14 ASSIGNMENT TOPICS WITH MATERIALS

UNIT 1:

1. **Describe Transportation is currently the major source of which of the primary pollutants.**

   Carbon monoxide, hydrocarbons, and NOx, One possible way to reduce NO_x in lean exhausts is by using NO_x trap catalysts. This paper addresses storage of NO_x on such catalysts at temperatures below the catalyst light-off. Experiments carried out on commercial samples in synthetic exhausts revealed a large capacity for storage of NO_x when NO_2 was added at temperatures below 150°C. In contrast, when NO was added instead, no storage took place. CO was found to decrease the storage by reacting with NO_2 and forming NO and CO_2. Propene inhibited the reaction between NO_2 and CO and therefore gave rise to larger NO_x storage when CO was present. The paper concludes with a discussion of a possible mechanism for the storage of NO_x at low temperatures.

   2.Describe the relative success of regulatory programs in reducing emissions of CO, NOx, sulfur oxides?

   To develop these targets and to determine how the targets will be allocated among the covered sectors, the government undertook a benchmarking exercise. This involved assessing the environmental performance, the technology and operating practices, and the most stringent operating permits of existing regulatory regimes in Canada and other jurisdictions. For some sectors, these regulatory limits or emission performance levels were adapted to take into account characteristics specific to those sectors in Canada, including the financial situation of the sector, potential impacts on the economy, and the raw materials used relative to the benchmarked jurisdiction. The results of this benchmarking exercise and the date of coming into force will be validated through discussions with provinces and territories, each of the covered sectors, and labour, environmental and health groups over the next several months. To provide flexibility in meeting their emission caps, there will be two options for firms to meet their legal obligations

   3.Why are CO and CO2 air quality concerns?

   Carbon monoxide is a concern because it can adversely affect human health at elevated concentrations. Carbon dioxide is a major greenhouse gas that can cause global warming.

   4.How are CO and CO2 removed from the atmosphere?

   Water and carbon dioxide are byproducts. Notice that photosynthesis and respiration are essentially the opposite of one another. Photosynthesis removesCO2 from the atmosphere and replaces it with O2. Respiration takes O2 from the atmosphere and replaces it with CO2.

5.Describe the relative significance of emissions of SOx and reduced sulfur compounds to the atmosphere.

Sulfur dioxide is an atmospheric pollutant that can adversely affect humans, plants, and materials. On conversion to H2SO4, it is the major contributor to acidic deposition and visibility reduction. Reduced sulfur compounds are minor pollutants that primarily cause malodor problems.

6.Three major nitrogen oxides are naturally present in the atmosphere and are released to it by natural and anthropogenic sources.

Only about 10% of all NOx emissions come from anthropogenic sources (Godish 1991). The rest is produced naturally by anaerobic biological processes in soil and water, by lightning and volcanic activity, and by photochemical destruction of nitrogen compounds in the upper atmosphere. About 50% of emissions from anthropogenic sources comes from fossil-fuel-fired heat and electricity generating plants and slightly less from motor vehicles. Other sources include industrial boilers, incinerators, the manufacture of nitric acid and other nitrogenous chemicals, electric arc welding processes, the use of explosives in mining, and farm silos. These are N2O, NO, and NO2.

7.What is ozone and where is it in the atmosphere?

The **ozone** layer or **ozone** shield is a region of Earth's stratosphere that absorbs most of the Sun's ultraviolet radiation. It contains high concentrations of **ozone**(O_3) in relation to other parts of the **atmosphere**, although still small in relation to other gases in the stratosphere.

8.Why do we care about atmospheric ozone?

In contrast, excess ozone at Earth's surface that is formed from pollutants isconsidered “bad” ozone because it can be harmful to humans, plants, and animals. The ozone that occurs naturally near the surface and in the lower atmosphere isalso beneficial because ozone helps remove pollutants from the atmosphere.

9.Is total ozone uniform over the globe?

Total ozone at any location on the globe is found by measuring all the ozone in the atmosphere directly above that location. Total ozone includes that present in the stratospheric ozone layer and that present throughout the troposphere (see Figure Q1-2). The contribution from the troposphere is generally only about 10% of total ozone. Total ozone values are often reported in Dobson units, denoted “DU.” Typical values vary between 200 and 500 DU over the globe (see Figure Q4- 1). A total ozone value of 500 DU, for example, is equivalent to a layer of pure ozone gas on Earth’s surface having a thickness of only 0.5 centimeters (0.2 inches).

10.How is ozone measured in the atmosphere?

Ozone is measured in what are called Dobson units. A Dobson unit of gas is equal to a layer of gas, at the surface of the Earth, with a thickness of one hundredth of a millimeter. The ozone in the atmosphere is about 300 Dobsons.

UNIT 2:

1.Why can't polluted air in most cases penetrate an inversion layer? Indicate the physical principles involved.

Air moves across an energy gradient from warmer to cooler. Polluted air cannot move through air that is warmer than it is.

2.How are subsidence inversions produced?

A subsidence inversion develops when a widespread layer of air descends. The layer is compressed and heated by the resulting increase in atmospheric pressure, and as a result the lapse rate of temperature is reduced. If the air mass sinks low enough, the air at higher altitudes becomes warmer than at lower altitudes, producing a temperature inversion. Subsidence inversions are common over the northern continents in winter and over the subtropical oceans; these regions generally have subsiding air because they are located under large high-pressure centres.

3. Characterize subsidence inversions relative to their vertical temperature profile, geographical scale, and persistence.

Subsidence inversions are characterized by decreasing lapse rate conditions with altitude above the ground, with inverted lapse rate conditions occurring hundreds – thousands of feet above the ground. They affect an area of hundreds of thousands of square kilometers and may persist for days.

4.What meteorological factors affect plume rise?

Air movements influence the fate of air pollutants. So any study of air pollution should include a study of the local weather patterns (meteorology).If the air is calm and pollutants cannot disperse, then the concentration of these pollutants will build up. On the other hand, when strong, turbulent winds blow, pollutants disperse quickly, resulting in lower pollutant concentrations.Meteorological data helps: identify the source of pollutants, predict air pollution events such as inversions and high-pollutant concentration days,simulate and predict air quality using computer models.When studying air quality, it is important to measure the following factors as they can help us understand the chemical reactions that occur in the atmosphere wind speed and direction, temperature, humidity, rainfallsolar radiation.

5.Under what lapse rate conditions are looping, coning, and fanning plumes produced?

LOOPING:

It is a type of plume which has a wavy character. It occurs in a highly unstable atmosphere because of rapid mixing. The high degree of turbulence helps in

dispersing the plume rapidly but high concentrations may occur close to the stack if the plume touches the ground.

CONING:

It is a type of plume which is shaped like a CONE.This takes place in a near neutral atmosphere,when the wind velocity is greater than 32 km/hr. However the plume reaches the ground at greater distances than with loping.

FANNING:

It is a type of plume emitted under extreme inversion conditions. the plume under these condition will spread horizontally, but little if at all vertically. Therefore the prediction of ground level concentration (SLC) is difficult here.

6.When do maximum ground level concentrations of pollutants occur in mountain valleys? Why?

Maximum ground level concentrations occur a few hours after sunrise when inversion layers are broken up and brought to the ground.

7.What is an urban plume? How is it formed?

An urban plume is the large mass of polluted air that moves downwind of a city. It is produced from emissions from both mobile and stationary sources.

8.What air quality problems are associated with long-range transport?

Long-range transport results in elevated pollutant concentrations hundreds to thousands of miles downwind. It increases background levels in areas subject to regulatory compliance with air quality standards.

9. By what mechanisms are pollutants transported into the stratosphere?

These include (1) a uniform rising motion across the tropical tropopause, (2) in the middle latitudes, rising along surfaces of constant potential temperature that cross into the tropopause, and (3) in events known as tropopause folds.

10.What is dry deposition? What factors contribute to increased deposition rates?

Dry deposition is the removal of pollutants from the atmosphere in the absence of precipitation. Deposition rates for gas-phase pollutants are affected by their reactivity with surfaces and solubility in water.

UNIT 3

1. List the advantages and disadvantages of fabric filters.

(1) Very high collection efficiencies possible (99.9 + per cent) with a wide range of inlet grain loadings and particle size variations. Within certain limits fabric collectors have a constancy of static pressure and efficiency, for a wider range of particle sizes and concentrations than any other type of single dust collector.
(2) Collection efficiency not affected by sulfur content of the combustion fuel as in ESPs.
(3) Reduced sensitivity to particle size distribution.
(4) No high voltage requirements.
(5) Flammable dust may be collected.
(6) Use of special fibers or filter aids enables sub-micron removal of smoke and fumes.
(7) Collectors available in a wide range of configurations, sizes, and inlet and outlet locations.

