MODULE- V

AIR QUALITY SAMPLING AND MONITORING

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Contents…

Stack sampling, instrumentation and methods of analysis of SO_2, CO etc, legislation for control of air pollution and automobile pollution.

Air Quality Sampling and Monitoring…

What is air quality?

- ✓ complicated by a lack of knowledge as to what is "clean" and what we mean by quality
- ✓ main reason for air pollution control programs is to protect public health - define air quality based on its effects on people and the environment
- ✓ effects of air pollution are chronic and not immediately obvious

- Measurements of air quality generally fall into three classes:
  - **Measurements of Emissions** - also called **source sampling** - when a particular emission source is measured, generally by on the spot tests
  - **Meteorological Measurement** - Measures meteorological factors that show how pollutants are transferred from source to recipient
  - **Ambient Air Quality** - Measures the quality of all the air in a particular place. Almost all the evidence of health effects is based on these measurements

- Also now have:
  - **Industrial Hygiene sampling** - for testing the air quality inside of factories and places of work
  - **Residential Indoor sampling** - to evaluate the quality of air in living spaces

Air Sampling Techniques

- ✓ Most air pollution monitoring equipment performs the act of sampling and analysis in one action = real time measurement

- ✓ older equipment = intermittent sampling (time lag between when the sample was obtained and when data was available)

- ✓ Almost all gaseous pollutants are monitored by real time analysis - Particulate pollutants are still mostly monitored by intermittent sampling, even though real time methods are available

Air Sampling Techniques

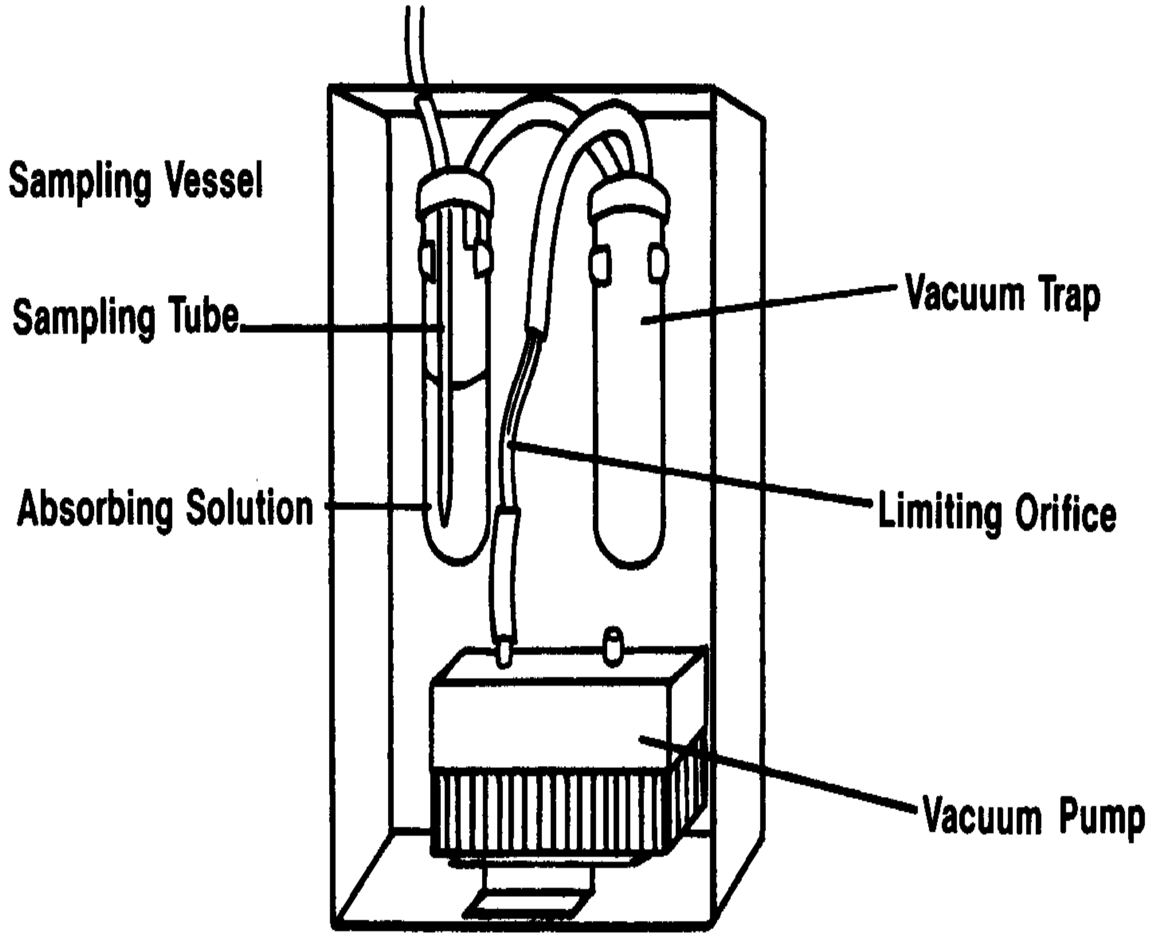
- When obtaining a sample for air pollution analysis
  - should be sufficient sample for analysis. Most pollutants ,very low levels and require a large volume of gas for accurate measurement
  - pollutants in very small quantities are easy to contaminate. Take care to purge sampling containers if grab samples are used
  - Collection and analysis limitations may require collection over extended periods means data may only be a 24 hr avg.
  - real time produces so much data - are often set to give hourly avg. to make data more understandable

Air Sampling Systems

- ✓ require gases or particles to be drawn to the surface of a collecting medium or a sensor
- ✓ sampling trains, which may include a vacuum pump, vacuum trap, a flow regulator and a collecting device or sensing unit
- ✓ Sampling trains for gases may also utilize filters to present particles from entering the collection unit

Air Sampling Systems

Impingers



Air Sampling Procedures

- ✓ conducted by static, grab, intermittent or continuous procedures
- ✓ first air monitoring used **static sampling** - simple and cheap – requires days for data e.g. deposit gauge
- ✓ **Grab sampling** not commonly used to monitor ambient air quality – uses bladders of syringes

Site Selection

- **General Requirements for Site Selection**
  - purpose of monitoring
  - number and type of instruments required
  - duration of measurements
  - best available general guide comes from AS2922
  - should be easily accessible

Meteorological Monitoring

- changing weather conditions can produce dramatic changes in air quality and ambient pollution levels
- Factors such as:
  - wind dispersion rates (velocity and direction)
  - temperature inversions
  - photochemical reactions, and
  - rain

Choice of Monitoring Equipment

- For almost every type of air pollutant there are several different acceptable methods of analysis
- The type of equipment and methodology used for analysis may be determined by many factors such as
  - cost
  - the number of data points required
  - the purpose for which the data are being used
  - the time interval required between data points
  - the devices power requirements
  - the type of air pollutant, and
  - the environment in which the monitoring equipment is being placed

Calibration Procedures

- ✓ When a device uses airflow input need to calibrate the airflow system
- ✓ involves using a device or a pre-calibrated gas flow meter to check on the ambient airflow into the device
- ✓ All devices MUST be calibrated according to manufacturer's spec's in maintenance manual - times and results of these MUST be kept in the instrument logbook

Calibration Procedures

- ✓ two types of calibration procedures commonly used on air monitoring equipment – static methods and dynamic methods
- ✓ **Static methods** - involve a simple one point electrical or chemical test
- ✓ **Dynamic methods** - based on generating a flowing stream of calibration gas – which is used to calibrate the whole instrument = preferred method for calibration

Data Handling

- ✓ range from the simplest manual methods to very sophisticated electronic devices
- ✓ **Manual methods** - use field data sheets or log books, where all parameters are entered manually – not suitable for remote sites
- ✓ **Data loggers** - electronic devices that store many data points in an electronic memory. They can be attached to a device and accumulate the data for long periods of time if required

Reference Methods

- ✓ consider only those which are Australian Standards or where no Australian Standards exists US EPA Methods
- ✓ **first generation devices** - low cost unpowered devices - require long time to accumulate data e.g. deposit gauge
- ✓ **second generation devices** - powered and require small amounts of time to produce data e.g. high volume sampler
- ✓ **third generation devices** - produce instant (continuous data) e.g. nephelometer, gravimetric microbalance, remote UV-visible detectors and remote infra red sensors

Source Sampling

- ✓ some sources are monitored continually with automated instruments (real time analysers)

