

Lecture 4

Filtration

- “ Particulates having a diameter of less than $10\ \mu$, according to Stokes law tend to remain entrained in an air stream such particulates are referred to as suspended (respirable) particulates.
- “ Respirable particulates are harmful to man than the larger diameter Settle able particulates.

Filtration

- “ Particles are quantitatively removed from an air stream flowing through a dense material containing sub-micrometer pore size.
- “ Any material that passes through such a filter is considered.
- “ There are several mechanisms that can act to cause particles to be separated from a gas stream.
- “ Which specific mechanism or combination of mechanisms acts and which **particular mechanism dominates is strongly dependent on particle size.**

Filtration

Particle collection is achieved by 5 processes

1. Direct interception (if its size is too great to permit it to pass through the filter pores)
2. Internal deposition (if its inertia is sufficiently great for it to impact on the solid structural material of the filter)
3. Diffusional deposition
4. Electrical attraction
5. Gravitational attraction

Each of these mechanisms applies one or more forces to a particle such as electrostatic force or inertial force to cause it to move to a collecting surface.

Filtration

The particulate matter from air can be sampled by passing the air through a filter whose pore size is small enough to retain the particles.

Selection of filter medium depends on
(1) Objectives of sampling (2) Types of particulates to be collected (3) Size of the particles (4) Chemical nature of filter

Filtration

Lab grade paper filter is **not use for sampling** of ambient air as

- “ They are not satisfactory for recovery of small particles ($< 0.5 \mu\text{m}$).
- “ Not possess mechanical strength to withstand airflows of the order of 25 lit/s.

Filtration

Membrane filter: Study of the sizes and morphology

Glass fiber filter (nonhygroscopic): particles to be collected for measuring their weight.

Organic particulates may dissolved certain synthetic fiber while NO_x or SO_x may attack or decompose membrane fiber. For silica, glass fiber filter is not use.

Glass fiber filter: inert to acid and organic solvent

Filtration

- “ Use **dense cellulose** paper: Whatman No. 41 (absorb H_2O)
- “ **Organic membrane** filter : Millipore, Nucleopore, pallflex, Aerapor (composed of cellulose acetate nitrocellulose)
- Fluoropor, Miller: Teflon filter (inert for organic and inorganic)

sampling of stack monitoring

Recent trends in sampling of stack monitoring

Methods of measurement of particulates emission in flue gases generally fall into two categories:

1. Opacity measurement
2. Mass measurement

1. Opacity measurement

- “ Are necessary because the particulates emitted from a stack may produce visible plume which may be itself objectionable and which can cut out sunlight and produce a haze.
- “ Plum visibility has been measured by Ringelmann scale which consists of a black regular pattern superimposed on a white card.
- “ The lines are of definite width and spacing such that in different sections of the card the ratio of black to white changes.

Ringelmann Smoke Chart (contd..)

- “ The chart is held at eye level, at a distance of several meters, such that patterns merge to form a range of greys which can be compared with the plume greyness.
- “ The observer notes the number of the chart most nearly corresponding to the shade or opacity of the plume.
- “ **Photometers** have been used to quantify the Ringelmann measurement.

Ringelmann Smoke Chart

- “ Dark smoke is partially burned particles, the result of incomplete combustion.
- “ White smoke is mainly tiny water droplets, generated when vapour released during combustion condenses in cool air.
- “ Dark smoke is clearly visible against a light sky while a white smoke is visible in darkness.
- “ Smoke is commonly measured in terms of its apparent density in relation to a scale of known greyness.

Ringelmann Smoke Chart (contd..)

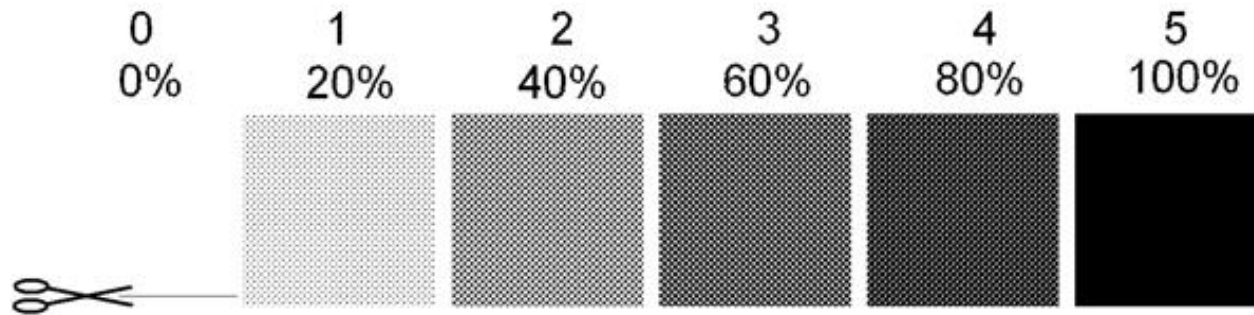
- “ The most widely used scale is that developed by Professor Maximilian Ringelmann in 1988.
- “ It has 5 levels of density inferred from a grid of black lines on a white surface which, if viewed from a distance merge into known shades of grey.
- “ Smoke level 0 is represented by white, levels 1 to 4 by 10 mm square grids drawn with 1 mm, 2.3 mm, 3.7 mm and 5.5 mm wide lines and level 5 by all black.

Ringelmann Smoke Chart (contd..)

Apparent darkness of smoke depends upon concentration of the particulate matter in the effluent, the size of the particulate, the depth of the smoke column being viewed and natural lighting conditions such as direction of sun relative to observer while the accuracy of chart itself depends on the whiteness of the paper and blackness of the ink used.

Bar type:

Black and white print. Cut along the edge shown, hold at arm's length and compare the smoke source with the cut edge.



Circle Type:

Grey scale print. Cut out the central hole and hold at arms length and view the smoke source through the hole.



Black grids on a white paper:

