Answer question no.1 compulsorily

Answer ONE question from each unit

1. **Answer ONE question in short**

a) List the greenhouse gases

The major greenhouse gases are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous oxide (NO_2) and Chlorofluorocarbons (CFC)

b) What are the natural sources of air pollution?

Natural Sources of air pollution are Volcano, forest fire, dust storms, oceans, plants and trees.

c) Write the examples of secondary air pollutants.

- Ozone
- PAN (peroxy acetyl nitrate)
- Photochemical smog
- Aerosols and mists (H_2SO_4)

d) Explain the effects of moisture and relative humidity on pollutant dispersion.

Humidity is the amount of water vapor in the atmosphere. Water vapor is the invisible presence of water in its gaseous state. Humidity is a significant aspect of the atmosphere because it affects the weather and the climate.

e) Define wind rose diagrams

A wind rose is a graphic tool used by meteorologists to give a succinct view of how wind speed and direction are typically distributed at a particular location.

f) Define particulate matter?

Particulate matter (PM), also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets that get into the air. Once inhaled, these particles can affect the heart and lungs and cause serious health effects
Examples: ash from fires, asbestos from brakes and insulation, dust

g) Describe the adiabatic lapse rate

The rate of decrease in temperature of artificially heated gases or air with height is called adiabatic lapse rate

h) Explain the principle involved in setting chambers.

Settling chambers use the force of gravity to remove solid particles. The gas stream enters a chamber where the velocity of the gas is reduced. Large particles drop out of the gas and are recollected in hoppers.

i) List out the various source correction methods for air pollution

Some of the effective methods to Control Air Pollution are as follows: (a) Source Correction Methods (b) Pollution Control equipment (c) Diffusion of pollutant in air (d) Vegetation (e) Zoning.

j) Write the sources of SOx emissions?

Power stations, oil refineries and other large industrial plants contribute the majority of the total mass released. Motor vehicles and domestic boilers, as well as natural sources such as active volcanoes and forest fires, release sulphur dioxide.

k) What are the adverse effects of NOx?

High levels of NOx can have a negative effect on vegetation, including leaf damage and reduced growth. It can make vegetation more susceptible to disease and frost damage.

l) Define Photochemical Smog

The Photochemical smog is caused by the interaction of some hydrocarbons and oxidants under the influence of sunlight giving rise to dangerous peroxy acetyl nitrate (PAN)

l) What are the various solvents used to remove Sox from air?

i. Lime/limestone solution/slurries

ii. MgO slurries/$Mg(OH)_2$ solution

iii. NaOH solution

iv. Na_2SO_3-$NaHSO_3$ solution

UNIT I

2. Explain the effects of air pollutants on the following:

i Acid rains ii) Materials

Acid Rain

Rain fall by nature is slightly acidic due to the tendency to each chemically with atmospheric CO_2. Forming a weak solution of carbonic acid with PH 5.6, by definition any rain water measuring less than 5.6 on the pH scale is considered acid rain. Acid rain is only one form in which acid deposition occurs. Fog, snow, mist, and dew also trap and deposit atmospheric contaminants. Furthermore, fall out of dry sulfate, nitrate, and chloride particles can account for as much as half of the acidic deposition in some areas.

Remedial Measures

The numbers of possible solutions for acid rain that are available to us are aplenty:

i. One of the most fundamental acid rain solutions is to utilize fuels that burn more cleanly, or to burn coal more efficiently. This will greatly reduce the possibilities of acid rain developing in the atmosphere.

ii. As fast as industrial power plants are concerned, the best solution is to attach devices known as 'scrubbers' in the chimneys of these plants. These scrubbers reduce the amount of sulfur produced in the smoke by 90 – 95%.

iii. Vehicles and cars must be mandatory required to comply with very tight and efficient emission standards. Fitting catalytic converters into the exhaust pipes of vehicles also reduces the amount of sulfur dioxide produced by the vehicles.

iv. For industrial power plants, there are many more acid rain solutions that must be enforced, as they are clearly the biggest contributors to the formation of acidified water droplets in the atmosphere. Industries must regularly inspect and clean all their emission equipment and chimneys and pipes.

v. All these acid rain solutions will be pointless unless people are informed and educated about the ill-effects and harms of acid rain. A widespread and nationwide effort must be made to make people aware. Only after that is done will all the acid rain solutions actually make a difference.