- ✓ manual sampling techniques and testing are often required e.g. Pitot Probe

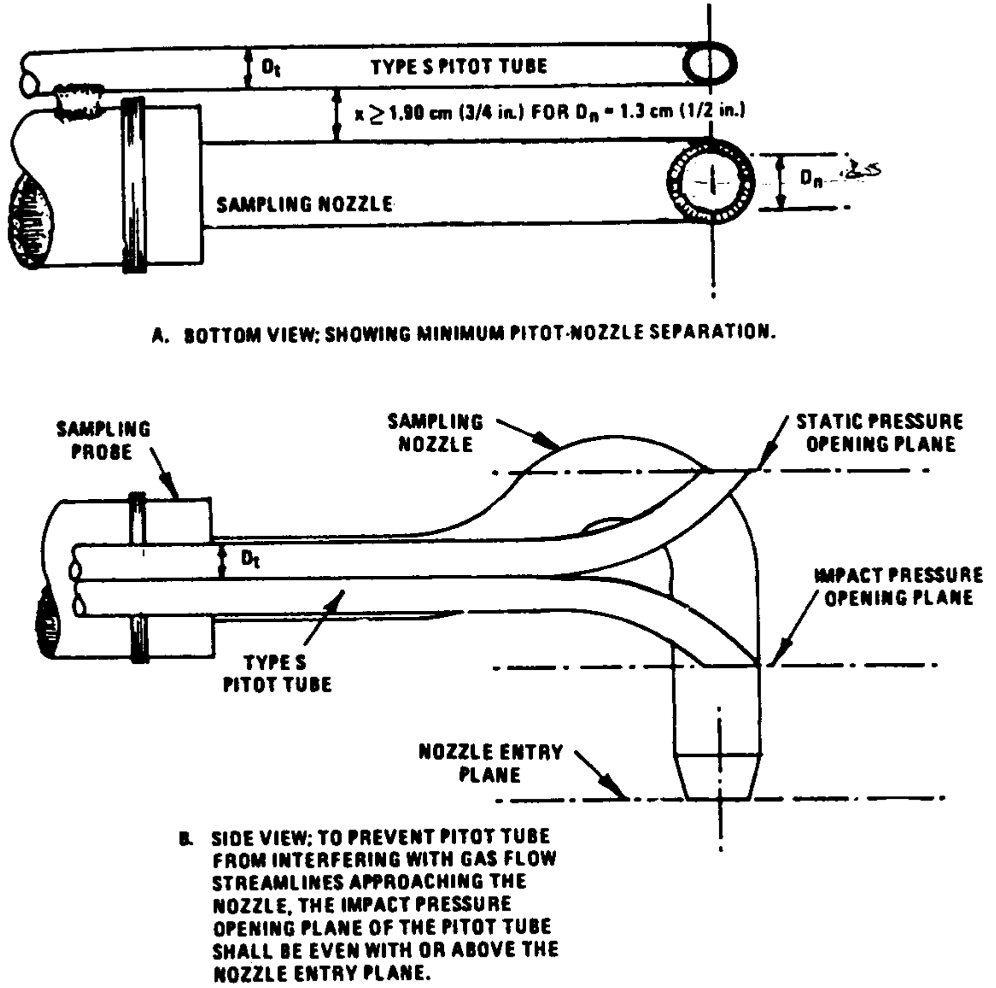
Source Sampling

- ✓ introduce a probe into a waste gas stream flowing in smokestack - probe withdraws sample of waste gas, which is analysed in laboratory
- ✓ Gaseous pollutants collected by absorption in impingers, adsorption on charcoal or other media, or condensation in collecting traps
- ✓ Particulate matter be collected by a variety of techniques including wet scrubbing, filtration, impaction, and electrostatic precipitation

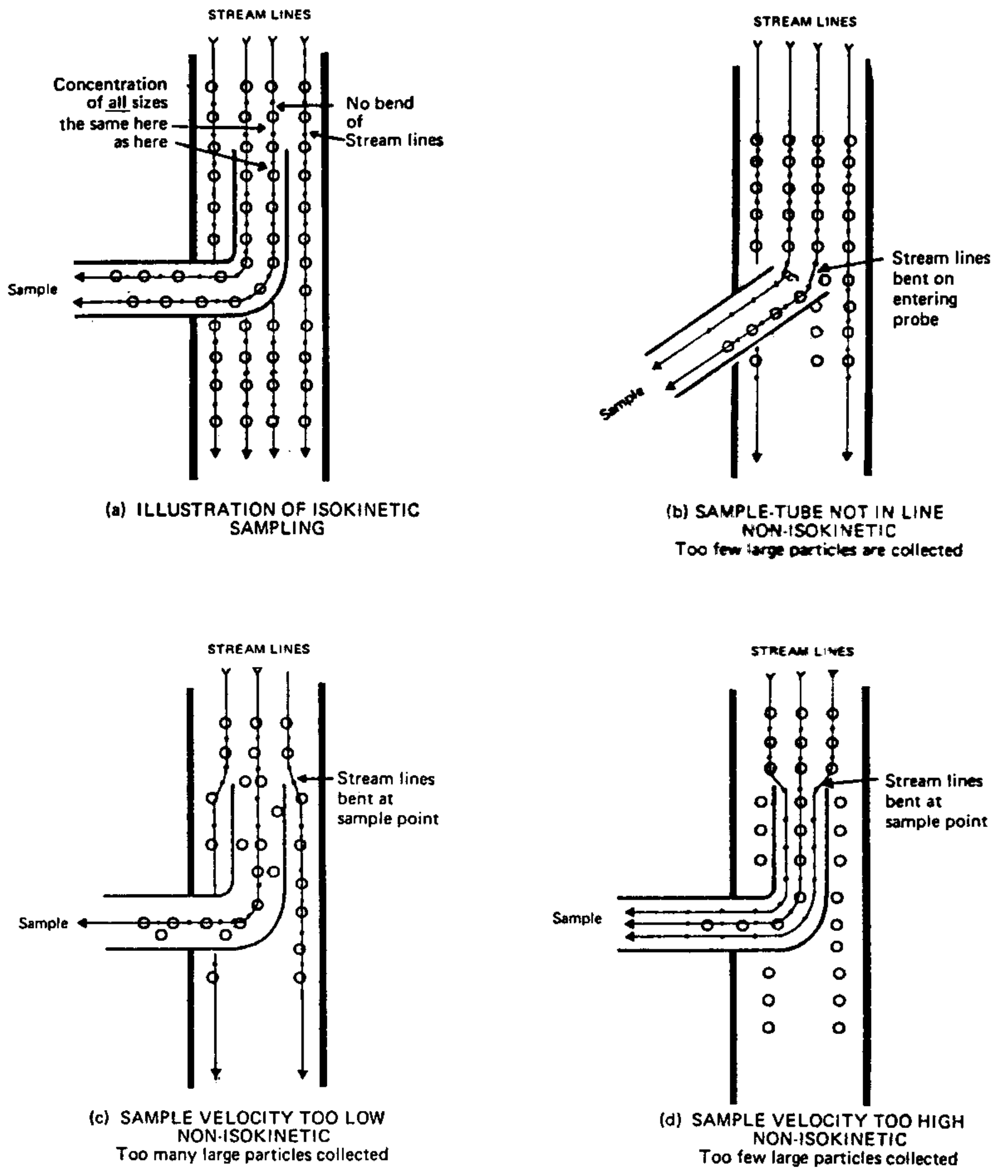
Stack Sampling

- ✓ emissions associated with combustion, velocity and temperature may be much higher than ambient conditions - measure to correct to standard conditions
- ✓ Velocity data determined from pressure measurements utilising a **pitot-tube** are necessary to calculate mass loading to the atmosphere, i.e., plant emission rates
- ✓ requires airflow through the sampling probe to be at the same rate as that flowing in the waste gas stream **isokinetic**