2. Describe Source Correction Method.

Source correction methods: In case of industrial pollutants, the designing and development of plants may be so selected so as to have minimum emission of air pollutants.

Examples:
By suitable design modification of the tanks, evaporation from petroleum refineries can be minimized.Use of correct grade of raw material like low-sulphur oil and coal is recommended Cleaning of gaseous effluents'. These techniques control pollution by the removal of pollutants from the exhaust. These methods are used in combination with source correction methods.

For gaseous pollutants:
The gaseous pollutants are removed by absorption in a liquid, or adsorption on a solid. Catalytic converters are also used as they convert gaseous air pollutants into harmless gases.

For particulates:
Following techniques are generally used for control of particulate emissions.

I. Gravitational settling chambers,

II. Cyclone separators,

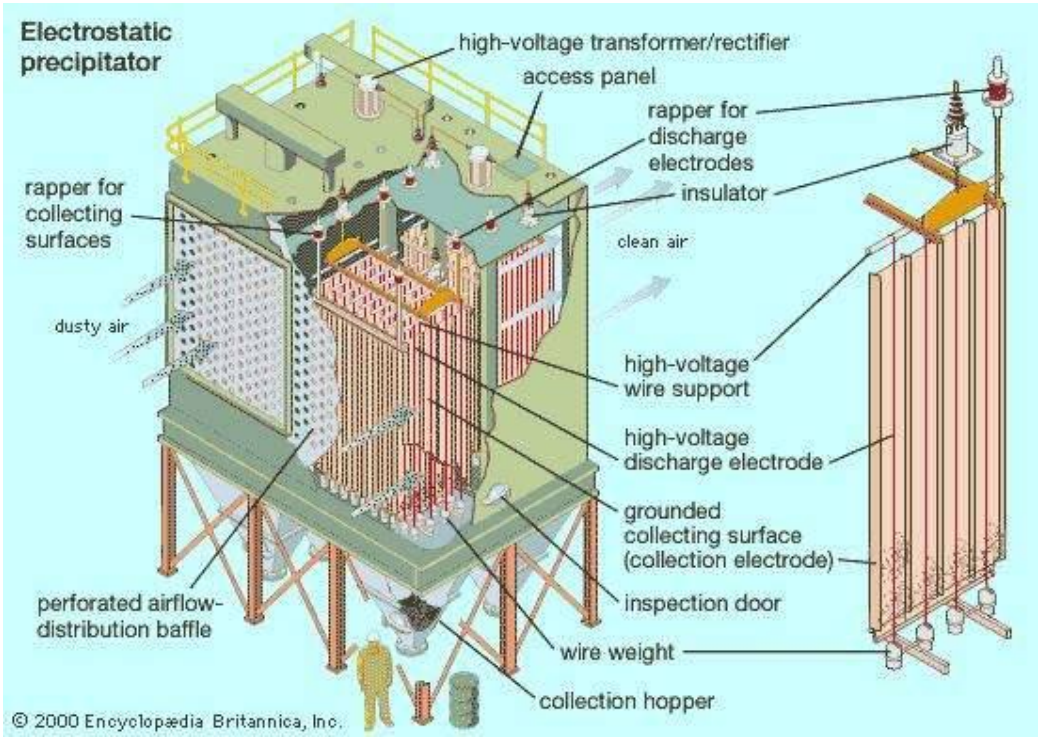
III. Fabric Filters,

IV. Electrostatic precipitators,

3.Explain Electrostatic Precipitators.

Electrostatic precipitator, also called electrostatic air cleaner, a device that uses an electric charge to remove certain impurities—either solid particles or liquid droplets—from air or other gases in smokestacks and other flues. The precipitator functions by applying energy only to the particulate matter being collected, without significantly

impeding the flow of gases. Originally designed for recovery of valuable industrial-process materials, electrostatic precipitators are used for air pollution control, particularly for removing particles from waste gases at industrial facilities and power-generating stations.



Precipitators function by electrostatically charging particles in the gas stream. The charged particles are attracted to and deposited on plates or other collection devices. The treated air then passes out of the precipitator and through a stack to the atmosphere. When enough particles have accumulated on the collection devices, they are shaken off the collectors by mechanical rappers. The particulates, which can be either wet or dry, fall into a hopper at the bottom of the unit, and a conveyor system transports them away for disposal or recycling. Precipitators are often deployed with denitrification units that remove nitrogen oxides and scrubbers or other devices that remove sulfur dioxide.

The most basic precipitator design consists of a row of thin vertical wires and a stack of large flat vertical metal plates. The plates are spaced from less than 0.5 inch (1.3 cm) to about 7 inches (about 17.8 cm) apart, depending on the application. The gas stream flows horizontally between the wires and through the stack of plates. A negative charge of several thousand volts is applied between the wires and plates to remove impurities from the gas stream.

Plate precipitators are often marketed to the public as air purifiers or as a permanent replacement for furnace filters. Unlike some other air purification technologies, they typically do not become breeding grounds for harmful forms of bacteria. Yet, the plates can be difficult to clean and can also produce osszone and nitrogen oxides. Some consumer precipitation filters are sold with special soak-off cleaners that allow the entire plate array to be removed and soaked for several hours, which loosens the particulates.

In many industrial plants, particulate matter created in the manufacturing process is released as dust in the hot exhaust gases. If released into the atmosphere, the particulates reduce visibility, can contribute to climate change, and lead to serious health problems in humans, including lung damage and bronchitis. Fine particles that are smaller than 2.5 microns (0.0001 inch) in diameter can be especially dangerous because they are drawn deep into the lungs and can trigger inflammatory reactions.

Electrostatic precipitators are important tools in the process of cleaning up flue gases. They are highly effective at reducing particle pollution, including those particles whose sizes approximate 1 micron (0.00004 inch) in diameter, and some precipitators can remove particles of 0.01 micron in diameter. In addition, they can handle large volumes of gas at various temperatures and flow rates, removing either solid particles or liquid droplets.

4. Write the concept behind wet scrubbers?

Wet scrubbers are effective air pollution control devices for removing particles and/or gases from industrial exhaust streams. A wet scrubber operates by introducing the dirty gas stream with a scrubbing liquid – typically water. Particulate or gases are collected in the scrubbing liquid. Wet scrubbers are generally the most appropriate air pollution control device for collecting both particulate and gas in a single system.

Pollution Systems offers a variety of wet scrubber systems specifically designed for your process application. Many important operating variables are considered when evaluating the size and type of scrubber for any specific application, and your deadline is always a factor in our responsiveness. We will work with you and use our experience and knowledge to provide the proper solution for your process.

Typical wet scrubber systems consist of a scrubbing vessel, ductwork and fan system, mist eliminator, pumping (and possible recycle system), spent scrubbing liquid treatment and an exhaust stack. Modern controls are used to monitor the system and make any necessary adjustments.

Wet scrubbers are common in many industrial applications including pollutant reduction at petroleum refineries, chemical processes, acid manufacturing plants, and steel making.

Wet Scrubber Service

At Pollution Systems, we have the skills and experience to evaluate your systems performance and effectiveness. We are able to make any necessary repairs and improvements to optimize your equipment. In addition to studying the air and liquid streams and pressure drops, we will evaluate your current equipment design relative to your process to assess the opportunities for improvement. We can then develop an engineered solution to provide you with a pollution system which will be efficient and effective well into the future.

4. **List out the types of wet scrubbers**.

Types of Wet Scrubbers

- Chemical Scrubbers / Gas Scrubbers
- Particulate Scrubbers / Venturi Scrubbers
- Ammonia Scrubbers
- Chlorine Scrubbers
- Particulate / Dust Scrubbers
- Sulfuric Acid Scrubbers

Typical wet scrubber systems consist of a scrubbing vessel, ductwork and fan system, mist eliminator, pumping (and possible recycle system), spent scrubbing liquid treatment and an exhaust stack. Modern controls are used to monitor the system and make any necessary adjustments.

Wet scrubbers are common in many industrial applications including pollutant reduction at petroleum refineries, chemical processes, acid manufacturing plants, and steel making.

5. **What do you mean by inertial impaction, interception and diffusion**?

inertial impaction

The deposition of large aerosol particles on the walls of an airway conduit. The **impaction** tends to occur where the airway direction changes. Small particles have less inertia and are more likely to be carried around corners and continue in the path of the airflow.