Effects of Air Pollution on materials.

Air pollution is renowned for soiling building surfaces, clothing and other articles. This is Generally a result of smoke particles adhering to the surface in question, but there are many other more sinister effects. Most important are effects on metals, carbonate building stones, paints, textiles, fabric dyes, rubber, leather, and paper. In Western Europe, which is a repository for many monuments of history and fine works of art, air Pollutant induced damage has been incalculable**.**

Materials can be affected by both physical and chemical mechanisms. Physical damage may result from the abrasive effect of wind-driven particulate matter impinging on surfaces and the soiling effect of passive dust deposition. Chemical reactions may result when pollutants and materials come into direct contact. An example of this is the reaction of lead in older paint materials with sulfurous materials (particularly H_2S) from air pollution to produce the unsightly lead sulfide black streaks on buildings.

Metal Corrosion

Metal corrosion in industrialized areas represents one of the most costly effects of atmospheric pollutants. Since corrosion is natural we tend not to recognize the role that pollutants play in accelerating this process. As the ferrous metals, iron and steel, account for about 90% of all metal usage, pollution-induced corrosion on these metals is of particular significance. The acceleration of corrosion in industrial environments is associated with high levels of atmospheric SO_2 and particulate matter pollution is very significant. Oxidants, such as ozone, inhibit the effects of SO_2 by producing a more corrosion-resistant product.

Rubber and Fabrics

Another important material damaged by pollution is rubber, which is attacked by ozone. This leads to cracking, which is an economically significant problem. Fabrics such as nylon are also affected by air pollution. These tend to disintegrate upon prolonged exposure to the air. Bleaching and discoloration may also occur.

3. a) Discuss the classification of air pollutants

Air pollution: Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and his environment. These substances include gases (SOx, NOx, CO, HCs, etc) particulate matter (smoke, dust, fumes, aerosols) radioactive materials and many others. Most of these substances are naturally present in the atmosphere in low (background) concentrations and are usually considered to be harmless.

Primary air pollutants - Materials that when released pose health risks in their unmodified forms or those emitted directly from identifiable sources.

Example: Five major materials released directly into the atmosphere in unmodified forms.

-Carbon monoxide
-Sulfur dioxide
-Nitrogen oxides
-Particulate matter

Secondary air pollutants - Primary pollutants interact with one another, sunlight, or natural gases to produce new, harmful compounds

Example:

- Ozone
- PAN (peroxy acetyl nitrate)
- Photochemical smog
- Aerosols and mists (H_2SO_4)

b) Explain stationary and mobile sources of air pollution.

Stationary sources of air pollution, including factories, refineries, boilers, and power plants, emit a variety of air pollutants.

Mobile source air pollution includes any air pollution emitted by motor vehicles, airplanes, locomotives, and other engines and equipment that can be moved from one location to another.

UNIT II

4. Discuss in detail about stack height and plume rise.

Design of a stack height:

Central Board for Prevention and Control of Water Pollution developed a method. According to that,

i) For Chimney emitting particulate matter h = 74 (Q_P) 0.27

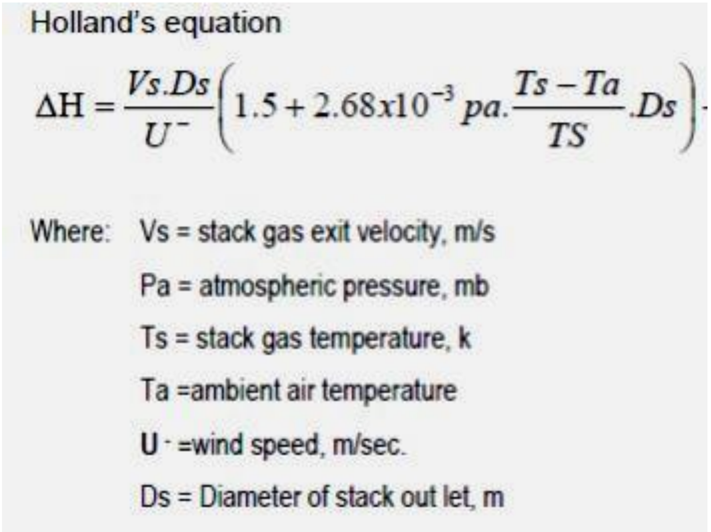
Where h = height of chimney (m)
Q_P = Particulate matter emission (tones/hr)

