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Analytical Methods for Monitoring Air Pollutants

PRINCIPLES OF MONITORING METHODS – CONTINUOUS MONITORING INSTRUMENTS

When a pollutant is emitted as a result of carelessness and especially when it is extremely necessary to measure its concentration at the site of emission, various laboratory methods fail to give reliable information. Under these circumstances, it is also very difficult to collect the sample and bring it to the laboratory for analysis. It may also be possible and rather necessary to take several measurements on regular intervals. In such a case it is necessary to have some rapid methods with the help of which it is possible to analyse substances such as air pollutants on a continuous basis on the site of emission such as in a field, or in any other outdoor location.

There are some laboratory methods that can be used on the outdoor location and it is also possible to use basic principles underlying laboratory methods for testing the pollutants, so that a suitable and feasible method can be employed for continuous measurement. This type of continuous measurement is generally known as **monitoring**.

While measuring air pollution on a regular, constant and continuous basis, some physical property of the pollutants are necessary to be identified for the measurements. The component of instrument which is capable of measuring such physical parameters is known as **transducer**. Generally, a specific property that is characteristic of a particular pollutant is measured. These properties include light absorbance or transmittance, electrical conductivity, change in potential, formation or generation of some material by passing electric current, nucleation of fog formation, or radioactivity. For example,

- (a) Pollutants such as CO, NO₂, SO₂ and H₂S can be measured by employing the physical principles of molecular absorbance employed in ultraviolet, visible and infrared spectroscopy.
- (b) SO₂ and mercury pollution can be monitored by using atomic absorption spectroscopy (AAS).
- (c) SO₂ and NO₂ pollutants can also be monitored by employing molecular luminescence (fluorescence).
- (d) Particulates can be monitored by using light scattering employed in nephelometry and turbidimetry.
- (e) Organic pollutants can be monitored by making use of nuclear magnetic resonance (NMR) or electron spin resonance (ESR).
- (f) SO₂ can be monitored also be conductance measurements, high frequency methods, coulometry and anode stripping voltametry (ASV).
- (g) Organics can also be monitored by using gas chromatography (GC) and high performance liquid chromatography (HPLC).

- (h) Pesticides can be monitored by making use of amperometry and polarography.
- (i) Radioactive pollutants can be monitored by employing neutron activation analysis (NAA).
- (j) Potential pH measurements and ion selective electrodes are used for the monitoring of NO-NO_x.

The monitoring instrument is generally composed of three important components. These are:

- (a) Air remover (b) Transducer (c) Recorder.

The **air remover** consists of flow meter as well as a pressure guage. The air remover measures flow rate of air passing and the pressure under which the gas pollutants exist.

The **transducer** measures a physical property characteristic of the pollutant. The **recorder** records the change in physical property of the gaseous pollutant. For example, concentration of the pollutant can be measured by **flow colorimeters or flow spectrophotometers**. The instrument is regularly checked for various parameters such as response time, sensitivity, specificity, maintenance and overall accuracy.

Some common air pollutant monitoring instruments are given below :

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| (1) (a) Infrared (IR) gas analyser | CH ₄ , CO and hydrocarbons (HC) |
| (b) Non-dispersive infrared (NDIR) gas analyser | CO and CO ₂ |
| (c) Vehicle exhaust meter | Auto exhaust analysis |
| (d) Carbon monoxide monitor | Catalytic oxidation. |
| (2) SO ₂ monitor | Conductivity, conductometric titrations. |
| (3) Ozone monitor | Chemiluminescence |
| (4) NO-NO _x monitor | Chemiluminescence |
| (5) H ₂ S analyser | Colorimetry. |

Some air monitoring instruments and techniques involved are given in the table 1. Very few instruments are available for monitoring and analysis of aerosols.

It is clear that a number of instruments and techniques are available for the measurement or monitoring of gaseous pollutants such as CO, CO₂, H₂S, SO₂, NO - NO_x etc. The instruments are based upon the measurement of various physical properties. For example, H₂S gas can be measured by employing flow colorimetry, while SO₂ gas can be monitored by making use of conductance measurements as well as coulometric technique.

It is also possible to monitor other pollutants such as ozone, organic pollutants, hydrocarbons (HC), smoke and dust as well as metal pollutants, on a continuous basis. For monitoring such pollutants we can use measurement of light scattering as in case of smoke and dusts, fluorescence quenching as in case of organic pollutants, atomic absorption and emission spectroscopy as in case of metal pollutants etc., in addition to the usual conventional methods of quantitative analysis.

In the last two decades, we have made good progress in the field of pollution control measures in India. But as far as monitoring instruments are concerned, we are almost no where in the field. While prescribing standards for pollutants, we were quite aware of our limitations, but while evolving methods of monitoring and analysis, we never imagined whether a particular instrument is available easily and cheaply in India.

Some of the instruments available in India for monitoring of pollutants include SO₂ analyser (conductance), NO-NO_x meter (absorbance), ozone analyser (absorbance, chemiluminescence).

CO analyser (infrared gas analyser), CO, CO₂ and HX (non-dispersive infrared (NDIR) analyser etc.

Table (1) Air monitoring instruments and technique

S.No.	Instruments	Pollutant measured	Technique of analysis
1.	Conductometric analyser	SO ₂	Conductometric measurement
2.	Continuous SO ₂ monitor	SO ₂	Coulometric measurement
3.	Gas liquid chromatograph	CO, NO, hydrocarbons	Gas chromatography with different detectors
4.	Nitric oxide monitor	NO ₂	Fluorescence technique
5.	O ₂ analyser	O ₂	Measurement emission spectrograph
6.	Ozone monitor	O ₃	Chemiluminescence technique
7.	Infrared analyser	CO, CH ₄ and other hydrocarbons	Infrared absorption limit of 10–1000 ppm for CO, NDIR technique
8.	Fluorescence spectroscopy	Organic pollutant	Fluorescence, phosphorescence spectroscopy
9.	Smoke	Smoke; smog	Light scattering technique
10.	Atomic absorption spectrophotometer	Trace metal analysis	Atomic absorption spectroscopy (AAS)
11.	Spectrophotometer	Metal pollutants at trace levels	UV visible spectroscopy

From some years back, some sophisticated instruments such as atomic absorption spectrophotometer, gas liquid chromatograph, carbon, hydrogen and nitrogen analysers and many of the meteorological instruments are also readily available in India.

NMR, NDIR, GS-MS instruments are also being designed and developed in India. Some of the Monitoring instruments which rightly suit Indian conditions and are developed in India include smoke meter, stack monitoring kit, high volume sampler, portable, multi gas sampler, CO and CO₂ monitor including NDIR model, SO₂ monitor and NDIR set up, H₂S monitor, ozone monitor, NO–NO_x monitor, NDIR methane monitor, fluorescent SO₂ monitor, temperature sensor, wind direction recorder and wind speed recorder etc.

PRINCIPLES OF ENVIRONMENTAL MONITORING