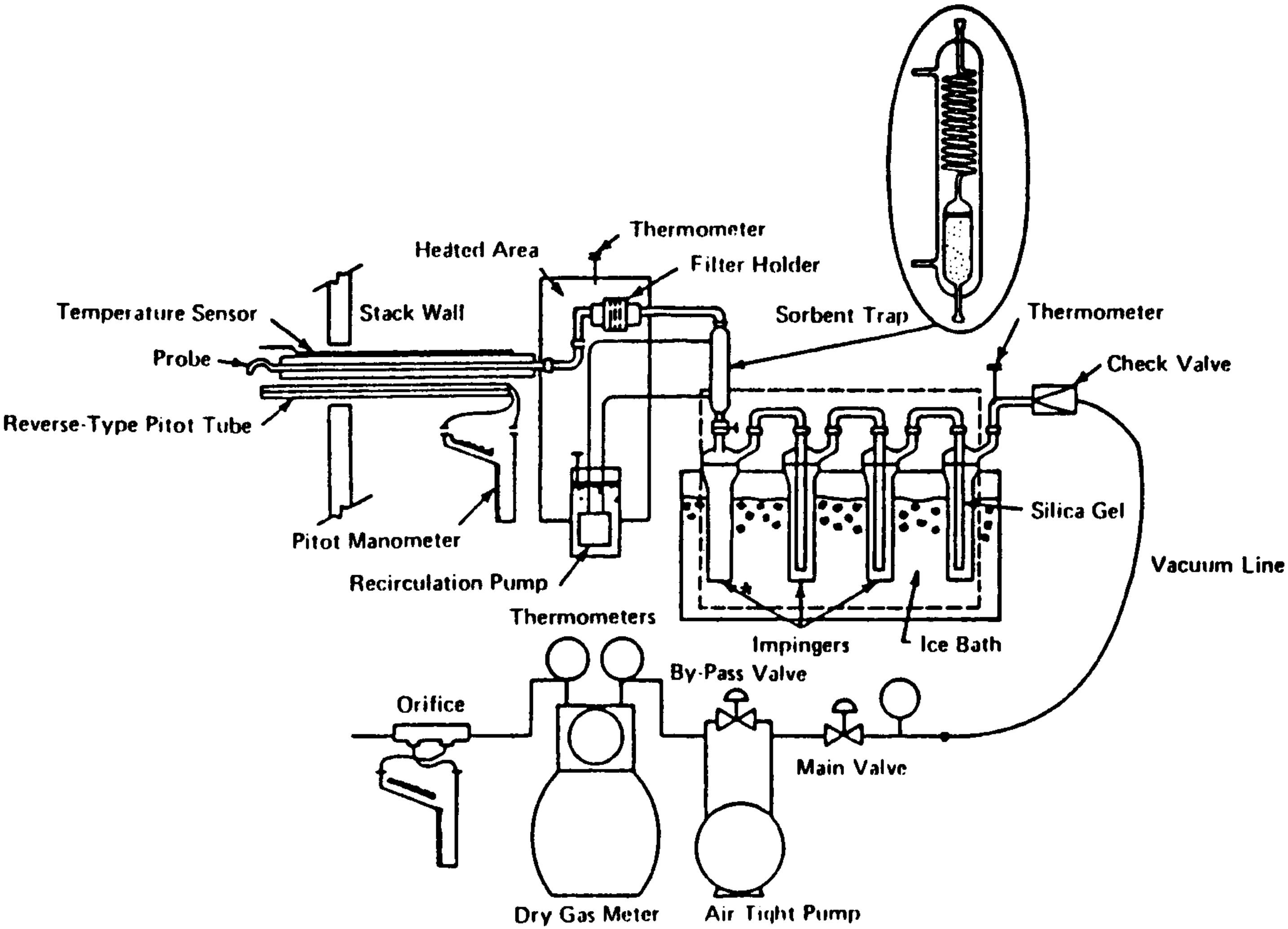
Air Quality Measurement



Air Quality Measurement



Air Quality Measurement

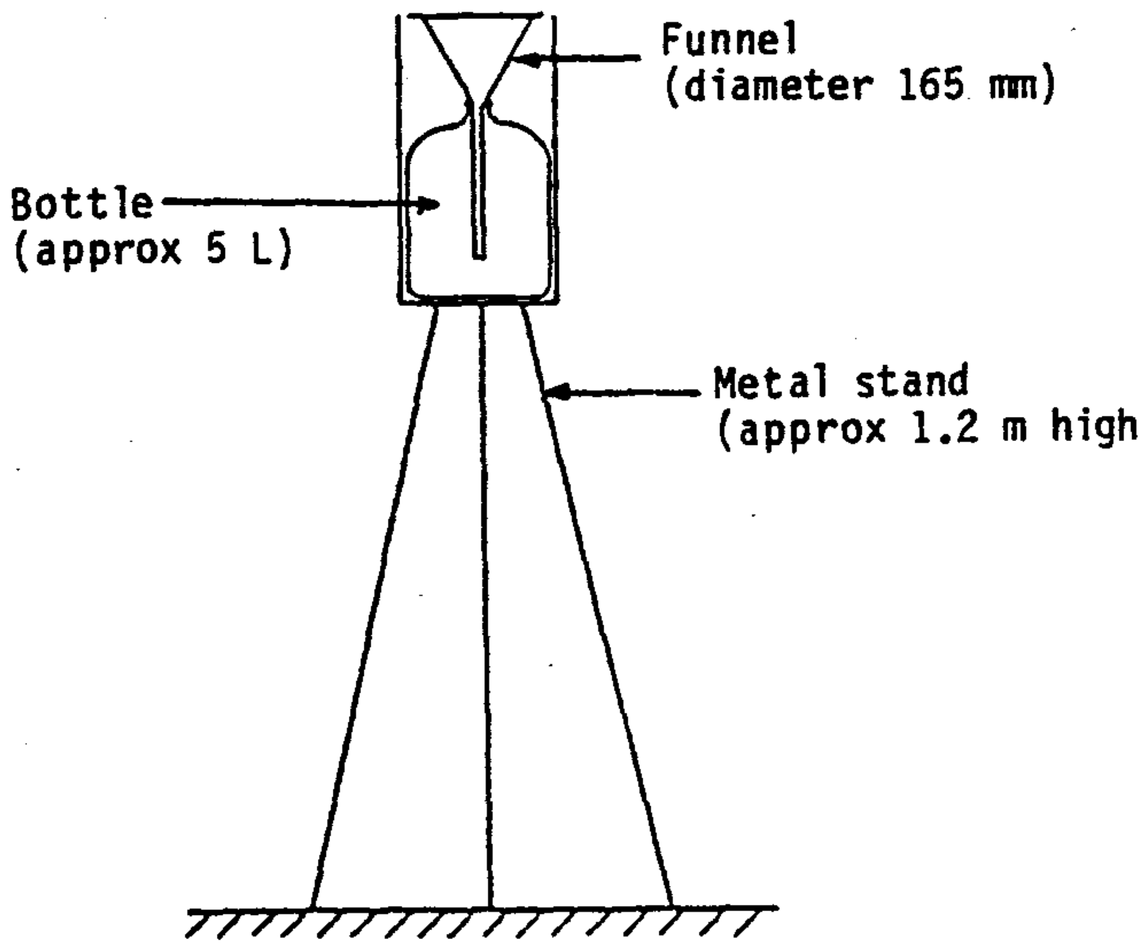


Real Time Analysis

- ✓ Several methods provide real time analysis, the most popular is remote UV detection for SO_2

Particulates – Deposit Gauge

- ✓ involves simple collection of dust that settles to the earth by gravitation
- ✓ generally over a period of 30 days - 1 data point per month (See AS3580.9 for details)
- ✓ suffer from many problems (uncooperative pigeons and drunks who can't find anywhere else to go)