ii) For Chimney emitting SO_2 $H_s = 14 (Q_s)$ 1/3
Where $Q_s = SO_2$ emission (kg/hr)

iii) Minimum Values
a) For chimney adopted for industries (except thermal power plant) ------ 30m
b) For thermal power plants above 200MW and below 500MW ---------- 220m
c) For thermal power plants greater than 500 MW capacity --------------- 275m
the design height of the stack will be maximum of the above three conditions.

Plume rise

The rise of the plume after release to the atmosphere is caused by buoyancy and the vertical momentum of the effluent. This rises of the plume adds to the stack an additional height ΔH, such that the height H of the virtual origin is obtained by adding the term ΔH, the plume rise, the actual height of the stack, Hs.
The plume center line height H = Hs +ΔH is known as the effective stack height



Holland's equation

$$\Delta H = \frac{Vs.Ds}{U^{-}}\left(1.5 + 2.68x10^{-3}\, pa.\frac{Ts - Ta}{TS}.Ds\right)$$

Where: Vs = stack gas exit velocity, m/s
Pa = atmospheric pressure, mb
Ts = stack gas temperature, k
Ta =ambient air temperature
U - =wind speed, m/sec.
Ds = Diameter of stack out let, m

For unstable conditions, the above value of ΔH should be increased by 10 to 20 %
For stable conditions, the above value of ΔH should be decreased by 20 to 10 %

ii) Davidson and Brayant equation:

$$\Delta H = Ds \left(\frac{Vs}{U}\right)^{1.4} \left(1 + \frac{\mathrm{Ts} - \mathrm{Ta}}{\mathrm{T}}\right)$$

5. **Explain the influence of meteorological parameters on air quality**

Meteorological conditions play a large part in determining air quality at any particular place and time. Emission levels may be fairly constant in most ambient air, but 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.

Wind Direction and Velocity Measurements

These should be available whenever possible for each sampling site. Wind sensors (anemometers) should be installed to measure the general winds of the local urban or regional area under investigation and should not be influenced by physical obstructions. The standard exposure of anemometers over level open terrain is 10 meters above the ground. Any obstructions to the airflow, such as buildings, hills or tall trees, should be distant by at least five, and preferably ten, times their height. In some cases rough guides to general wind direction can be provided by double sided adhesive tapes on the outside of devices such as deposit gauges.

Atmospheric Stability

The ability of the atmosphere to disperse the pollutants emitted in to it depends to a large extent on the degree of stability. A comparison of the adiabatic lapse rate with the environmental lapse rate gives an idea of stability of the atmosphere. When the environmental lapse rate and the dry adiabatic lapse rate are exactly the same, a raising parcel of air will have the same pressure and temperature and the density of the surroundings and would experience no buoyant force. Such atmosphere is said to be neutrally stable where a displaced mass of air neither tends to return to its original position nor tends to continue its displacement When the environmental lapse rate (-dT/dz.) is greater than the dry adiabatic lapse rate, the atmosphere is said to be super adiabatic. Hence a raising parcel of air, cooling at the adiabatic rate, will be warmer and less dense than the surrounding environment. As a result, it becomes more buoyant and tends to continue its upward motion. Since vertical motion is enhanced by buoyancy, such an atmosphere is called unstable. In the unstable atmosphere the air from different altitudes mixes thoroughly.

UNIT III

6. **a) Describe the various types of plume behaviour**.

Plume behavior

The mixing or dispersion of the waste gases and products into the atmosphere is called plume behavior. Depending on the conditions close to the plume source, the plume may acquire shapes very different from the regular diffusion shape. Various plume shapes and associated phenomena are described below.

a. Looping plume:

In very unstable situations, the eddies causing plume dispersion may be much larger than the plume width. This results in a “solid-body” motion of the plume, also called the “meandering plume”

b. Conning plume

With moderate winds and overcast days, the plume may become a coning plume. This plume is wider than it is deep, and is elliptical in shape. This plume exists for several hours

c.fanning plume;