Interception

refers to precipitation that does not reach the soil, but is instead **intercepted** by the leaves, branches of plants and the forest floor. It occurs in the canopy (i.e. canopy **interception**), and in the forest floor or litter layer (i.e. forest floor **interception**)'

Diffusion

Micrometeorology fundamentals, variation of wind, temperature and water in the lower layers of the atmosphere energy and moisture balances. Flux profile relationships. Estimation of atmospheric dispersion - diffusion equations, effects of stability, estimation of vertical and horizontal dispersion, evaluation of wind speed, accuracy of estimates, calculation of maximum ground level concentrations, estimates of deposition. Effective height of emission and maximum concentration, estimate of required Stake heights, effects of evaporative cooling, effect of aerodynamic downwash, effects of gravity. Concentrations in an inversion, break-up fumigation, plum trapping, concentrations at ground level compare to concentrations at the level of effective stake height from elevated continuous sources, total dosage from a finite release, cross wind integrated concentration, estimation of concentration for sampling times longer than a few minutes estimation of seasonal or annual average concentrations at a receptor from a single pollutants source. Meteorological conditions associated with maximum ground level concentrations - Concentrations at a receptor point from several sources - instantaneous sources - relation to other diffusion equations. Urban air pollution models: different types, their accuracies and transport models.

6. **What is the difference between dry and wet scrubbers**?

Wet **scrubber** is a device that removes pollutants from a furnace flue gas or from other gas streams. In wet scrubbers, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid so as to remove the pollutants. Wet scrubbers remove pollutant gases by **dissolving** or **absorbing the pollutants** into the liquid.

Advantages and Disadvantages of Wet Scrubbers:

Advantages:

1. Relatively small space requirements
2. Can collect gases as well as particulates
3. Can handle high-temperature, high-humidity gas streams
4. Capital cost low and after the particulate matter is collected, it cannot escape from hoppers or during transport.
5. Various dry dusts are flammable. Using water eliminates the possibility of explosions.
6. High collection efficiencies on fine particulates
7. Handle gas streams containing flammable or explosive materials.
8. Wet scrubbers can neutralize corrosive gases.

Disadvantages:

1. Possible creation of water-disposal problem and the product collected is wet.
2. Moist exhaust gas precludes use of most additional controls
3. Pressure-drop and horsepower requirements are possibly high and Solids buildup at the wet-dry interface might be a problem
4. Relatively high maintenance costs and Must be protected from freezing
5. Low exit gas temperature reduces exhaust plume dispersion

Dry scrubber :

A dry Scrubbing system does not saturate the flue gas stream that is being treated with moisture. In some cases no moisture is added; while in other only the amount of moisture that can be evaporated in the flue gas without condensing is added. Dry scrubbers generally do not have wastewater handling/disposal requirements. Dry scrubbing systems are used to remove acid gases(such as SO2 and HCl) primarily from combustion sources

Advantages and Disadvantages of Dry Scrubbers

Advantages:

1. No wet sludge is produced.

2. Relatively small space requirements
3. Can collect acid gases at high efficiencies
4. Can handle high-temperature gas streams
5. Dry exhaust allows addition of fabric filter to control particulate

Disadvantages

1. Acid gas control efficiency not as high as with wet scrubber

7. What are the most polluted cities in the world?

India should follow China's example and clean up the air in its cities, which are among the world's worst for outdoor pollution, the World Health Organization said on Wednesday.

The WHO's database of more than 4,300 cities showed Indian cities such as New Delhi, Varanasi and Patna were among the most polluted, based on the amount of particulate matter under 2.5 micrograms found in every cubic metre of air.

Chinese cities such as Xingtai and Shijiazhuang and the Saudi refining hub at Jubail were also highly polluted, but the data for those places was 4-5 years old, and Maria Neira, WHO's head of public health, said China had made big improvements that India should follow

"There is a big step at the government level (in China) declaring war on air pollution," Neira said. "One of the reasons for that is that the health argument was very strongly presented, and the fact that the citizens were really breathing air that was totally unacceptable."

"We would be very happy if we would see a similar movement now in India which is one of the countries for which we are particularly concerned, although there are good initiatives which can be put in place quickly, still the levels are very high and we would like to see a similar decision and leadership."

The WHO says nine out of 10 people on the planet breathe polluted air, and it kills 7 million people each year, almost all of them in poor countries in Asia and Africa. About a quarter of deaths from heart disease, stroke and lung cancer can be attributed to air pollution, the WHO says.

Globally, outdoor air pollution has remained high and largely unchanged in the past six years, while household air pollution has got worse in many poorer countries, as people continue to cook with solid fuel or kerosene, instead of cleaner fuels such as gas and electricity.

9. What are the implications of Air pollution for public health?

Greenhouse gas emissions, including ozone (O3), carbon dioxide (CO2) and particulate matter from fossil fuels, not only cause climate change but also pollute the breathable air, causing many public health problems.

10. Describe the nature of, and need for, stack sampling?

Stack sampling. Air sampling from stacks is one of the main measures used for testing for airborne pollutants from focal industrial sources.The air sampling fromstacks department has dozens of tests, who allow for up to five teams to operate simultaneously.

UNIT 4:

1.List out the methods to control gaseous pollutants.

The techniques and devices used to control a gaseous **pollutant** depend on the properties of the specific gas to be controlled. The techniques or control methods are generally classified as absorption, adsorption, combustion, closed collection and recovery system as well as masking and contraction.

1. **List out the equipments use to remove gaseous pollutants using principal of absorption.**

Different types of absorbers are used for control of gaseous pollutants. These include spray towers, plate or tray towers and packed towers. The gas absorption units are so designed that there occurs an intimate contact between the gas and the liquid. This will ensure optimal absorption of gas into the liquid.

Spray towers: They can efficiently remove gaseous pollutants, besides the particulates. These devices are particularly useful for the removal of pollutant gases with high concentrations of particulates.

Plate or tray towers: These absorbers are designed with horizontal trays or plates so as to provide large liquid-gas interfacial surface. In the perforated tray tower, the absorbent enters the column from the top, spills and flows in a zigzag fashion. The polluted air enters the column from an inlet at the side of the bottom. As the air passes through the openings of the trays, it gets in close contact with liquid due to repeated exposure. This enables the removal of gaseous as well as particulate pollutants. The clean gas emerges at the top.

Packed towers: In this case, the liquid (absorbent) is sprayed over a packing material (e.g. all rings, Berl saddles) with large surface to volume ratio The air with gaseous pollutants enters from the side of the bottom of the tower and the clean air comes out from the top.

3.Write short notes on extraction of sulphur from fuels.

In the HYD pathway mechanism, the primary reaction products formed directly from DBT are tetrahydrodibenzothiophene (THDBT) and/or hexahydrodibenzothiophene (HHDBT). Both THDBT and HHDBT are very reactive intermediates and are difficult to isolate for detection. These compounds get further desulfurized to form cyclohexylbenzene (CHB) as the secondary product. This pathway is referred to as HYD pathway since the sulfurcompound is hydrogenated prior to desulfurization. Direct C–S bond hydrogenolysis of DBT gives biphenyl *via* DDS pathway. Sequential hydrogenation of biphenyl produces CHB.

Bicyclohexyl (BiCh) is the tertiary product formed in traces *via* the slow hydrogenation of CHB formed by any of the two pathways.

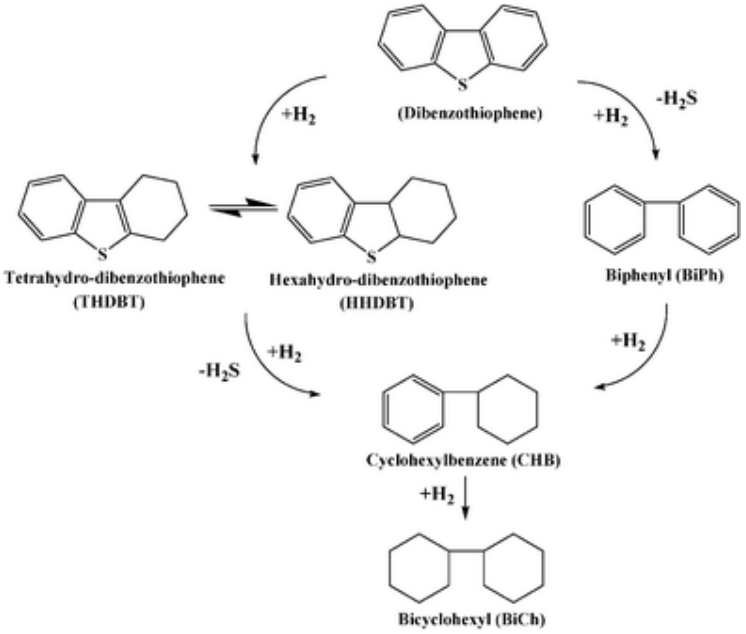


Fig. 1 Pathways for the HDS of DBT at 300 °C and 102 atm in the presence of $CoMo/Al_2O_3$.[28]

This indicates that HYD is a better route for increasing the desulfurization extent of the refractory compounds. The desulfurization rate of hindered compounds is greatly increased through the HYD route. Without one or both of the rings, the sulfur molecule becomes much more flexible, and the sulfur atom approaches the catalyst surface much easily and gets removed. In general, when the unpaired electrons of the sulfur can resonate with the pi electrons of the organic structure, the energy of the carbon-sulfur bond (C–S) becomes practically identical with that of the carbon-carbon (C–C) bond. This leads to a reduction in the selectivity of the HDS process, and hydrogenation of carbon-carbon bonds happens. Saturated hydrocarbons lead to a lower-grade fuel, and require additional processing steps

4. What do you mean by Desulphurization of fuel oil?

Desulfurization is the removal of sulfur or sulfur compounds (as from coal or flue gas), mostly from fuels. The most commonly required desulfurization process is in natural gas, but it is also required for flue gas, coal and oil.