Funnel
(diameter 165 mm)
Bottle
(approx 5 L)
Metal stand
(approx 1.2 m high

Particulates – Hi Vol Sampler

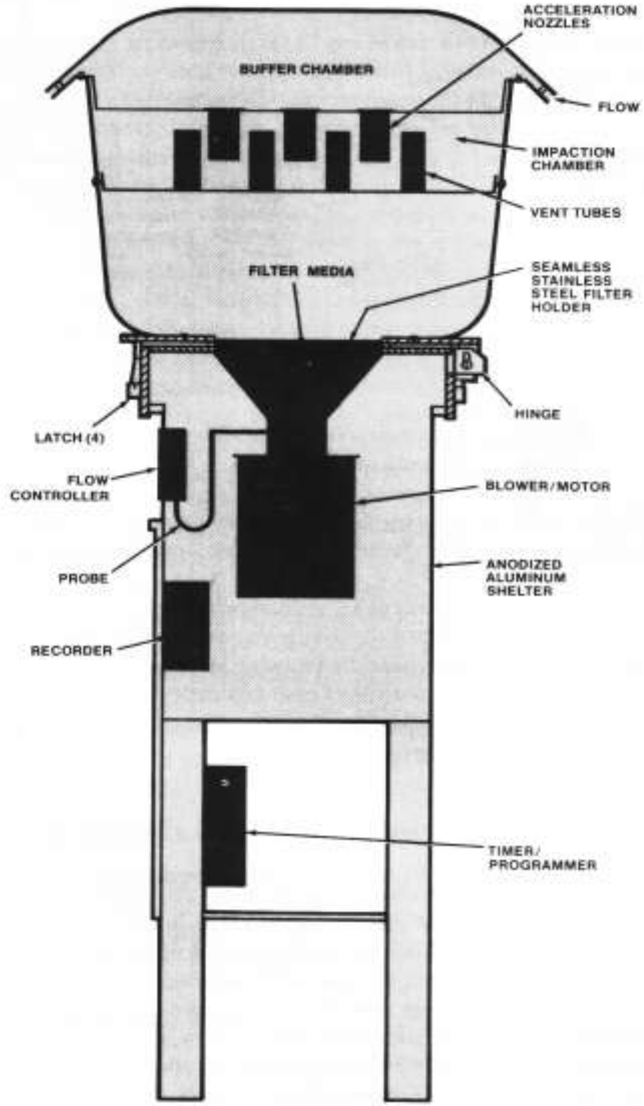
- ✓ most commonly used particle sampling method
- ✓ analysis is gravimetric - filter is weighed before and after the analysis on an analytical balance, and difference is particulates collected
- ✓ A standard high volume sampler collects particles in the size range from 0.1 - 100µm

Particulates – Hi Vol Sampler

- ✓ airflow is measured by a small flow meter (calibrated in m^3 air/minute)
- ✓ particulate concentration measured is referred to as the **Total Suspended Particles** (TSP), = combination of Settleable particles and suspended particles
- ✓ expressed as $\mu g/m^3$ for a 24hour period – normally as part of 6 day cycle

Particulates – Hi Vol Sampler

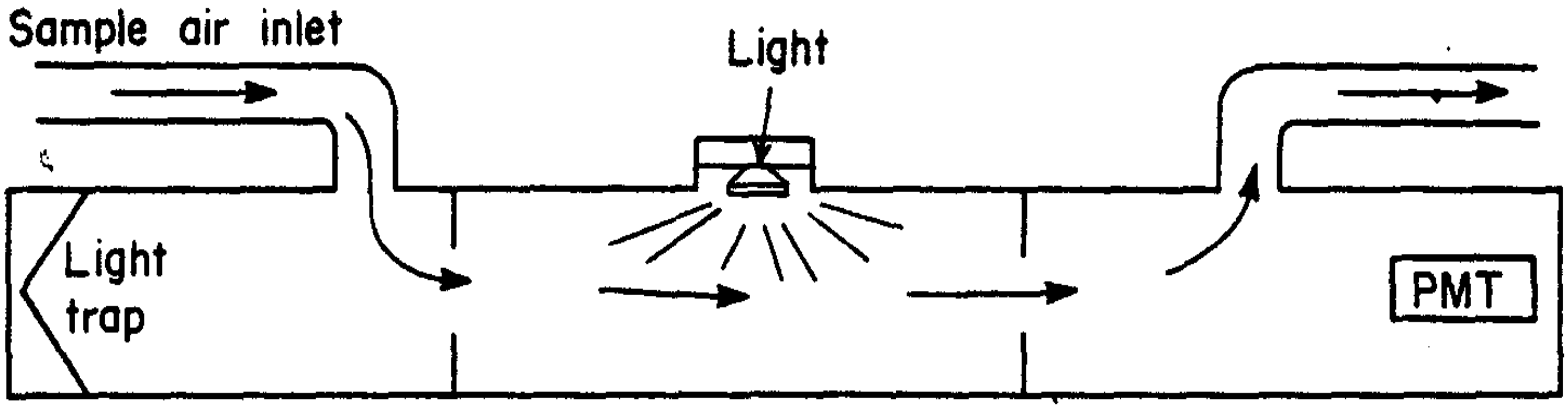
- ✓ More information and the correct operating procedures on high volume samplers is available in **Australian Standard AS3580.10 - 1990**
- ✓ PM_{10} and $PM_{2.5}$ high volume samplers –only collect particles with aerodynamic sizes of 10µm or less, or 2.5µm or less
- ✓ recognised by PM_{10} head, which looks like a cross between a flying saucer and an overgrown wok!



ACCELERATION NOZZLES
BUFFER CHAMBER
FLOW
IMPACTION CHAMBER
VENT TUBES
FILTER MEDIA
SEAMLESS STAINLESS STEEL FILTER HOLDER
HINGE
LATCH (4)
FLOW CONTROLLER
BLOWER/MOTOR
ANODIZED ALUMINUM SHELTER
PROBE
RECORDER
TIMER/ PROGRAMMER

Particulates – Nephelometers

- ✓ devices which use the scattering of light to measure the size and number of particles in a given air sample
- ✓ best used to determine the amount of particulate matter in different size fractions
- ✓ usually used to examine the amount of particulate material in the 0.1 – 2.5μm size range – that which presents the greatest risk to human health


Sample air inlet
Light
Light
trap
PMT

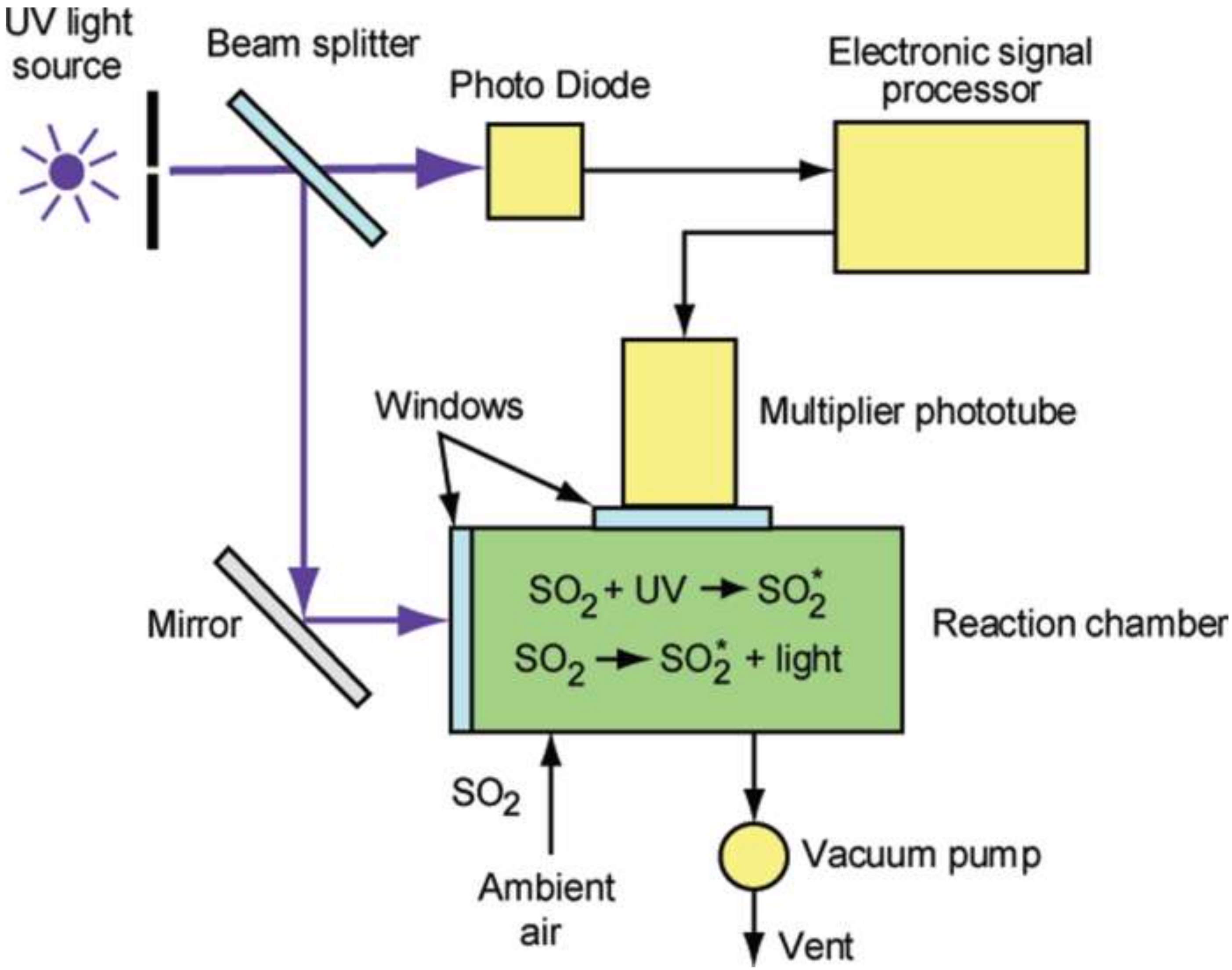
Gases – Sulfur Dioxide

- ✓ many methods available for determination of SO_2
- ✓ **AS3580.4.1 - 1990.** appropriate for SO_2 0-5ppm
- ✓ permits the use of any of the following detection methods;
  - UV fluorescence analyser
  - flame photometric detector (with or without gas chromatograph)
  - electrochemical (coulimetric detector)
  - most widely used method in this country is the **UV fluorescence analyser**