In stable air, and where the vertical movement of the plume is slow, a fanning plume is produced. This wide, shallow, spreading plume is very common after calm clear nights.A layer of warm air limits the rise of the plume into the upper atmosphere, and creates a higher concentration of polluted air at lower levels. This plume exists for several hours.

d. Fumigation;

If a plume is emitted into a very stable atmosphere (e.g. during a clear night), the plume travels downwind with very little dispersion. After dawn, as the sun heats the ground, an unstable layer is formed and the mixing height associated with the edge of this layer travels upwards as time. When this turbulent layer hits the plume, it causes very quick transport of the pollutant to the ground. This episode is called fumigation and it can result in very high ground concentrations, but for relatively short times.

e. Lofting

If either due to a very high stack or due to very high buoyant plume rise the plume source is effectively above the inversion, then the plume is dispersing upwards, but not downwards. The inversion acts like a solid boundary. This situation protects the ground receptor from high pollutant levels. .

f. Trapped plume

If the plume is below the inversion, it cannot penetrate it and the pollutant is not dispersing upwards. This causes higher ground concentrations than if the inversion were not there and is often the reason for high pollution levels in cities.

Plume behaviour

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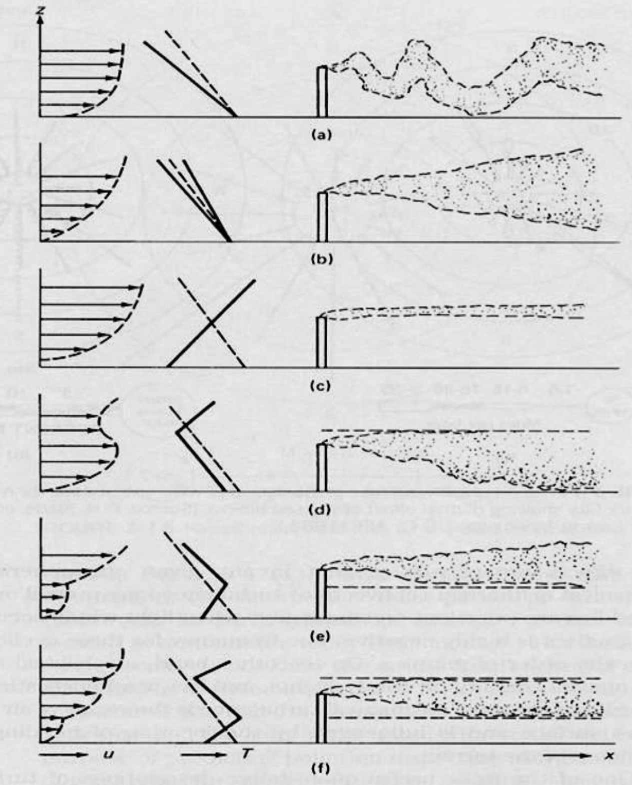


FIGURE 3-18 (a) Typical velocity profile, temperature profile, and plume shape in the x-z coordinate system for various atmospheric conditions. (Dry adiabatic lapse rate - - - ; ambient lapse rate—) (a) Looping, strong instability; (b) coning, near neutral stability; (c) fanning, surface inversion; (d) fumigation, aloft inversion; (e) lofting, inversion below stack; (f) trapping, inversion below and above stack height.

b) Discuss the limitations of Gaussian plume model

Limitation of Gaussian plume model

The followings are the limitations of Gaussian models and they should be considered and weighed up against the advantages before employing this type of model in any dispersion study

Causality effects

Gaussian-plume models assume pollutant material is transported in a straight line instantly (likea beam of light) to receptors that may be several hours or more in transport time away from the source. They make no account for the fact that wind may only be blowing at 1m/s and will only have travelled 3.6 km in the first hour. This means that Gaussian dispersion models cannot account for causality effects. This feature becomes important with receptors at distances more than a couple of kilometers from the source.

Low wind speeds

Gaussian-plume models 'breakdown' during low wind speed or calm conditions due to the inverse wind speed dependence of the steady-state plume equation, and this limits its application. Unfortunately, in many circumstances, low wind is the condition that produces the worst-case dispersion results for many types of sources. These models usually set a minimum wind speed of 0.5 or 1m/s and sometimes overwrite or ignore input data below this with this lower limit.