Desulfurization of fuel oils such as diesel, fluidized catalytic cracking (FCC)gasoline, kerosene, jet fuel and heating oil is an important practice in oil refining. Sulfur compounds (S-compounds) in fuel oils are undesirable as they create problems during refining as well as during their commercial use.

Sulfur in crude oil, natural gas, process gas and natural gas liquids (LNG) may take many forms, including hydrogen sulfide (H_2S), carbonyl sulfide (COS), sulfur oxides (SOx) and the whole family of mercaptans.

High sulfur levels in fuel, when combined with water vapor, can cause corrosive wear on valve guides and cylinder liners, which can lead to premature engine failure.

5.Differentiate between Absorption and Adsorption.

Adsorption	**Adsorption**	
Definition	Assimilation of molecular species throughout the bulk of the solid or liquid is termed as absorption.	Accumulation of the molecular species at the surface rather than in the bulk of the solid or liquid is termed as adsorption.
Phenomenon	It is a bulk phenomenon	It is a surface phenomenon.
Heat exchange	Endothermic process	Exothermic process
Temperature	It is not affected by temperature	It is favoured by low temperature
Rate of reaction	It occurs at a uniform rate.	It steadily increases and reaches equilibrium
Concentration	It is same throughout the material.	Concentration on the surface of adsorbent is different from that in the bulk

6. List the equipments use to control waste gases by combustion.

Incineration;

Incineration is used to convert VOC emissions into carbon dioxide and water through combustion. The incineration generally takes place in a specialized piece of equipment known as an afterburner, which is built to create the conditions necessary for complete combustion (such as sufficient burn time and a high temperature). Additionally, the incinerated gas must be mixed to ensure complete combustion.

7. Explain Thermal and Catalytic incinerators.

Thermal incinerator

The heart of the thermal incinerator is a nozzle-stabilized flame maintained by a combination of auxiliary fuel, waste gas compounds and supplemental air added when necessary. Upon passing through the flame, the waste gas is heated from its inlet temperature to its ignition temperature. The ignition temperature varies for different compounds and is usually determined empirically. It is the temperature at which the combustion reaction rate (and consequently the energy production rate) exceeds the rate of heat losses, thereby raising the temperature of the gases to some higher value. Thus, any organic/air mixture will ignite if its temperature is raised to a sufficiently high level. The organic-containing mixture ignites at some temperature between the preheat temperature and the reaction temperature. That is, ignition, as defined in this section, occurs at some point during the heating of a waste stream as it passes through the nozzle-stabilized flame regardless of its concentration. The mixture continues to react as it flows through the combustion chamber.

Catalytic incinerators

Catalytic incinerators employ a bed of active material (catalyst) that facilitates the overall combustion reaction given in The catalyst has the effect of increasing the reaction rate, enabling conversion at lower reaction temperatures than in thermal incinerator units. Nevertheless, the waste stream must be preheated to a temperature sufficiently high (usually from 300 to 900 F) to initiate the oxidation reactions. The waste stream is preheated either directly in a preheater combustion chamber or indirectly by heat exchange with the incinerator's effluent or other process heat or both The preheated gas stream is then passed over the catalyst bed. The chemical reaction (combustion) between the oxygen in the gas stream and the gaseous pollutants takes place at the catalyst surface. Catalytic incineration can, in principle, be used to destroy essentially any oxidizable compound in an air stream. However, there are practical limits to the types of compounds that can be oxidized due to the poisoning effect some species have on the

catalyst. These limits are described below. In addition, most configurations require a low heating value of the inlet gas and a particulate content which is less than some small value. Until recently, the use of catalytic oxidation for control of gaseous pollutants has really been restricted to organic compounds containing only carbon, hydrogen and oxygen. Gases containing compounds with chlorine, sulfur, and other atoms that may deactivate the supported noble metal catalysts often used for VOC control were not suitably controlled by catalytic oxidation systems.

8. Explain "Absortion by liquids" and "Adsorption by solids" .

This is a quite widespread phenomenon which has not been recognized before. We call it solid/solid adsorption. This phenomenom may be attributed to the formation of strong surface bonds between the atoms, ions or molecules of these solids and the surface of the supports. Another driving force for this phenomenon is the entropy increase associated with the changing from an ordered three-dimensional crystalline phase to a less ordered two-dimensional phase. In addition, the diffusion of atoms along the surface is much easier than that into the bulk of a support, so under suitable conditions the monolayer dispersion may be a stable state.

9. Explain the working principal of typical fixed bed operating on a batch cycle.

Fixed-bed operations are widely used in pollution control processes such as removing toxic organic compounds and separating ions by an ion exchange bed by adsorption. In a batch operation, the adsorbent and adsorbate are in contact for a period of time until equilibrium is reached. In a column operation, adsorbate continuously enters and leaves the column; therefore, equilibrium is never achieved at any stage. As the solution flows down the column, the feed zone, which is the upper part of the packed adsorbent, will be saturated and the low concentration of adsorbate will encounter fresh adsorbent material at the bottom of the packing. The overall performance of the column is judged by its service time, which can be defined as the time the adsorbed adsorbate breaks through the column bed and is detected in the effluent.

10.Explain The major difference between batch and fixed-bed operations is in equilibrium establishment.

At that time, the column is considered to be saturated and column operation can be stopped. Continuous operation is the most suitable mode from both an economical and process control point of view. The continuous sorption process is usually characterized by the so-called breakthrough curves, that is, a representation of the pollutant effluent concentration versus time profile in a fixed-bed column. The major difference between batch and fixed-bed operations is in equilibrium establishment.

Column adsorption is more practical and more efficient to remove pollutants from real wastewater using fixed-bed columns. Fixed-bed operations have been widely used in various chemical industries for removing pollutants because of their simple operation and good adsorption capacity. A fixed-bed continuous flow column is an effective process for cyclic adsorption/desorption, as it makes the best use of the concentration difference driving force for adsorption, allows for a more efficient utilization of the adsorbent

capacity, and results in better quality of the effluent. The performance of the fixed-bed columns in terms of a priori design and their optimization are described using the breakthrough curve concept. The breakthrough curve illustrates the behavior of a fixed-bed column from the point of view of the pollutant quantity that can be retained and is usually expressed in terms of a normalized concentration defined as the ratio of the effluent metal concentration to inlet concentration, as a function of flow time or volume of the effluent for the fixed-bed depth. The breakthrough curve is a representation of the pollutant effluent concentration versus time profile in a fixed-bed column. In addition, breakthrough curve prediction through mathematical models is a useful tool for scale-up and design purposes.

In a column, a solution is passed through a bed of sorbent beads where its composition is changed by sorption. The composition of the effluent and its change with time depend on the properties of the sorbent, the composition of the feed, and the operating conditions (flow rate, bed height, etc.). As the wastewater is fed into the column, most of the mass transfer takes place near the inlet of the bed, where the fluid first comes in contact with the sorbent. If the solid contains no sorbate at the start, the concentration in the fluid drops exponentially to zero before the end of the bed is reached. As the process starts, the solid near the inlet is nearly saturated, and most of the mass transfer takes place farther from the inlet. The concentration gradient is S-shaped. The region where most of the change in concentration occurs is called the mass transfer zone. This is the real behavior of the mass transfer process in fixed beds. When the axial or radial mass transfer resistances are neglected, sorption occurs homogeneously, and this is the ideal case. In fact, mass transfer resistances can be minimized but not effectively eliminated. Comments about such phenomenon will be better detailed. The limits of the breakthrough curve are often taken as C/C_o values of 0.05-0.95, unless any other recommendation is fixed. This is the case with wastewater treatment of highly toxic sorbates. When the concentration reaches the limiting permissible value or zero value, it is considered the break point. The flow is stopped, the column is regenerated, and the inlet concentration is redirected to a fresh sorbent bed.

UNIT 5:

1. **Give the Indian Air Quality Standards (SPM, SO2, NOx, CO) for Residential, Industrial and Sensitive areas**.