Gases – Sulfur Dioxide

- ✓ UV Fluorescence = air sample drawn into a scrubber chamber (removes PAH) and then on into an irradiation chamber where it is exposed to UV light
- ✓ SO_2 absorbs in 190-230nm
- ✓ The amount of fluorescent radiation is directly proportional to the concentration of SO_2

Measurement of sulphur dioxide (SO_2) by UV fluorescence



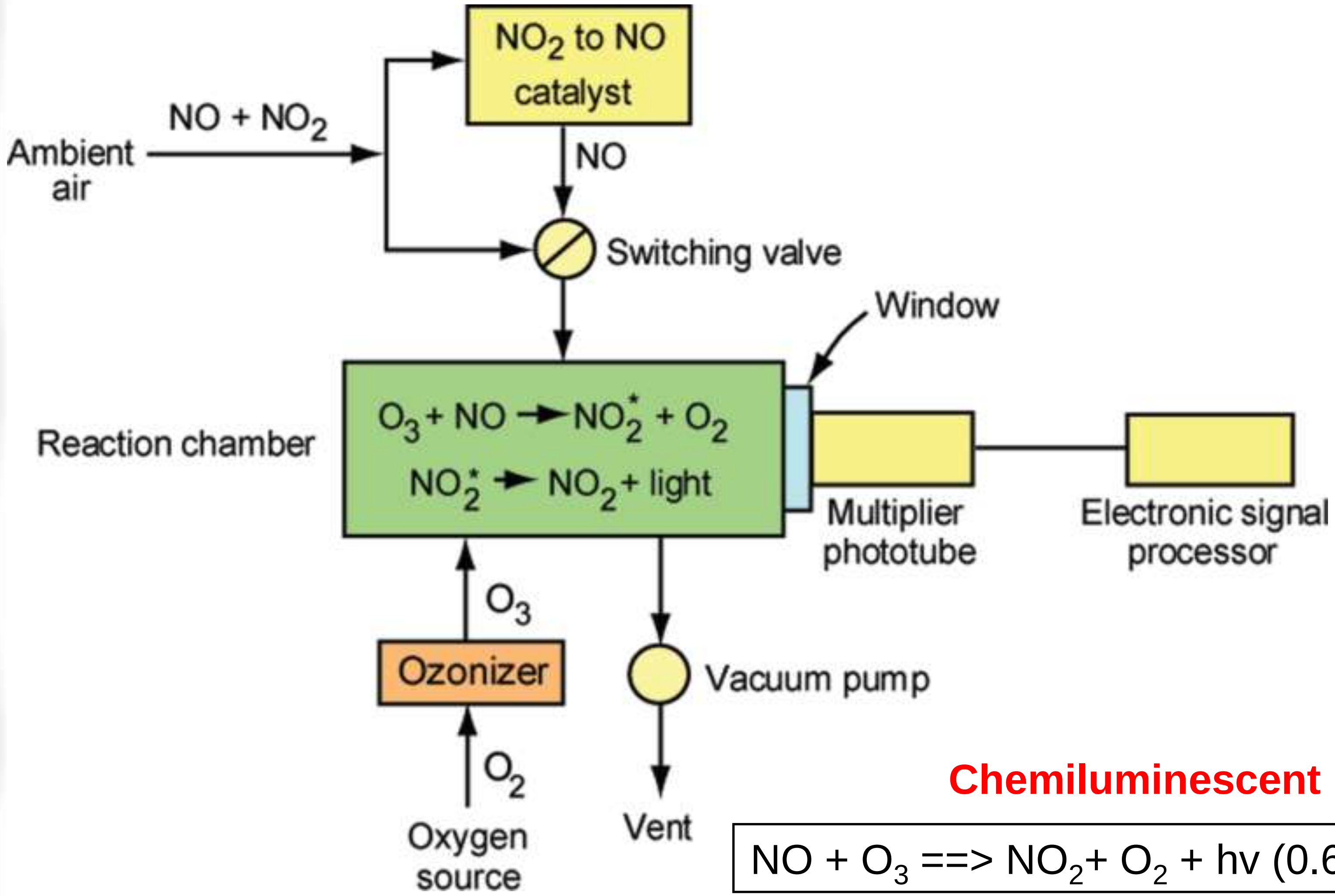
Gases – Sulfur Dioxide

- ✓ $SO_2 + UV \longrightarrow SO_2^*$
- ✓ $SO_2^* \longrightarrow SO_2$ + light

Gases – Oxides of Nitrogen

- ✓ determined using **chemiluminescence**
- ✓ specific for NO, but total oxides of nitrogen determined by passing sample over a catalyst to convert NO_2 to NO
- ✓ suitable for ambient air containing NOx (NO and NO_2) at levels less than 1 mL/m^3

Measurement of nitric oxides (NO_x) by chemiluminescence



Chemiluminescent reaction

$NO + O_3 ==> NO_2 + O_2 + h\nu$ (0.6 – 3 μm)

Gases – Oxides of Nitrogen

- ✓ reaction of NO with ozone in a dark enclosed chamber to produce light - detected by a pmt
- ✓ Provided the ozone is present in excess the light output is directly proportional to the concentration of NO

- ✓ $NO + O_3 \longrightarrow NO_2^* + O_2$
- ✓ $NO_2^* \longrightarrow NO_2 + h\nu$ (light)

Gases – Ozone

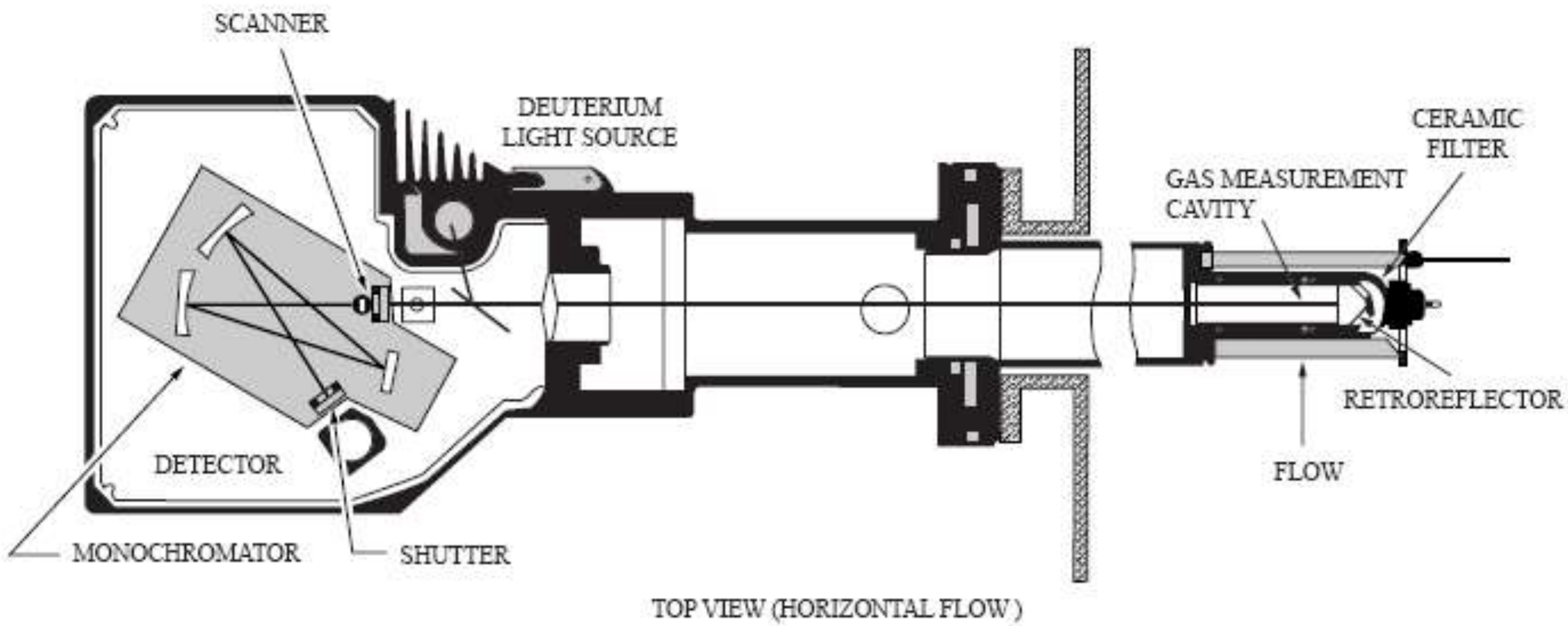
- ✓ determined either by chemiluminescence methods or direct reading UV detectors. **AS3580.6 - .6.1 - 1990**
- ✓ sample drawn into a mixing chamber mixed with a stream of ethane - causes a chemiluminescent reaction and the subsequent emitted light at about 430nm
- ✓ direct reading UV method - stream of gas in the sample is drawn through a flow cell where it is irradiated with UV light at 254nm