7. With neat sketches, discuss the working of following equipment.
i) Electrostatic precipitators ii) Cyclone separators

i) Electrostatic precipitators

The electrostatic precipitator is one of the most widely used device for controlling particulate emission at industrial installations ranging from power plants, cement and paper mills to oil refineries. Electrostatic precipitator is a physical process by which particles suspended in gas stream are charged electrically and, under the influence of the electrical field, separated from the gas stream

The precipitator system consists of a positively charged collecting surface and a high voltage discharge electrode wire suspended from an insulator at the top and held in passion by weight t the bottom. At a very high DC voltage, of the order of 50kV, a corona discharge occurs close to the negative electrode, setting up an electric field between the emitted and the grounded surface.

The particle laden gas enters near the bottom and flows upward. The gas close to the negative electrode is, thus, ionized upon passing through the corona. As the negative ions and electrons migrate toward the grounded surface, they in turn charge the passing particles. The electrostatic field then draws the particles to the collector surface where they are deposited.

Periodically, the collected particles must be removed from the collecting surface. This is done by rapping or vibrating the collector to dislodge the particles. The dislodged particles drop below the electrical treatment zone and are collected for ultimate disposal

Advantage:

- Maintenance is nominal, useless corrosive and adhesive materials are present in flue gases.
- They contain few moving parts.
- They can be operated at high temperature up to 300_oC-450_o C.

Disadvantage:

- Higher initial cost.
- Sensitive to variable dust loading and flow rates.
- They uses high voltage, and hence may pose risk to personal safety of the staff.
- Collection efficiency reduces with time.

ii) Cyclone separators

Separation by centrifugation is probably the most common form of particulate removal. A cyclone separator consists of a cylindrical shell, conical base, dust hopper and an inlet where the dust-laden gas enters tangentially. Under the influence of the centrifugal force generated by the spinning gas, the solid particles are thrown to the wall of the cyclone as the gas spirals upward at the inside of the cone. The particles slide down the walls of the cone and into the hopper. The operating efficiency of a cyclone depends on the magnitude of the centrifugal force exerted on the particles. The greater the centrifugal force, the greater the spreading efficiency. The magnitude of the centrifugal force generated depends on particle mass, gas velocity within the cyclone, and cyclone diameter.

$$F_c = M_p \frac{v_i^2}{R}$$

Where, F_c=centrifugal force, N; M_p=particulate mass, Kg; Vi equals particle velocity and R equals radius of the cyclone, m/s. From this equation, it can be seen that the centrifugal force on the particles, and thus the collection efficiency of the cyclone collector can be increased by decreasing R.

Large-diameter cyclone have good collection efficiencies for particles 40 to 50 μm in diameter.

Advantages

- Low capital cost
- Relative simplicity and few maintenance problems
- Low pressure drop (ca. 2–6 w.c)
- Dry collection and disposal
- Relatively small space requirements

Disadvantages

- Offer low particulate collection efficiencies especially for particulate sizes below 5 µm
- Inability to handle sticky materials

UNIT IV

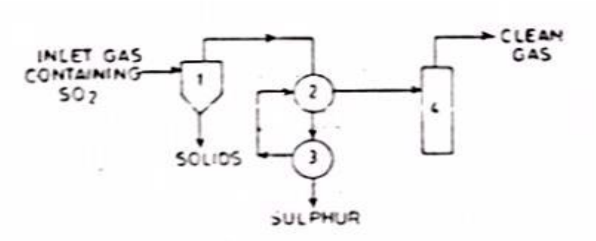
8. Explain the following methods of control of SOx emissions.
i) Wet method ii) Dry method.

REDUCTION OF SULPHUR DIOXIDE CONCENTRATION

There are more than 60 processes under different stages of development and an innumerable number of patents on methods and process equipment for the removal of SO_2 from stack gases. They are broadly classified under two heads

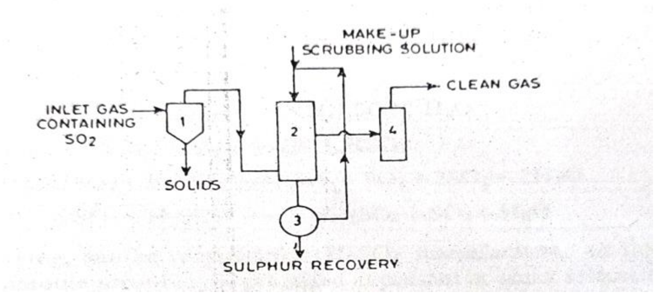
1. **Wet processes**
2. **Dry processes**

General schemes for the two are shown in Figs.1 and 2.