   Sulphur Dioxide (SO2), µg/m3 Annual* 24 hours** 50 80 20 80

   Nitrogen Dioxide (NO2), µg/m3 Annual* 24 hours** 40 80 30 80

   Particulate Matter (size less than 10 µm) or PM10 µg/m3 Annual* 24 hours** 60 100 60 100 Particulate Matter (size less than 2.5 µm) or PM2.5 µg/m3 Annual* 24 hours** 40 60 40 60

   Carbon Monoxide (CO) mg/m3 8 hours* 1 hour** 02 04 02 04

2. **What are regulations for air pollution control?**

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. ... One of the goals of the Act was to set and achieve NAAQS in every state by 1975 in order to address the public health and welfare risks posed by certain widespread air pollutants.

3. **Describe the air quality standards.**

Pollutant	**Time Weighted Average**	**Concentration in Ambient Air**	
		Industrial, Residential, Rural and Other Areas	**Ecologically Sensitive Area (notified by Central Government)**
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO_2),	Annual*	40 80	30 80

µg/m^3	24 hours**		
Particulate Matter (size less than 10 µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60
Ozone (O_3) µg/m^3	8 hours* 1 hour**	100 180	100 180
Lead (Pb) µg/m^3	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH_3) µg/m^3	Annual* 24 hours**	100 400	100 400
Benzene (C_6H_6) µg/m^3	Annual*	5	5
Benzo(a)Pyrene (BaP)- particulate phase only, ng/m^3	Annual*	1	1
Arsenic(As), ng/m^3	Annual*	6	60
Nickel (Ni), ng/m^3	Annual*	20	20
* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of			

monitoring.

4. Classify the Sampling Methods.

Sampling Methods can be classified into one of two categories:

Probability Sampling: Sample has a known probability of being selected
Non-probability Sampling: Sample does not have known probability of being selected as in convenience or voluntary response surveys

Probability Sampling
In probability sampling it is possible to both determine which sampling units belong to which sample and the probability that each sample will be selected. The following sampling methods are examples of **probability sampling**:
1. Simple Random Sampling (SRS)
2. Stratified Sampling
3. Cluster Sampling
4. Systematic Sampling
5. Multistage Sampling (in which some of the methods above are combined in stages)

Non-probability Sampling
The following sampling methods that are listed in your text are types of non-probability sampling that should be avoided:
1. Volunteer samples
2. Haphazard (convenience) samples

5.Differentiate intermittent and continuous sampling.
In intermittent sampling, air is collected for a distinct interval over which the concentration is integrated. In continuous sampling, real-time data is collected continuously 24 hours/day, etc.

6.List the preliminary information required before sampling.

Site selection
Air sampling indoors
Air sampling outdoors
2. Collecting the sample
3. Quality assurance
4. Quality control
5. Shipping and storage

7. How do you select air sampling station?

The recommended criteria for siting the monitoring stations

1. The site is dependent upon the use/purpose of the results of the monitoring programs.

2. The monitoring should be carried out with a purpose of compliance of air quality standards.

3. Monitoring must be able to evaluate impacts of new/existing air pollution sources.

4. Monitoring must be able to evaluate impacts of hazards due to accidental release of chemicals.

5. Monitoring data may be used for research purpose.

8. Write short notes on stack sampling.

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

9. What do you mean by Air pollution control act , write short notes on it .

The Air Pollution Control Act of 1955 was the first Clean Air Act (United States) enacted by Congress to address the national environmental problem of air pollution on July 14, 1955. This was "an act to provide research and technical assistance relating to air pollution control". The act "left states principally in charge of prevention and control of air pollution at the source". The act declared that air pollution was a danger to public health and welfare, but preserved the "primary responsibilities and rights of the states and local government in controlling air pollution".

The act put the federal government in a purely informational role, authorizing the United States Surgeon General to conduct research, investigate, and pass out information "relating to air pollution and the prevention and abatement thereof".Therefore, The Air Pollution Control Act contained no provisions for the federal government to actively combat air pollution by punishing polluters. The next Congressional statement on air pollution would come with the Clean Air Act of 1963.

The Air Pollution Control Act was the culmination of much research done on fuel emissions by the federal government in the 1930s and 1940s. Additional legislation was passed in 1963 to better fully define air quality criteria and give more power in defining what air quality was to the secretary of Health, Education, and Labor. This additional

legislation would provide grants to both local and state agencies. A replacement, the Clean Air Act (United States) (CAA), was enacted to replace the Air Pollution Control Act of 1955. A decade later the Motor Vehicle Air Pollution Control Act was enacted to focus more specifically on automotive emission standards. A mere two years later, the Federal Air Quality Act was established to define "air quality control regions" scientifically based on topographical and meteorological facets of air pollution.

10. Distinguish between quality assurance and quality control as they are applied to Air quality monitoring activities.

Quality assurance is the overall program that sets data quality objectives, reviews collection activities, etc. Quality control focuses on the technical aspects of data quality programs, e.g., calibrations, audits, etc.

KG REDDY College of Engineering & Technology

16 UNIT WISE-QUESTION BANK

Assignment Question

Unit 1

Two marks question with answers

1. What is the chemical composition of the atmosphere?

   Ans - 78% Nitrogen, 21% Oxygen, 1% other gases including CO_2

2. What is the innermost layer called?

   Ans-Troposphere

3. How thick are these layers?

   Ans- T = 11 miles at equator, 5 miles at poles. S - above T to @ 30 miles

4. What layer does the most filtering?

   Ans –Stratosphere

5. What are some examples of natural air pollution?

   Ans -volcanoes, forest fires, dust storms, seas salt nuclei form wave action, pollen, mold spores.

Three marks question with answers

1) What is the difference between primary and secondary air pollutants?

   Ans -Primary added directly to air, secondary is formed as a result of chemical and physical reactions between the primary pollutants and other atmospheric components such as water vapor or each other..

2) What are some examples of each?

   Ans -Primary includes carbon, sulfur, and nitrogen and their oxides and hydrocarbons. Secondary include oxides and salts of the primary and compounds such as ozone and PAN. What is a VOC and what are some examples. Volatile organic compound -- methane, propane, CFC's, gasoline.

3) What is the difference between London smog and LA smog?

   Ans -London is a mixture of fog and smoke it occurs in cool foggy areas, LA is caused by a photochemical reaction between the pollutants (mostly from auto exhaust and industry) and light and occurs in warm sunny areas.

4). Define air pollution.

   Ans - Air pollution is probably one of the most serious environmental problems confronting our civilization today. Most often, it is caused by human activities such as mining, construction, transportation, industrial work, agriculture, smelting, etc. However, natural processes such as volcanic eruptions and wildfires may also pollute the air, but their occurrence is rare and they usually have a local effect, unlike human activities that are ubiquitous causes of air pollution and contribute to the global pollution of the air every single day.

5.Describe sources of natural air pollution and their air quality significanc?

   Ans -Natural sources are emissions from biological, geological, and other processes. These include biological decomposition, volatilization of volatile chemicals by plants, volcanoes, forest fires, sea spray, lightning, mold, and pollen.

Five marks question with answers.

1. Describe the effects of air pollutant on human health and animals.

Ans -Some environmental poisons can cause acute illness and even death. Others may be harmful, but the disease may take years or even decades to appear. Air pollution mainly affects the respiratory system. Bronchitis, emphysema, asthma and lung cancer are some of the chronic diseases caused due to exposure to polluted air. It is feared that lung cancer is caused mainly due to polluted air because carcinogens are found in it. Its mortality rate is higher in urban areas.

The impact of air pollution on animals is more or less similar to that on man. Chronic poisoning results from the ingestion of forage contaminated with atmospheric pollutants. Among the metallic contaminants, arsenic, lead and molybdenum are important. Fluoride is another pollutant, which causes fluorosis among animals. A number of livestock have been poisoned by fluorides and arsenic in North America. Bone lesions in animals due to excessive fluorides have also been reported.

2. What are the causes for photochemical smog?

Ans -Smog is a term evolved from smoke and fog. Smoke emitted from factories, vehicles and domestic ovens that use coal mix up with fog and forms a thick layer in the atmosphere. Smog envelops considerable areas of towns and cities. Photochemical smog is caused by the action of solar ultraviolet radiation on atmosphere polluted with hydrocarbons and oxides of nitrogen especially from automobile exhaust. Smog can occur both during the day and at night but photochemical smog only happen in the presence of sunlight. Photochemical smog is a widespread problem all over the world as industrial and vehicular emissions increase day by day.

3 What are the causes for Acid rain?

Ans -Acid rain is caused by a chemical reaction that begins when compounds like sulfur dioxide and nitrogen oxides are released into the air. These substances can rise very high into the atmosphere, where they mix and react with water, oxygen, and other chemicals to form more acidic pollutants, known as acid rain.