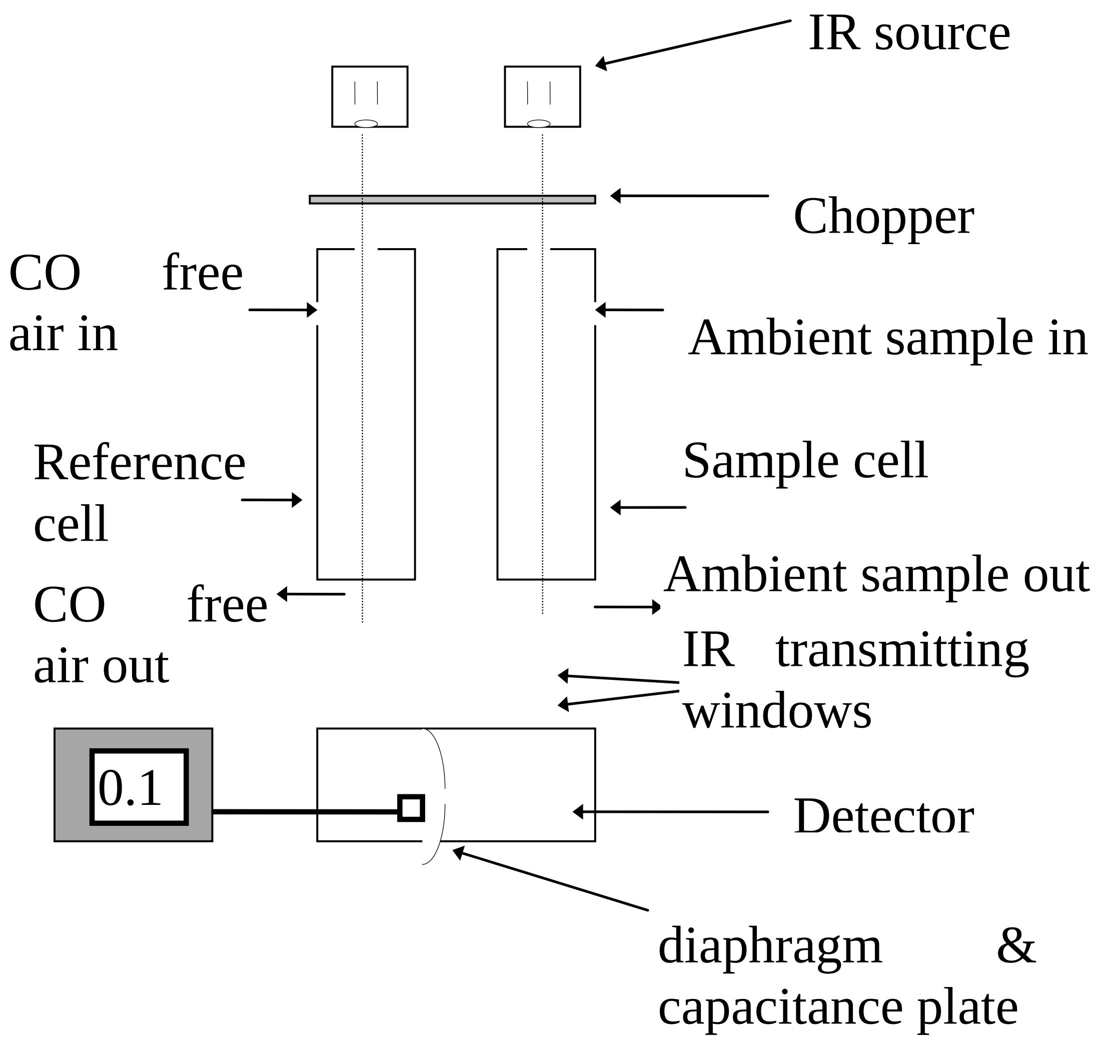
Gases – Carbon Monoxide

- ✓ non-dispersive infra red (NDIR) devices, suitable for detection from 0-500ppm by volume
- ✓ sample through a flow cell in the instrument where it is irradiated with infrared radiation
- ✓ essentially just a modified dual beam infrared spectrophotometer

Measurement of carbon monoxide (CO) by IR photometry

Schematic of a NDIR head




IR source
Chopper
CO free air in
Ambient sample in
Reference cell
Sample cell
Ambient sample out
CO free air out
IR transmitting windows
0.1
Detector
diaphragm & capacitance plate

Gases – Non-methane H/C

- ✓ essential to discriminate between methane and other H/C's, as it is the only hydrocarbon that naturally occurs in large amounts in the atmosphere - remember those cows & termites!
- ✓ feed a continuous stream of gas sample into a GC with a FID
- ✓ hand held field gas chromatographs now available which allow sampling and analysis to be done in the field – eliminating sampling error

Gases – Fluoride

- ✓ **AS2618.2-1984** which is suitable for determining levels of 0.1μg/m3 or greater
- ✓ automatic sampler draws ambient air through an inlet tube which passes it through an acid impregnated paper tape (initial filter tape) to collect particulate fluorides and then through an alkali-impregnated paper tape (final filter tape) to collect acidic gaseous fluorides
- ✓ New methods impinge the gas and use F^- ISE

Gases – Hydrogen Sulfide

- ✓ Automatic Intermittent Sampling Gas Chromatographic Method as outlined in **AS3580.8.1 - 1990**
- ✓ applicable to ambient air with H2S concentrations in the range 0.003 - 2ppm and is totally specific
- ✓ GC is designed to sample air automatically at least ten times per hour

LEGISLATION FOR CONTROL OF AIR POLLUTION

According to the Environment Protection Act of 1986, Environment is that which includes the "inter-relationship which exists among and between water, air, and land and human beings, other living creatures, plants, micro-organism and property."

The Air (Prevention And Control Of Pollution) Act, 1981

- This Act was passed for the "prevention, control and abatement of air pollution."
- This law defined an air pollutant as "any solid, liquid or gaseous substance present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment."

- In this Act, power to declare air pollution, control areas has been given to the state government after consulting the State Board.

- By this, it may control or even prohibit burning of certain materials in those specific areas.

- This Act requires approval prior to operating any industrial plant.

- Government may suggest “control equipment” prior to giving its consent to any industry for its operation.

- It may include chimney etc. In case there is any new technology for emission control, then the Board may insist on this to being installed.

- Standards specific to industries have been specified.

- Penalties were for a minimum of six months imprisonment to a maximum of seven years and fine up to Rs. 5,000 for every day during which contravention continues after conviction for the first such contravention.

- This law makes it clear that when offenses are committed by a company, its director, manager, secretary or other officers could be held guilty and punished accordingly.