(1) MECHANCAL SEPARATORS (2) DY BED FOR S07 REMOVAL (3) REGENERATION OF DAY BED MATERIAL (4) STACK

Fig.1Generalized dry scheme for Sox removal from effluent gases



(1)MECHANICAL SEPARATORS (2) SCRUBBING COLUMN (3) REGENERATION OF SCRUBBING SOLUTION (4) STACK

Fig.2 Generalized wet scheme for So2 removal from effluent gases

1. WET PROCESSES

Wet scrubbing can be a physical absorption of SO2 or a chemical reaction.The absorbent should have a large capacity for absorbing SO2 at a fast rate so as to reduce the size of the equipment. Besides, it should be possible to regenerate the absorbent to make the process viable in practice SO2 is only slightly soluble in water so, its use as an absorbent is ruled out. Even so, a process has been patented in Japan, where the concentration of SO, in the exit gases can be reduced to about 100 ppm by scrubbing with water (1.9 l of water/m^3 of gases). Low pressure steam, normally available in the plant, can be employed for stripping SO2, In actual practice, a chemical reaction is incorporated since mass transfer with chemical reaction enhances the rate of absorption.

"Sulphur dioxide being acidic in nature, is readily absorbed by alkaline solutions. There are a number of such scrubbing solutions.

v. Lime/limestone solution/slurries

vi. MgO slurries/Mg(OH)$_2$ solution

vii. NaOH solution

viii. Na_2SO_3-$NaHSO_3$ solution

ix. Na_2CO_3 solution

x. NH_3-liquor solution

xi. Dimethylaniline solyent

xii. Xylidinc-water system

xiii. Ammonium sulphite solution

i Lime/Limestone Solution/Slurry

In the Battersea process a small amount of chalk slurry added to slightly alkaline river water is used for scrubbing the gases. The liquid effluent, however, needs to be disposed of, setting restrictions on the location of the plant.

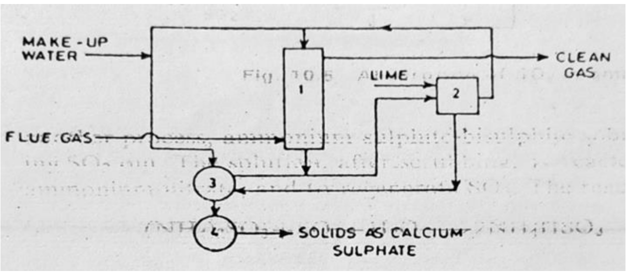
Of all the chemicals listed above, lime /limestone are the cheapest and readily available. In the Calsox process scrubbing is done by lime/limestone solution/slurry in contactors such as venturi, turbulent bed, floating bed or even gravity scrubbers. The overall reactions for lime and limestone are,

$$CaO+SO_2+2H_20 \longrightarrow CaSO_3.2H_20$$

(Calcium sulphite dihydrate)

$$CaCO_3+SO_2+2H_20 \longrightarrow CaSO_3.2H_20+ CO_2$$

Calculations for the equilibrium constant indicate that the reaction of lime and SO_2 is more favourable than limestone and SO_2. In the first case the formation of calcium ion, the critical step in both reactions, is dependent only on the presence of Cao. In the second, calcium-ion formation depends on the presence of limestone as well as H+ concentration. The limestone system will therefore, operate at a lower pH than the lime system. It has been determined that the optimum pH range for the limestone system is between 5.8 and 6.2 and for the lime system about 8.0. The lime/limestone process carried out at high pH results in a soft pluggage of calcium sulphite and at low pH in a hard scale of calcium sulphate. A cyclic lime process is shown in Fig.3 Calcium sulphite formed is readily oxidized to calcium sulphate which is deposited in the scrubber and lines. This difficulty can be overcome by the incorporation of a delay tank where the deposition of calcium sulphate is increased by the addition of chalk. The calcium sulphate can be settled and filtered out. The main disadvantage of the method is the disposal of calcium sulphate.



