Lecture 5

Stack Monitoring

Stack Sampling

Å **Stack sampling or source sampling** may be defined as a method of collecting representative samples of pollutant laden air/gases at the place of origin of pollutants to determine the total amount of pollutants emitted into the atmosphere from a given source in a given time

Stack Sampling

Å The purpose of stack sampling is to determine emission levels from plant processes to ensure they are in compliance with any emission limits set by regulatory authorities to prevent macro environmental pollution.

Stack Sampling

Stack sampling is used for the assessment of the following:

1. To determine the **quantity and quality of the pollutant** emitted by the source.
2. To measure the **efficiency of the control equipment** by conducting a survey before and after installation
3. To determine the **effect on the emission** due to changes in raw materials and processes.
4. To compare the **efficiency of different control equipments** for a given condition.
5. To **acquire data** from an innocuous individual source so as to determine the cumulative effect of many such sources.
6. **To compare with the emission standards** in order to assess the need for local control

Stack Sampling

Source sampling is carried out in a process ventilation stack to determine the emission rates/or characteristics of pollutants.

Planning the study:

Å Familiarity of the process and operations to determine the time of cyclic operations, peak loading that might cause variations in the characteristics.

Å Method of sampling

Å Method of analysis of samples

Å Sampling time because certain industries undergo cyclic changes

Å Amount of sample required

Å Sampling frequency

Stack Sampling

Representative sample:

Å Sample collected must truly represent the conditions prevailing inside the stack.

The important considerations for accurate representative sample collection include:

Å Accurate measurement of pressure, moisture, humidity and gas composition

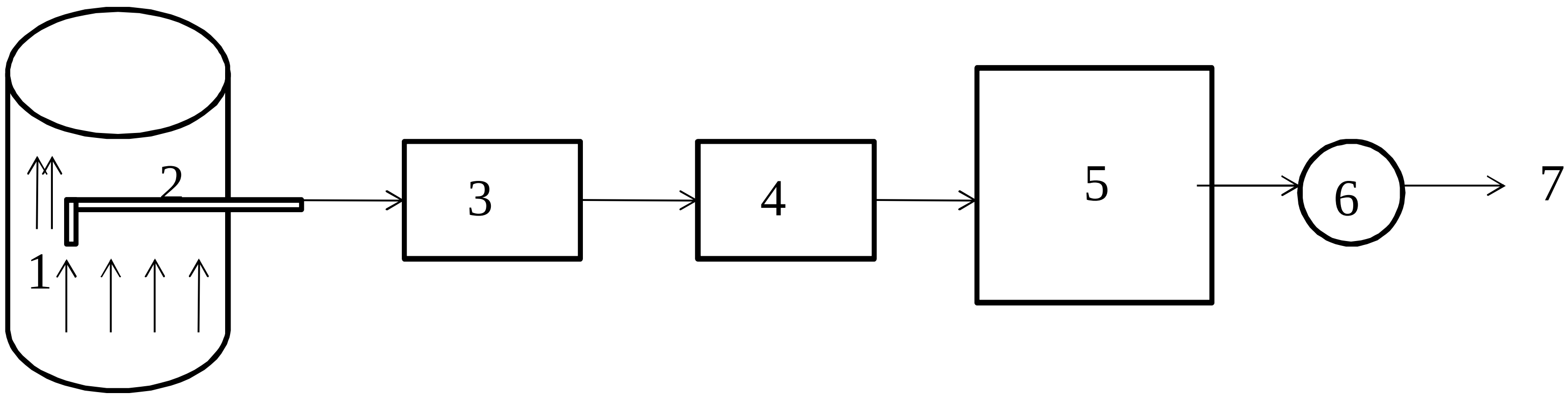
Å The selection of suitable locations for sampling

Å Determination of the traverse point required for a velocity and temperature profile across the cross section of the stack and sampling for particulate matter

Stack Sampling

Sampling System:

Å Stack sampling is carried out by diverting a part of the gas stream through a sampling ñtrainò of which a general arrangement is shown below.



1 Nozzle 2 Sampling probe 3 Particulate collector 4 Gas collector 5 Gas flow meter 6 Flow control valve 7 To vacuum pump

Stack Sampling

Å The train consists of a nozzle placed in the gas stream, a sampling probe through which the sample is drawn at different traverses, particulate and gas collection devices, a flow measuring device and a prime mover such as a vacuum pump or an ejector.

Å **Nozzle:** It is at the end of the probe is sharp edged, pointing inward from the outside edge and the traversing probe is made of stainless steel with glass or Teflon lining.