4. Describe the ill effects of Acid rain on metals.

Ans - Acid rain is a mixture of wet and dry deposited material that contains unusually large amounts of nitric and sulfuric acids. This toxic precipitation—formed when sulfur dioxide and nitrogen oxide emissions react with water, oxygen and other chemicals—can corrode metals like bronze, chip away paint and depreciate marble and limestone.

5. Describe the ill effects of Acid rain on fertility and crop yield.

Ans -Acidic water dissolves the nutrients and helpful minerals in the soil and then washes them away before the trees and other plants can use them to grow. At the same time, the acid rain causes the release of toxic substances such as aluminum into the soil.

Health: animals, plants -- can sickens or kill them. Major problems in animals are respiratory problems such as asthma and lung cancer. Materials - acid deposition causes major deterioration.

Fill in the blanks -

1.…… episode is caused by the interaction between chemical pollutants and sunlight.

2.Secondary air pollution of acidic compounds such as ……..and ….when ultimately settles out on land or on water is known as acid deposition.

3. The acidic compounds often settle out in the form of …… or ….. not just rain.

4.burning of fossil fuels by autos, power plants industry and Metal refineries are the major sources of ……

5 .Our noses have….. And…… to filter out the larger pollutants, the repiratory tract is also lined with cells that have cilia that constantly beat and force stuff up and out.

6.The trapping of a cool air near the surface by a warmer upper layer which is a reverse of the normal condition is called as …….

7.Air pollutants are trapped in the cooler air and can't be dispersed away from the area so they build up and become more of a health hazard this phenomena is known as ……..

8.Using cleaner fuels, alternative energy sources, devices to trap pollutants before they are released, are some of the methods to prevent ……

9.Only when we have few pollutants and small populations then…… …became the solution to pollution.

10.Is indoor pollution is ……..than outdoor.

Q. NO	Ans
1	LA smog
2	sulfuric acid and nitric acid
3	solids or snow.
4	outdoor pollution
5	hairs, mucus
6	Thermal inversion
7	Thermal inversion
8	Air Pollution
9	Dilution
10	worse

Multiple Choice Questions:

1 According to EPA of USA, the following is not one of the six major pollutants?

a) Ozone
b) Carbon monoxide
c) Nitrogen oxides
d) Carbon di-oxide

2 The Pollution Standard Index (PSI) scale has span from

a) 0-200
b) 0-300
c) 0-400
d) 0-500

3 Which of the following is an organic gas?

a) Hydrocarbons
b) Aldehydes
c) Ketones
d) Ammonia

4 Which of the following is/are inorganic gas (es)?

a) Carbon monoxide
b) Hydrogen sulphide
c) Chlorine
d) All of the above

5. The major contributor of Carbon monoxide is

a) Motor vehicle
b) Industrial processes

c) Stationary fuel combustion
d) None of the above

6 Fugitive emissions consist of

a) Street dust
b) Dust from construction activities
c) Dust from farm cultivation
d) All of the above

7 Which of the following is an air pollutant?

a) Nitrogen

b) Carbon dioxide

c) Carbon monooxide

d) Oxygen

8 Which of the following is a secondary air pollutant?

(a) Ozone

(b) Carbon dioxide

(c) Carbon monooxide

(d) Sulphur dioxide

9 Ozone lies in …… layer of atmosphere

(a) Stratosphere

(b) Mesosphere

(c) Troposphere

(d) Ionosphere

10. Which of these are referred to as ODS.

a) CFCs
b) HCFCs
c) Freons
d) All the above

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	d	d	d	d	a	d	c	a	a	d

Unit 2

Two marks question with answers.

1.Name the four layers of atmosphere.

Ans – The four layers of atmosphere are the troposphere, stratosphere, mesosphere, and thermosphere.

2. How many types of Inversion are there, name them?

Ans – There are two types of inversion Radiation inversion and Subsidence inversion.

3.What do you mean by temperature inversion?

Ans - Temperature inversion is a reversal of the normal behavior of temperature in the troposphere, in which a layer of cool air at the surface is overlain by a layer of warmer air. (Under normal conditions, temperature usually decreases with height).

4.List out the effects of Temperature inversion.

Ans - Inversions play an important role in determining cloud forms, precipitation, and visibility. An inversion acts as a cap on the upward movement of air from the layers below. As a result, convection produced by the heating of air from below is limited to levels below the inversion. Diffusion of dust, smoke, and other air pollutants is likewise limited.

In regions where a pronounced low-level inversion is present, convective clouds cannot grow high enough to produce showers. Visibility may be greatly reduced below the inversion due to the accumulation of dust and smoke particles. Because air near the base of an inversion tends to be cool, fog is frequently present there. Inversions also affect diurnal variations in temperature. Diurnal variations tend to be very small.

5.List out the ideal condition for temperature inversion.

Ans – (a) Long nights, so that the outgoing radiation is greater than the incoming radiation. (b) Clear skies, which allow unobstructed escape of radiation. (c) Calm and stable air, so that there is no vertical mixing at lower levels.

Three marks question with answers.

1.Write short notes on Ground inversion (Surface Temperature inversion).

Ans - A ground inversion develops when air is cooled by contact with a colder surface until it becomes cooler than the overlying atmosphere; this occurs most often on clear nights, when the ground cools off rapidly by radiation. If the temperature of surface air drops below its dew point, fog may result. This kind of temperature inversion is very common in the higher latitudes. Surface temperature inversion in lower and middle latitudes occurs during cold nights and gets destroyed during daytime.

2.Write short notes on Subsidence Inversion.

Ans - A subsidence inversion develops when a widespread layer of air descends. The layer is compressed and heated by the resulting increase in atmospheric pressure, and as a result the lapse rate of temperature is reduced. If the air mass sinks low enough, the air at higher altitudes becomes warmer than at lower altitudes, producing a temperature inversion. Subsidence inversions are common over the northern continents in winter (dry atmosphere) and over the subtropical oceans; these regions generally have subsiding air because they are located under

large high-pressure centers. This temperature inversion is called upper surface temperature inversion because it takes place in the upper parts of the atmosphere.

3.Write short notes on Frontal Inversion.

Ans - A frontal inversion occurs when a cold air mass undercuts a warm air mass (Cold and Warm Fronts: we will study in detail later) and lifts it aloft; the front between the two air masses then has warm air above and cold air below. This kind of inversion has considerable slope, whereas other inversions are nearly horizontal. In addition, humidity may be high, and clouds may be present immediately above it. This type of inversion is unstable and is destroyed as the weather changes.

4.What is the correct order of earth's atmospheric layers from bottom to top?

Ans - Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere.

5.What is the importance of ozone in stratosphere?

Ans - Ozone is a gas in the atmosphere that protects everything living on the Earth from harmful ultraviolet (UV) rays from the Sun. Without the layer of ozone in the atmosphere, it would be very difficult for anything to survive on the surface. Plants cannot live and grow in heavy ultraviolet radiation, nor can the plankton that serve as food for most of the ocean life. The ozone layer acts as a shield to absorb the UV rays, and keep them from doing damage at the Earth's surface.

Five marks question with answers.

1.Explain the vertical thermal structure of atmosphere.

The atmosphere consists of 4 layers: the troposphere, stratosphere, mesosphere, and thermosphere. The placement of the different layers of the atmosphere and how the temperature changes with height as you go from the ground up to space. The troposphere is the lowest layer of the atmosphere. This is the layer where we live and where weather happens. Temperature in this layer generally decreases with height. The boundary between the stratosphere and the troposphere is called the tropopause. The jet stream sits at this level and it marks the highest point that weather can occur. The height of the troposphere varies with location, being higher over warmer areas and lower over colder areas. Above the tropopause lies the stratosphere. In this layer the temperature increases with height. This is because the stratosphere houses the ozone layer. The ozone layer is warm because it absorbs ultraviolet (UV) rays from the sun. The mesosphere is the layer above the stratosphere. The temperature decreases with height here just like it does in the troposphere. This layer also contains ratios of nitrogen and oxygen similar to the troposphere, except the concentrations are 1000 times less and there is little water vapor

there, so the air is too thin for weather to occur. The thermosphere is the uppermost layer of the atmosphere. In this layer the temperature increases with height because it is being directly heated by the sun.

2. Describe the plume behavior.

Dispersion is the process of spreading out pollution emission over a large area and thus reducing their concentration. Wind speed and environmental lapse rates directly influence the dispersion pattern.

Looping plumes take place when there has been a super-adiabatic lapse rate and solar heating. The large thermal eddies in the unstable air may bring the plume to the ground level periodically. In general, however, the direction of the plume with the surrounding air occurs rather rapidly.