Ambient Air quality Standards

- NAAQM network is operated through NEERI and CPCB

- Ambient Air Quality Status is described as Low **(L),** Moderate **(M),** High **(H)** and Critical **(C)**

- 2 types of NAAQS: primary and secondary

NAAQS

POLLUTANTS	Time Weighted Average	Concentration of Ambient Air			
		Industrial Area	Residential Rural and other area	Sensitive area	Method of Measurement
Sulphur Dioxide (SO_2)	Annual Average 24 hours	$80\mu g/m^3$ $120\mu g/m^3$	$60\mu g/m^3$ $80\mu g/m^3$	$15\mu g/m^3$ $30\mu g/m^3$	Improved west and Gacke Method Ultraviolet fluorescence
Oxides of Nitrogen (NO_2)	Annual Average 24 hours	$80\mu g/m^3$ $120\mu g/m^3$	$60\mu g/m^3$ $80\mu g/m^3$	$15\mu g/m^3$ $30\mu g/m^3$	Jacab Hochheister modified (Na-Arsentire method Gas Phase Chemilumine Scene
Suspended Particulate Matter (SPM)	Annual Average 24 hours	$360\mu g/m^3$ $500\mu g/m^3$	$140\mu g/m^3$ $200\mu g/m^3$	$70\mu g/m^3$ $100\mu g/m^3$	High Volume sampling (average flow rate not less than 1.1 m^3/minute)

NAAQS

Suspended Particulate Matter (SPM)	Annual Average 24 hours	360µg/m³ 500µg/m³	140µg/m³ 200µg/m³	70µg/m³ 100µg/m³	High Volume sampling (average flow rate not less than 1.1 m³/minute)
Respirable Particulate Matter (size Less than 10µm) RPM	Annual Average 24 hours	120µg/m³ 150µg/m³	60µg/m³ 100µg/m³	50µg/m³ 75µg/m³	Respirable particulate matter sampler
Lead as Pb	Annual Average 24 hours	1.0µg/m³ 1.5µg/m³	0.75µg/m³ 1.0µg/m³	0.50µg/m³ 0.75µg/m³	AAS method after sampling using EPM 2000 or equivalent filter paper
Carbon Monoxide	8 hours 1 hour	5.0mg/m³ 10.0mg/m³	2.0mg/m³ 4.0mg/m³	1.0mg/m³ 2.0mg/m³	Non disbersive infrared spectroscopy

Annual Average : Annual Arithmetic Mean of minimum 104 measurements in a year taken twice a week 24-hourly at uniform interval

24 Hours Average : 24-hourly/8-hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not two consecutive days.

Revised NAAQS 2009

- PM 2.5 and ozone have been included
- Standards for NOx has been made more stringent
- Standards for short duration exposure to deadly gases like ozone and CO have been set
- Tighter standards for 'sensitive areas' have been notified. (forest &natural vegetation)

Air Quality Index

- Is a number used by government agencies to characterize the quality of the air at a given location.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Limitations of the AQI

- Most air contaminants do not have an associated AQI.
- The AQI can worsen (go up) due to lack of dilution of air emissions by fresh air.
- Stagnant air, due to anticyclone or temperature inversion, or lack of winds prevents dilution

LEGISLATION FOR CONTROL OF AUTOMOBILE POLLUTION

Multisectoral Handling

- Ministry Of Environment And Forests
  - -Environment Protection Act, 1986
  - -Emission Standards
  - -Central Pollution Control Board
  - -State Pollution Control Boards
- Ministry of Road Transport and Highways
  - -Central Motor Vehicle Rules (CMVR)
  - -Safety and Emission Standards
  - -State Transport Departments
- Ministry of Petroleum and Natural Gas
  - -Fuel Quality Specifications - Under BIS
- Ministry of Heavy Industries
  - -ARAI- Prototype Approvals for new vehicles- both for safety and emission

Chronology of Events

➢Emission Norms

The Journey Began **in 1984** - when the State of Maharashtra introduced norms for idling CO and free acceleration smoke.

1989- the above norms were extended for the entire country

1991 -Exhaust mass emission norms for gasoline for only CO & HC for vehicles below 3.5 ton GVW were introduced

-Full load and free acceleration smoke regulations for diesel vehicles also introduced.

1992- Exhaust mass emission norms for diesel vehicles / engines above 3.5 ton GVW introduced

1995 -Mandatory fitment of catalytic converter for gasoline Passenger cars in Metropolitan cities.

1996 -stringent norms for gasoline (CO, HC + NOx) and diesel vehicles introduced.

-Cold start emission test for diesel vehicles below 3.5 ton GVW.

1998 -Cold start emission test for gasoline passenger cars introduced

1999- India 2000 (Equivalent to Euro-I) norms introduced for passenger cars in National Capital Region (Delhi)

2000 **-** Bharat Stage I norms for all category of vehicles introduced

- Bharat Stage II (Equivalent to Euro-II) norms for gasoline and diesel passenger cars introduced in National Capital Region (Delhi)

-Particulate limit values introduced for diesel vehicles

➢ Future Emissions Norms

<u>In April 2005</u>

- Bharat Stage II (Equivalent to Euro-II) norms for gasoline and diesel passenger cars a will be introduced in entire country
- Bharat Stage II norms for 2 and 3 Wheelers will come into force in entire country
- Bharat Stage III (Equivalent to Euro-III) norms for gasoline and Diesel vehicles will be introduced in 11 cities

Emission Norms for Petrol Passenger Cars

Norms	CO(g/km)	(HC+ NOx)(g/km)
1991	14.3-27.1	2.0(Only HC)
1996	8.68-12.40	3.00-4.36
1998	4.34-6.20	1.50-2.18
India stage 2000	2.75	0.97
Bharat stage-II	2.2	0.5
Bharat Stage-III	2.3	0.35 (combined)
Bharat Stage-IV	1.0	0.18 (combined)

Emission Norms for Diesel Passenger Cars

YEAR	CO (g/km)	HC+NOx (g/km)	PM (g/km)
1991	16.5	02.1	-
1996	05.7	02.2	-
2000	02.72	0.97	0.14
EURO II	01.00	0.7	0.08
EURO III	0.64	0.56	0.05
EURO IV	0.5	0.3	0.025

Emission Norms for 2 wheelers

Norms	CO (g/km)	HC+ NOx (g/km)
1991	12-30	8-12 (only HC)
1996	04.5	03.6
India stage 2000	02.0	02.0
Bharat stage-II in 2005	01.6	01.5
Bharat Stage-III proposed in 2008	1.0	1.0

Emission Norms for 3 wheelers- Petrol

Norms	CO (g/km)	HC+ NOx (g/km)
1991	12-30	8-12 (only HC)
1996	6.75	5.4
India stage 2000	4.0	2.0
Bharat stage-II in 2005	2.5	2.5
Bharat Stage-III in 2008	1.25	1.25

Emission Norms for 3 wheelers- Diesel

Norms	CO (g/kwhr)	HC (g/kwhr)	NOx (g/kwhr)	PM (g/kwhr)
1991	304	12		-
1996	5.0	2.0		-
India stage 2000	2.72	0.9		0.14
Bharat stage-II in 2005	0.85	0.01		0.64
Bharat Stage-III in 2008	0.7	0.7		0.05

Emission Norms for Heavy Diesel Vehicles

Norms	CO (g/kwhr)	HC (g/kwhr)	NOx (g/kwhr)	PM (g/kwhr)
1991Norms	14	3.5	18	-
1996 Norms	11.2	2.4	14.4	-
India stage 2000 norms	4.5	1.1	8.0	0.36
Bharat stage-II	4.0	1.1	7.0	0.15
Bharat Stage-III	2.1	1.6	5.0	0.10
Bharat Stage-IV	1.5	0.96	3.5	0.02

In-use Vehicle Emission Control

Pollution Under Control (PUC)

- ✓ Under Rule 115 (7) of Central Motor Vehicle Rules (CMVR), 1989, motor vehicles are required to carry PUC Certificate to be given by an agency authorized for this purpose by State Govt.
- ✓ Measurement of emissions from petrol vehicle is done by gas analyzer and in case of diesel vehicle emission are measured by smoke meters. There is a list of approved vendors and models of PUC equipment which is compiled and circulated by ARAI, Pune.

