Aerosols

- Filter
- Sampling "head"
- Pump
- Flow calibration

Common Filter Types

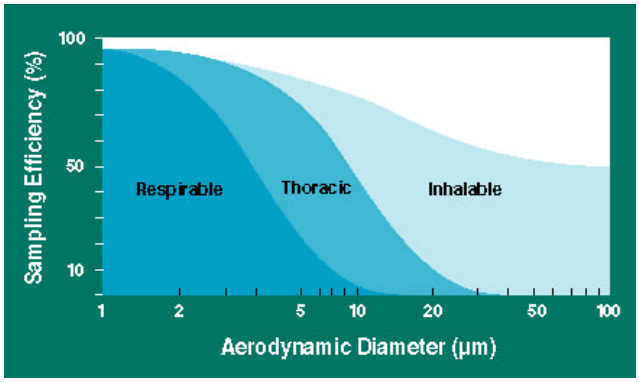
- Glass Fibre
  - gravimetric
- Membrane
  - metals
  - fibres (gridded cellulose ester)
  - mineral dusts
- Silver Membrane
  - best type when XRD or XRF analysis required
- Nucleopore
  - electron microscopy



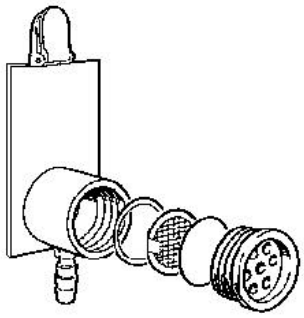
Sampling for particulates

- MDHS 14
- Total inhalable
- Respirable
  - fibres
  - non-fibrous

ISO Criteria



Total inhalable dust



7 hole head

IOM head

Operate at 2 litres/minute

Respirable dust

- Crystalline silica, talc, cadmium sulphide
- Cyclone elutriator
- Membrane filter
- Flow rate
  - 2.2 litres/minute
- Analysis
  - gravimetric - total respirable dust
  - XRD - silica

Respirable Dust

Fibre Sampling

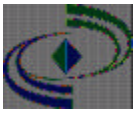
- Cowled, open face sampling head
- Gridded cellulose ester filter
- Filter cleared with acetone vapour
- Fibres counted under microscope

Analytical Methods - Particulates

Contaminant	Method
Total inhalable or respirable	▪ gravimetric (MDHS 14)
Metals and metal compounds	▪ atomic absorption spectroscopy (AA) ▪ inductively coupled plasma - atomic emission spectroscopy (ICP_AES) ▪ X-ray fluorescence (XRF)
Crystalline silica (and some other minerals)	▪ X-ray diffraction (XRD)
Asbestos and MMMF	▪ optical microscopy ▪ electron microscopy

Gravimetric Analysis

- Handle only with tweezers
- Condition filters
- Eliminate / minimise effects of
  - humidity
  - static
- Minimise losses due to
  - sample handling
  - internal losses
  - filter damage



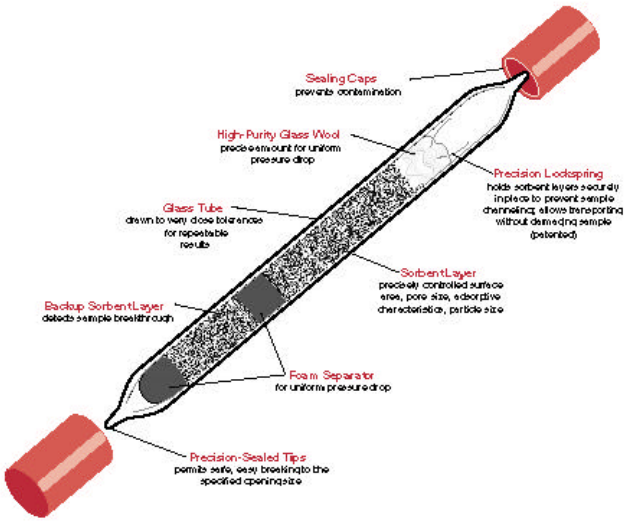
Sampling for Gases and Vapours

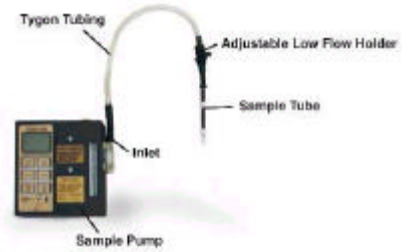
- Adsorption
- Absorption
- Treated filters
- Diffusive sampling
- Direct reading instruments
- Indicator tubes

Colorimetric Indicator Tubes

- Advantages
  - quick
  - easy
  - instant result
- Disadvantages
  - accuracy
  - not personal sampling
  - specificity

Adsorption Tubes





Adsorption

- Activated carbon
  - many organic solvents and other compounds
  - solvent desorption
- Silica gel
  - alcohols and other polar organic compounds
  - acid gases and mists
- Porous polymers
  - e.g. Tenax, Chromosorb, XAD
  - where thermal desorption required

Passive Sampling

- Does not use pump
- Holds sorbent
- Uptake by passive diffusion

Absorption Train

- Bubblers
- Impingers
- Gas dissolves or reacts with liquid sorbent
- Difficult to use for personal sampling

Examples of Liquid Sorbents

Gas / Vapour	Sorbent	Analysis
Aldehydes	MBTH	Spectrophotometry
Amines	H Cl in isopropanol	Spectrophotometry
Ammonia	Dilute sulphuric acid	Spectrophotometry
Chlorine	Methyl orange	Spectrophotometry
Formaldehyde	Water	Chromatropic acid
Nitrogen dioxide	Napthyl ethylanadiamine	Colour reaction
Ozone	Potassium iodide	Titration
Sulphur Dioxide	Tetrachloromercurate	Spectrophotometry
Isocyanates	1-methoxyphenyl-piperazine in dry toluene	HPLC

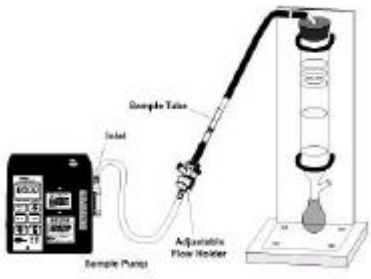
Bag Sampling

Sampling - Practical Aspects

- Calibration
- Referencing samples
  - labelling
  - assign unique number
  - chain of custody
- Avoid / Minimise losses
  - sample handling
  - storage
  - transport
- Quality Control
  - field blanks
  - analytical QC/QA

Calibration

- Primary flow measurement devices
  - bubble flow meter
- Secondary flow meters
  - rotameters



Direct Reading Instruments

Instrument	Application
Infra red	Organic vapours
Flame ionisation detector (FID)	Organic vapours (non-specific)
Photo-ionisation detector (PID)	Organic vapours (non-specific)
Paper-tape (colorimetric)	isocyanates, specific inorganic gases (e.g.. SO_2, NH_3, HCl)
Electrochemical cells	specific inorganic and organic gases
Ultra-violet	Mercury vapour
Light scattering	Dusts (semi-quantiative)
Colorimetric tubes	Wide range of inorganic gases and inorganic vapours plus some mists