Coning plume gets resulted in when the vertical air temperature gradient has been between dry adiabatic and isothermal, the air being slightly unstable with some horizontal and vertical mixing occurring. Coning is most likely to occur during cloudy or windy periods.

Fanning plumes spread out horizontally but do not mix vertically. Fanning plumes take place when the air temperature increases with altitude (inversion). The plume rarely reaches the grounds level unless the inversion is broken by surface heating or the plume encounters a hill. At night, with light winds and clear skies, fanning plumers are most probable.

Lofting plumes diffuse upward but not downwards and occur when there is a super-adiabatic layer above a surface inversion. A lofting plume will generally not reach the ground surface.

Fumigation causes the high pollutant concentration plume reaching the ground level along the length of the plume and is caused by a super-adiabatic lapse rate be4neath an inversion. The super-adiabatic lapse rate at the ground level occurs due to the solar heating. This condition has been favored by clear skies and light winds.

3.Explain the vertical temperature profile of atmosphere.

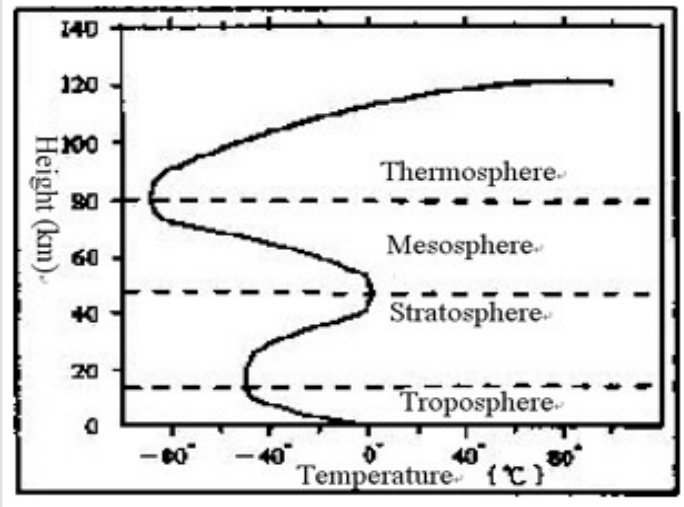
Ans – The troposphere is about 12 kilometers thick on average; it is thicker in summer than in winter. The troposphere over low latitude regions is usually thicker than over high latitude regions. The troposphere over the equator is about 18 kilometers thick, while its thickness in the regions nearest the two poles is only about eight to nine kilometers. The temperature in the troposphere usually decreases with height at the average lapse rate of 6.5 °C per kilometer. The air in the troposphere is more unstable and with strong convection. Almost all the water vapor in the atmosphere exists within this layer; therefore, common weather phenomena such as clouds, fog, rain, and snow, occur only in this layer and more often than not in its lower part.

The stratosphere extends from 10 kilometers to 50 - 55 kilometers above ground. Within the lower part which extends from the top of the troposphere to about 30-35 kilometers the

temperature is almost constant, or increases slightly with height. Above 35 kilometers the temperature actually increases with height at the average rate of 5 °C per kilometer. Since almost no dust or water vapor from the land surface will reach the stratosphere, the air flow in this layer is steady. The upper part of the stratosphere experiences an increase of temperature due to the fact that the sun's ultraviolet radiation is absorbed by the ozone layer.

The region of the mesosphere is about 50 to 80 kilometers in altitude. The temperature in this layer usually decreases as the height increases up to the top of the mesosphere where the temperature can be as low as - 95 °C or even lower. The composition of gases in the atmosphere from the ground to the top of the mesosphere, are almost identical except for water vapor and ozone. Therefore the region below the mesosphere is also called the homosphere.

The thermosphere is the region above the top of mesosphere where the temperature begins to rise again. When sun activity is low, this layer can extend to 400 kilometers in altitude. During high sun activity periods the layer can reach around 500 kilometers in altitude. The air in the lower region of the thermosphere is extremely thin; therefore the particles in the air can easily be ionized, resulting in profuse free electrons in the air. Therefore this layer is also called the ionosphere; it is very effective in reflecting radio waves.



4.Explain the importance of ozone in Atmosphere.

Ans - **ozone**, a gaseous molecule of three oxygen, makes it possible for you to do so without reaping the harmful effects of the sun's radiation. This helpful ozone is found in the stratosphere, which is the atmospheric layer just above where life exists and weather occurs. When that same gaseous ozone is found in our lower layer (called the troposphere), it is considered an air pollutant and is very harmful to human health. However, we need it in the stratosphere because even at the low concentration of 12 parts per million, ozone is so effective at absorbing the sun's UV radiation that this small amount is plenty enough to protect us on Earth. In humans, UV radiation causes skin cancer and cataracts. UV radiation also affects the fertility of other animals, as well as the viability of their offspring. Plants are affected by UV radiation because it affects their ability to grow and develop correctly. As you'll see later, UV radiation also influences how

chemicals break down and react, and this can lead to catastrophic changes in environments and ecosystems.

5.Explain Greenhouse Effect.

Ans - The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without its atmosphere. If a planet's atmosphere contains radiatively active gases (i.e., greenhouse gases) they will radiate energy in all directions. Part of this radiation is directed towards the surface, warming it. The intensity of the downward radiation – that is, the strength of the greenhouse effect – will depend on the atmosphere's temperature and on the amount of greenhouse gases that the atmosphere contains.

Earth's natural greenhouse effect is critical to supporting life. Human activities, primarily the burning of fossil fuels and clearing of forests, have intensified the natural greenhouse effect, causing global warming.

The mechanism is named after a faulty analogy with the effect of solar radiation passing through glass and warming a greenhouse. The way a greenhouse retains heat is fundamentally different, as a greenhouse works mostly by reducing airflow and thus retaining warm air inside the structure.

Fill in the blanks:

1) If molecule absorbs available ……..it results in increase of energy of molecule.
   Ans –

2) Strata-pause Layer of atmosphere which is accessed by jet-powered ……
   Ans-

3) Gas which is not part of greenhouse gases is …….
   Ans –

4) Stratosphere is the ……lowest layer of Earth's atmosphere.
   Ans –

5) Percentage of oxygen in atmosphere of Earth is ……..
   Ans –

6) Second most abundant constituent of dry air in terms of volume after nitrogen is……
   Ans –

7) Layer of Earth's atmosphere which is accessed by rockets is…….
   Ans –

Q. NO	Ans
1	photons
2	aircraft.
3	Oxygen
4	Second

8) Thermosphere is the Layer of Earth's atmosphere which is used by ……..

Ans -

9) Chlorofluorocarbons are replacing with less harmful compounds such as……

Ans –

10) With the increase in altitude atmosphere of Earth becomes……

Ans -

5	20.94
6	Oxygen
7	Mesophere
8	International Space Station
9	Dichlorodifluoromethane
10	Thinner

Multiple Choice Questions:

1.Border line which separates outer space and Earth's atmosphere is known as

a) Durand line
b) Space line
c) Venus line
d) Karman line

2 Height of layer mesosphere which lies after troposphere is

a) 70 to 80 km
b) 110 to 130 km
c) 80 to 85 km
d) 95 to 105 km

3 Second highest layer of Earth's atmosphere is

a) Stratosphere
b) Mesosphere
c) Troposphere
d) Thermosphere

4 Introduction of chemicals into atmosphere is known as

a) air pollution
b) radioactive pollution
c) atmospheric pollution
d) dense pollution

5 Troposphere layer of atmosphere extends from Earth to

a) 38 km
b) 32 km
c) 20 km
d) 12 km

6 Movement of Air through troposphere of atmosphere on a large scale is known as

a) infrared circulation
b) radioactive circulation
c) sound circulation
d) atmospheric circulation

7. Atmospheric density decreases with the

a) increase in longitude
b) decrease in altitude
c) increase in altitude
d) increase in latitude

8 Troposphere is bounded by boundary which is known as

a) Thermo pause
b) Stratopause
c) Tropo-pause
d) Mesopause

9 Chlorofluorocarbons are primarily used as

a) refrigerants
b) fuels of crafts
c) repairers of ozone layer
d) repairers of troposphere

10 Chlorofluorocarbons are primarily used as

a) refrigerants
b) fuels of crafts
c) repairers of ozone layer
d) repairers of troposphere

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	d	c	d	a	d	d	c	c	a	A

Unit 3

Two marks question with answers.

1.List out the measures used for controlling air pollution.

Ans - The measures used for controlling air pollution are – Source correction method , Process change method , Modification process and cleaning of gaseous effluents .

2.What do you mean by source control technology.

Ans- (a) Air quality management sets the tools to control air pollution emission.

(b) A control measure describes the equiptment process or action used to reduce air pollution.