(1) SCRUBBER (2) DELAY TANK 3) SETTLER (4) ROTARY FILTER

Fig.3 Typical lime-scrubbing process for so removal from effluent gases

ii. Double-Alkali Process

Here two alkalies, viz. sodium hydroxide and calcium oxide are used. The advantage of using NaOH as alkali is that no solids are formed during the reaction. This reduces erosion and wear of the nozzles, pipes, pumps, etc. Besides, the removal efficiency of SO_2 is very high. It is desirable to regenerate rate NaOH from the scrubber effluent. This can be done by reacting it with lime limestone outside the scrubber system. Thus avoiding sealing due to lime products without interrupting the scrubber operation. The process concept Is quite feasible as the consumable chemical is only lime/limestone which is quite readily available indigenously. The only precaution required is a minimal loss of NaOH. Coagulants can be used for the removal of calcium sulphate particles. The reactions occurring are:

$2NaOH+SO_2 \longrightarrow Na_2SO_3+H_2O$

$Na_2 SO_3 +SO_2+H \longrightarrow 2NaHSO_3$

$2Na_2SO_3+O_2 \longrightarrow 2Na_2SO_4$

$2NaHSO_3+ CaCO_3 \longrightarrow Na_2SO_3+CaSO_3+ CO_2+H_20$

$2NaHSO_3+ Ca(OH)_2 \longrightarrow Na_2SO_3+CaSO_3+2H_2O$

$Na_2SO_3+ Ca(OH)_2 \longrightarrow 2NaOH+CaSO_3$

$Na_2SO_4+Ca(OH) \longrightarrow 2NaOH+ CaSO_4$

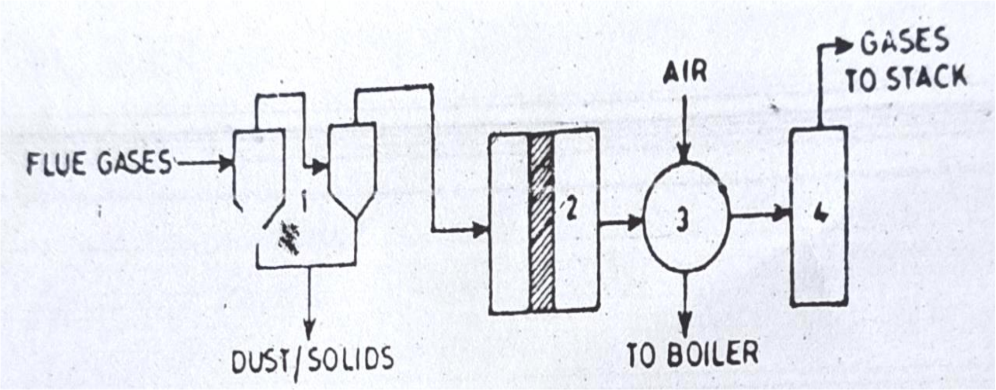
2. DRY PROCESSES

There are, broadly, two types of dry methods employed for the removal SO2 from the exit gases.

a) Oxidation/reduction
b) Use of metal oxides (limestone, Mgo or others)

a) Oxidation/Reduction

In the catalytic oxidation (CAT-OX) or Monsanto process, principally used in sulphuric acid plants, a fixed/fluidized bed reactor with V_2O_5 catalyst at 400-500 ^{O}C is used for good conversion efficiency. If the exit gases are at al lower temperature, they may be heated. The flow diagram for the process is shown in Fig.4. In a modified oxidation process, SO2 and oxygen present In the stack gas are adsorbed on the surface of an active carbon catalyst i which catalyzes the oxidation of SO2 to SO,. SO, subsequently reacts with the moisture present to form H_2SO_4 in the pores of the active carbon. The combined effect of absorption and catalysis by the active carbon can lead to an almost complete conversion of SO. Regeneration of the catalyst can be done by either heating the carbon so that H2SO4 is reduced to SO2 which



(1) MECHANICAL SE PARATORS (2) V_20_5 CATALYST BED (3) HEAT EXCHANGER

(4) ABSORPTION FOR H_2SO_4 RECOVERY

Fig.4 Catalytic oxidation of SOx

can subsequently be uscd in the manufacture of HSO4, or by washing the catalyst with water which takes away the H_2SO4 formed. Figure 5 shows the Lurgi Sulphacid process bascd on the above principle.