PUC

- ✓To ensure that the in-use vehicles are maintained well and less emitting
- ✓Gasoline vehicles are tested for CO emission
- ✓Diesel vehicles are tested for Free acceleration smoke

Present and Proposed Emission Norms for In-use -vehicles

S.No	Vehicle type	Present		Proposed	
		CO %	HC (ppm)	CO %	HC(ppm) n Hexane equivalent
1	2 Wheelers (2/4 stroke) & 3 wheelers (Pre year 2000)	4.5	-	4.5	9000
2	2 Wheelers (2-stroke) & 3 wheelers (Post year 2000)	4.5	-	3.5	6000
3	2 & 3 Wheelers (4 stroke) (Post year 2000)	4.5	-	3.5	4500
4	4 wheeler vehicles (Post year 2000) (Petrol/ CNG/LPG)	3.0	-	3.0	1500
5	Bharat Stage-II compliant Passenger cars/CNG Buses/ LPG (Fitted with 3 way closed loop catalytic converter) 4 GAS ANALYSER	3.0	-	0.5	750

Present PUC system - Limitations

- Test procedures and norms have not changed since introduction
- PUC Center operators are not trained
- Equipment not maintained / calibrated
- Proper test procedure not followed
- No well defined criteria for authorizing /registering PUC Center
- No auditing of PUC Center
- Lack of centralized agency for co-ordination
- The number of vehicles undergoing PUC test is very small due to absence of control mechanism to identify vehicles escaping PUC
- No analysis of the data collected
- Existing system is prone to tampering

Enhanced PUC system

- ✓ CMVR revised in February 2004- to be applicable from October 2004
- ✓ PUC system revised
- ✓ Revision in idle emission norms based on the year of vehicle manufacture.
- ✓ Introduction of idle HC emission standards
- ✓ Introduction of idle CO and HC emission norms for CNG / LPG vehicles
- ✓ Will have improved test methods for gasoline and diesel vehicles
- ✓ Four gas analyzer for better accuracy
- ✓ Measurement of Engine oil temperature and engine rpm for repeatable and consistent smoke readings

Enhanced PUC system

- ✓ Improved equipment operating conditions
- ✓ Compulsory AMC for min 5 yrs.
- ✓ Annual renewal based on AMC verification
- ✓ Training of PUC center operators by equipment suppliers and institutionalize the complete system
- ✓ Calibration of equipment three times per year
- ✓ Communication capability with computer for data transfer and storage

Proposed Revisions in Smoke Meter Specifications

- ✓ Oil temperature and engine rpm measurement built into the smoke meter.
  - ➢ oil temperature above 60 C will be used as an indication of engine warm-up.
  - ➢ engine rpm will be measured to ensure consistency of operation
- ✓ Smoke meter to identify the initial 6 flushing cycles based on the rpm measurement
- ✓ Software will ensure the repeatability of the maximum rpm achieved for each acceleration within ± 300 rpm for 4 Wheelers and ± 500 rpm for 3 wheelers.
- ✓ The smoke meter will provide the indications to assist the user for operation of the accelerator pedal.

4 gas analyzers v/s 2 gas analyzers

- ✓ Higher Accuracy of the Analyzer thereby reducing measurement errors
- ✓ Leak detection, low flow alarm and HC hang up test enhances accuracy of the test results
- ✓ Automatic gas calibration at least once a day for which a separate / inbuilt gas cylinder is required.
- ✓ Provision for RPM measurement is required
- ✓ Provision for NOx gas analysis for future requirements.

Proposal for Effective Inspection and Certification Regime

- ✓ Dovetail the present PUC system with I/C centers
- ✓ Develop loaded mode emission test methods in the long run
- ✓ Use technologies like Remote Sensing Device (RSD) as a supplement tool to identify gross polluting vehicles
- ✓ Change Pass/fail cut off points dynamically
- ✓ Involve general public in identifying the gross polluting vehicles by sending the SMSs through mobile phones or using the toll free numbers

Proposal for Effective Inspection and Certification Regime

- ✓ Introduce an efficient maintenance system to rectify the vehicles that have failed in the I/C centers
- ✓ Introduce certification and audit system for repair workshops
- ✓ For the quality of the services by the test centers, introduce audit system
- ✓ Develop a centralized software which is common to all the I&C centers for data transfer, storage, data analysis, uploading on a web site, etc
- ✓ I&C equipment manufacturers and suppliers to train I&C operators
- ✓ The validity of the I/C centers should be linked to 5 years AMC

Road map for controlling vehicular pollution from New vehicles (all vehicle except 2/3 wheelers)

Norms	Cities of Implementation	Effective date
1991 emission norms	Throughout the country	1.4.1991/92
1996 emission norms	Throughout the country	1.4.1996
Cat converter norms (for passenger cars)	45 cities	1.10.1998
India stage 2000 norms	Throughout the country	1.4.2000
Bharat stage-II norms	11 cities Throughout the country	2000-2003 1.4.2005
Bharat stage-III norms	11 cities Throughout the country	1.4.2005 1.4.2010
Bharat stage-IV norms	11 cities Throughout the country	1.4.2010 To be decided

Road map for controlling vehicular pollution from New 2/3 wheelers

Norms	Cities of implementation	Effective date
1991 emission norms	Throughout the country	1.4.1991
1996 emission norms	Throughout the country	1.4.1996
India stage 2000 norms	Throughout the country	1.4.2000
Bharat stage-II norms	Throughout the country	1.4.2005
Bharat stage-III norms	Throughout the country	1.4.2008/10

Fuel Quality Improvements

- ✓ Fuel Specifications changed progressively to meet the emission standards
- ✓ National Fuel Testing Laboratory established at Noida for testing Fuel Adulteration
- ✓ Another planned at Gurgaon - has difficulty
- ✓ Alternative fuels /Cleaner fuels like CNG/LPG encouraged
- ✓ Bio-diesel / Bio Fuels in use
- ✓ Eight States have introduced 5% ethanol in petrol
- ✓ Research on Hydrogen Fuel Cells
- ✓ Premixed oil for 2-stroke engines at fuelling station

Fuel Quality Improvements - Gasoline

- ✓ Lead phase out in 1998 in metro cities
- ✓ Lead phase out from gasoline in entire country– 1 February 2000
- ✓ Sulphur from gasoline reduced from 0.2 % to 0.1 % in entire country from 1st April 2000
- ✓ 4 Metro cities and NCR supplied with 0.05% max sulphur from 1st April 2000
- ✓ From 1st April 2005, 0.05% max sulphur fuel will be available in entire country

Fuel Quality improvements - Diesel

- ✓ Sulphur reduced from 1.0% max in April 1996 to 0.25 % in January 2000
- ✓ In 4 metro cities, sulphur reduced to 0.05 % max
- ✓ Cetane number increased from 45 to 48

Fuel Quality Specifications for Gasoline

For meeting norms	Lead(g/l)	Benzene(%)	Sulphur(%)
1991 norms	0.56 (leaded)	No limit	0.25
1996norms	0.15(low leaded) 0.013 (unleaded)	5	0.10(unleaded) 0.20 (leaded)
India stage 2000 norms	0.013	3(4 metros) 5 (rest of the country)	0.10
Bharat stage-II norms	0.013	(megacities) 3 (rest of the country)	0.05
Bharat stage-III norms	0.005	1	0.015
Bharat Stage-IV norms	0.005	1	0.005

Fuel Quality Specifications for Diesel

For meeting norms	Sulphur content	Cetane number	Density
1991 norms	1.0	42	-
1996 norms	0.50	45	820-880
India stage 2000 norms	0.25	48	820-860
Bharat Stage-II norms	0.05	48	820-860
Bharat stage-III norms	0.035	51	820-845
Bharat stage-IV norms	0.005	51	820-845

Road Traffic Management

- ✓ Construction of Flyovers
- ✓ Quality of Roads
- ✓ Synchronization of Traffic lights
- ✓ Installation of Timer at Traffic Lights
- ✓ Restriction of Plying certain category of vehicles on certain roads
- ✓ Decongestion of Road by altering the office timings
- ✓ Shifting of Some offices out of metro cities
- ✓ Construction of Metro Rail in Delhi
- ✓ Increase in Public Transport

Economic Instruments

- ✓ Levying Tax on Diesel
- ✓ Levying Tax on Diesel Vehicles
- ✓ Tax on owning more than one car
- ✓ Parking Tax

Role of Judiciary

- ✓ Various Directions and Judgments
- ✓ Environment Pollution (Prevention & Control) Authority (EPCA) for National Capital Region

Key Issues -Future Strategies

- ✓ Large fleet of In-use vehicles
- ✓ Large no. of 2-stroke vehicles
- ✓ No scrapping policy for vehicles
- ✓ 15 yr old vehicles shifted to other small cities
- ✓ Poor pollution monitoring system
- ✓ Road worthiness checked manually
- ✓ Pollution equipment either faulty or not calibrated
- ✓ Lack of inter- ministerial and inter state coordination-Poor information exchange
- ✓ Poor maintenance of vehicles
- ✓ Lack of awareness
- ✓ Overloading, Adulteration of fuel , Traffic Congestion

Thank u all…