Stack Sampling

- For Sampling hot gases whose temperature are above 400 ^{0}C, these probes are provided with a circulating **coolant system** to prevent combustion of particulate materials inside the probe and to prevent the temperature from exceeding the maximum allowable temperature of filtration materials.
- **Devices: Collection of particulates:** Filtration, wet or dry impingement, impaction, electrostatic and thermal precipitation
- **Collection of gases:** Absorption, adsorption, freeze out
- **Flow measurement:** Use rotameter or orifice meter or dry gas meter if the information on the total volume of the gas sampled is required.

Iso kinetic Sampling

Particulates sampling

Å Isokinetic stack particulate sampling is conducted to obtain a **representative particulate stack sample** independent of particle size.

Å To achieve this, the gas stream entering the collector should have a velocity (speed and direction) equal to that of the gas stream just ahead of the sampling port of the collector.

Iso kinetic Sampling

Å Webster's dictionary defines **ISO** as denoting equality, similarity, uniformity.

Å **Kinetic** is defined as due to motion.

Å Isokinetic sampling is an equal or uniform sampling of particles and gases in motion within the stack.

Å Isokinetic source sampling is achieved when the velocity of gas entering the sampling nozzle is exactly equal to the velocity of the approaching gas stream. This provides a uniform, **unbiased** sample of the pollutants being emitted by the source.

Different conditions...

1. Sample collection Velocity (V) > Stack gas velocity (W)

2. Sample collection Velocity (V) < Stack gas velocity (W)

3. Sample collection Velocity (V) = Stack gas velocity (W)

Minimum requirement of a stack monitoring equipment

- **Particulate Sampling :**
  2 –30 lpm collection on **thimble** type filter up to 0.3 micron rating

- **Gaseous sampling :**
  0.2 – 3 lpm collection in a set of Borosilicate glass **impingers**

- **Rotameter :**
  Rotameters:0 to 60 lpm for particulate monitoring and 0 to 3 lpm for gaseous monitoring.

- **Filter Holder :**
  Fabricated from SS 304 tube suitable to hold either cellulose filtration thimble or glass micro fibre thimble

- **Nozzles :**
  A set of 3 stainless steel nozzles

- **Digital clock :**
  0-60 minutes, 1 second readout with start and stop switches

- **Impinger Sampling Train :**
  2 No. of 240 ml capacity and 3 No. of 120 ml capacity borosilicate glass impingers with Ball socket joints accommodated in ice tray, made out of FRP, placed on the rear side of instrument panel with a provision of keep ice

- **Vacuum Pump :**
  Monoblock Rotary Vane type, oil lubricated, 0.5 HP single phase motor (230V) with more than 50 lpm free flow capacity

Steps for Stack Sampling

Procedure for particulate matter sampling

1. Determine the gas composition and correct to moisture content.
2. Determine the temperature and velocity at each traverse point.
3. Determine the empty weight of the thimble (W_1).
4. Mark out the traverse points on the probe. The marks are normally fixed by tying with asbestos thread.
5. Check all points for leakages.
6. Determine the flow rate to be sampled under isokinetic condition.

Steps for Stack Sampling

Sample recovery:

- Å After cooling, the outside of probe assembly is cleaned with cotton waste. Disconnect the nozzle.
- Å Remove the thimble and keep it in a clean glass beaker.
- Å The particulate matter adhered to the inside walls of the nozzle, should be transferred carefully to the thimble.
- Å Weigh the thimble with sample (W_2).
- Å The difference in weight (W_2- W_1) will give the particulate collected

Steps for Stack Sampling

Procedure for particulate matter sampling

7. Insert the probe at the traverse point 1, very close to the stack. Start the pump and adjust the flow so that the rotameter reads the predetermined value.
8. Switch ff the pump at the end of sampling time.
9. Read the vacuum at the dry gas meter (DGM) and also the temperature.
10. Move the probe to subsequent traverse points by repeating the steps five to eight.
11. After completion of collection of samples, remove the probe and allow it to cool.

Steps for Stack Sampling

Procedure for particulate matter sampling

12. Remove the thimble carefully. Some of the dust would have adhered to the nozzle. This should be removed by trapping and transferred to the thimble.
13. Weight the thimble with the sample. The difference in weight gives the dust collected.
14. The volume of sample collected in either given by the dry gas meter (m^3) or by sampling rate given by rotameter multiplied by the sampling time.
15. Hence from (13) and (14), the emission rate can be calculated. This will be at DGM conditions. This is to be corrected for temperature and pressure so as to obtain values for standard conditions.

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