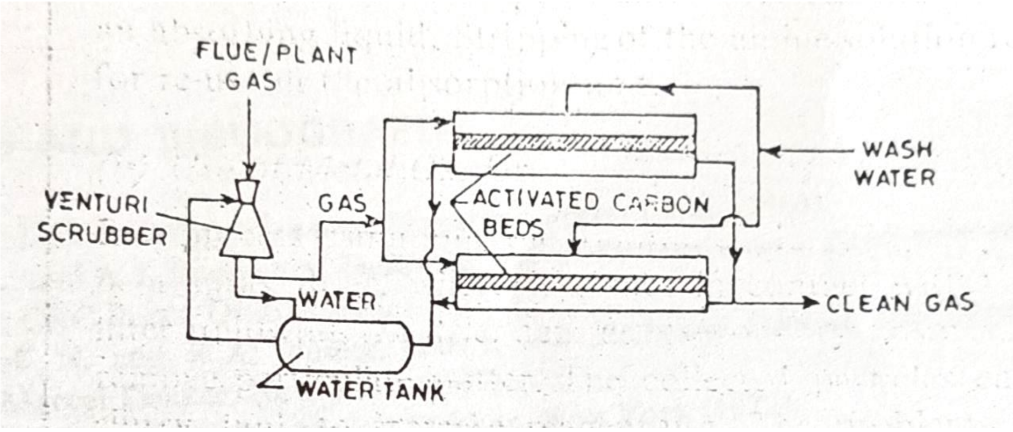


Fig.5 An outline of the lurgi sulphacid process

(b) Use of Metal Oxides

In a process using lime the solution or slurry is pumped through an atomizer in a spray drier, where it comes in contact with hot flue gases. A fabric filter following the drier acts as a secondary absorber as well as helping to remove particulate matter. The collected particles can be recycled into thei slurry tank to increase reagent use. The problems of plugging and solid disposal are reduced but the equipment cost is high.

Magnesium oxide as an adsorbent can also be used, where part of the Oxide reacts with SO_2 forming sulphate. With a working temperature in the range of 100-180 ^{O}C in the entrainment-type absorber, the bulk of the solids l arc collected in a suitable separation device and reused.

The remaining solids arc mixed with ammonia-water-air to produce ammonium sulphate, and the adsorbent reused

In another process. sodium aluminate is used to remove SO2 in a fluidized bed. The adsorbent is regenerated by treating with synthesis gas at 600 to 700^oC. HS formed can be converted to elemental sulphur. The alkalized alumina process employs a co-precipitate of sodium and aluminium oxides with a sodium oxide content of 20 per cent by weight. In the adsorber, counter current contact with up flowing gases takes place, during which SO2 gets oxdized to SO3.which in turn reacts with metal oxides to form sulphates. The spent adsorbent can be regenerated with a reducing gas such s hydrogen, producer gas or reformed natural gas. The H2S formed can be processed for the recovery of elemental sulphur

9. Discuss about the following:

i Monitoring of sulfur oxides. ii) Monitoring of SPM

The monitoring stations chosen should be free from any interference from the surrounding living stock. Sampling is usually done at 1.5 m height. It was ensured that filter is parallel to the ground. To obtain a representative sample the sample should not be placed under a tree, near a wall or other obstructions that would prevent free air flow from the ambient atmosphere.

According to the CPCB (Central pollution control board) the methods prescribed for the pollutant gases and the particulate pollutants are very sensitive ones yet percentage of errors are very less. The methods prescribed for the gases SO2, NOx and the particulate pollutants TSP, PM10 are respectively:

(i) Modified West and Gaeke method
(ii) Modified Jacob Hochheiser method
(iii) High Volume method
(iv) Cyclonic flow technique

i) Modified West and Gaeke method

Sulphur dioxide from air is absorbed in a solution of potassium tetrachloromercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. 25 Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with pararosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer. Concentration of sulphur dioxide in the range of 25-

1050 μg/cu-m can be measured under the conditions given are measure concentration below 25 μg/cu-m by sampling larger volumes of air, but only if, the absorber efficiency of the particular system is first determined and found to be satisfactory. Higher concentration can be analyzed by using smaller gas samples of a suitable aliquot of the collected sampler.