(c) The extent of air pollution reduction varies among technologies and measures.

The selection of control technologies depends on environmental , engineering , economic factors and pollutant type .

3.Write principle behind Settling Chambers.

Ans – Settling Chamber 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. Because settling chambers are effective in removing only larger particles, they are used in conjunction with a more efficient control device.

4.Write the efficiency of cyclone separators.

Ans – Cyclones are efficient in removing large particles but are not as efficient with smaller particles. For this reason, they are used with other particulate control devices.

5.Write the one major disadvantage of fabric filter.

Ans – One disadvantage of the fabric filter is that high temperature gases often have to be cooled before contacting the filter medium.

Three marks question with answers.

1.What is the efficiency of fabric filters?

Ans- Fabric filters , or baghouses, remove dust from a gas stream by passing the stream through a porous fabric. The fabric filter is efficient at removing fine particles and can exceed efficiencies of 99 percent in most applications.

2.List out the control technologies for gaseous pollutants.

Ans – There are four commonly used control technologies for gaseous pollutants.
Absorption, Adsorption, Condensation and Incineration.

3.What is catalytic incinerator?

Ans –catalytic incinerators are very similar to thermal incinerators. The main difference is that Passing through the flame area, the gases pass over a catalyst bed. A catalyst promotes oxidation at lower temperatures, thereby reducing fuel costs.

4.List out the equipment used to control waste gases by combustion.

Ans – Direct combustion or Flaring, Thermal incineration and Catalytic incineration

5. Differentiate between regenerative system and non-regenerative systems in Adsorption.

Ans – Regenerative system usually contains more than one carbon bed. As one bed actively removes pollutants another bed is being generated for future use.

Non-regenerative systems have thinner beds of activated carbon. In a non-regenerative adsorber, the spent carbon is disposed of when it becomes saturated with the pollutant.

Five marks question with answers.

1.Write about gravitational settling chambers and Electrostatic precipitators.

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.

An electrostatic precipitator (ESP) is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit.

2.What are the merits and de-merits of cyclones?

Cyclone separators are beneficial because they are not expensive to install or maintain, and they have no moving parts. This keeps maintenance and operating costs low. As well, the removed particulate matter is collected when dry, which makes it easier to dispose of. Finally, these units take up very little space. Although effective, there are also De-merits in using cyclone separators. Mainly, the standard models are not able to collect particulate matter that is smaller than 10 micrometers effectively and the machines are unable to handle sticky or tacky material well.

3.List the factors which should be considered while selecting the process.

The selection and design of a gaseous contaminant control system is done based on some specific information concerning the gas stream to be treated. Following are some factors considered during selection of a process-

- Gas stream particulate matter characteristics
- Gas stream average and peak flow rates
- Gas stream average and peak temperatures
- Gas stream particulate matter average and peak concentrations
- Gas stream minimum, average, and maximum oxygen concentrations
- Contaminant average and peak concentrations
- Contaminant ignition characteristics

4.Difference between physical and chemical adsorption.

Physical Adsorption	Chemical adsorption
Gas or vapour molecule is weakly held to the solid surface by intermolecular attractive forces.	Gas contaminant and is held strongly to the solid surface by valence forces.

It is accompanied by capillary condensation within the pores.	Chemical reaction occurs between the adsorbent and the gaseous contaminant.
Physical adsorption is easily reversed by the application of heat or by reducing the pressure.	Chemical reaction is usually irreversible.
Commonly used for the capture and concentration of organic compounds.	It is frequently used for the control of acid gases. Chemical adsorption is also used for the control of mercury vapour
Gas temperature is usually maintained at levels less than approximately 120°F.	Chemical adsorption can be conducted at higher temperatures(100°F to 400°F)

5.Explain the factors which affect the performance of Adsorption system.

Ans - **Temperature**: For physical adsorption processes, the capacity of an adsorbent decreases as the temperature of the system increases. With increase in the temperature, the vapour pressure of the adsorbate increases, raising the energy level of the adsorbed molecules. Adsorbed molecules now have sufficient energy to overcome the van der Waals' attraction and migrate back to the gas
phase. Molecules already in the gas phase tend to stay there due to their high vapour pressure.

Pressure: Adsorption capacity increases with an increase in the partial pressure of the vapour.
The partial pressure of a vapour is proportional to the total pressure of the system. Any increase
in pressure will increase the adsorption capacity of a system. The increase in capacity occurs
Because of a decrease in the mean free path of vapour at higher pressures.

Gas velocity: The gas determines the contact or residence time between the contaminant streams
and adsorbent. The slower the contaminant stream flows through the adsorbent bed, the greater
the probability of a contaminant molecule reaching an available site. In order to achieve 90% or more capture efficiency, most carbon adsorption systems are designed for a maximum airflow velocity of 100 ft/min (30 m/min) through the adsorber. A lower limit

of at least 20 ft/min (6 m/min) is maintained to avoid flow problems such as channeling. Gas velocity through the adsorber is a function of the cross-sectional area of the adsorber for a given volume of contaminant gas.

Fill in the blanks...

1. We humans live in the----------, and nearly all weather occurs in this lowest layer.
2. Air pressure---------, and temperatures get----------, as you climb higher in the troposphere.
3. The jet stream flows near the border between the ----------and the ----------
4. High-energy ----------radiation from the Sun are absorbed in the thermosphere, raising its temperature to hundreds or at times thousands of degrees.
5. There is no clear-cut upper boundary where the ----------finally fades away into space.
6. ----------is a mass transfer process in which a porous solid comes in contact with a liquid or gaseous stream to selectively remove pollutants or contaminates by ---------- them onto the solid.
7. Fabric filters, or baghouses, remove dust from a gas stream by passing the stream through a ----------

8. Two-stage precipitators are considered to be separate and distinct types of devices compared to large, high-gas-volume, ----------
9.Catalytic incinerators are very similar to ----------

10.Most air contaminants originate from ---------- processes.

Q. NO	Ans
1	troposphere
2	drops, colder
3	troposphere , stratosphere
4	X-rays and UV
5	exosphere

6	Adsorption, adsorbing
7	porous fabric
8	single-stage ESPs
9	thermal incinerators
10	combustion

Multiple Choice Questions:

1. Which of the following devices is suitable for the removal of gaseous pollutants?

(a) Cyclone separator (b) Electrostatic precipitator (c) Fabric filter (d) Wet scrubber

2. Which of the following air pollution control devices is suitable for the removing the finest dust from the air?

(a) Cyclone separator (b) Electrostatic precipitator (c) Fabric filter (d) Wet scrubber

3. Air pollution from automobiles can be controlled by fitting:

(a) Cyclone separator (b) Electrostatic precipitator (c) Catalytic converter (d) Wet scrubber

4. Taj Mahal at Agra may be damaged by:

(a) Sulphur dioxide (b) Chlorine (c) Hydrogen (d) Oxygen

5. Air pollution is severe in……..

(a) Cities (b) Industrialized area (c) Densely populated area (d) all of these

6. Air pollution can be of …..

(a) Natural origin (b) Artificial or manmade origin (c) both a and b (d) b only

7. Mobile combustion accounts

(a) 10-20% of air pollution (b) 40-50 % of air pollution (c) 50-60% of air pollution (d) 5-10% of air pollution.

8. The supersonic jets cause pollution by the thinning of …..

(a) it reacts with O_2 (b) it inhibits glycolysis (c) makes nervous system inactive (d) reacts with hemoglobin.

9. Fine organic or inorganic particles suspended in air is called …

(a) Particulate pollutant (b) Gaseous pollutant (c) Aerosol (d) None of these

10. Dry scrubbing systems are used to remove acid gases such as …….. primarily from combustion sources.

(a) So2 (b) HCL (c) SO2 and HCL both (d) NO

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	d	b	c	a	d	c	c	d	c	C

Unit 4

Two marks question with answers.

1.Discuss the adsorption, absorption, combustion and condensation.

Adsorption is a surface-based process while absorption involves the whole volume of the material. Combustion is often a complicated sequence of elementary radical reactions where as Condensation is the changes of the physical state of matter from gas phase into liquid phase, and is the reverse of evaporation.

2.How control of gaseous pollutants achieved?

Gaseous criteria pollutants, as well as volatile organic compounds (VOCs) and other gaseous air toxics, are controlled by means of three basic techniques: absorption, adsorption and incineration (or combustion). These techniques can be employed singly or in combination. They are effective against the major greenhouse gases as well. In addition, a fourth technique, known as carbon sequestration, is in development as a means of controlling carbon dioxide levels.

3.Why reduction of total emission of Sox is important?

Traditionally, measures designed to reduce localized ground-level concentrations of sulfur oxides (SOx) used high-level dispersion. Although these measures reduced localized health impacts, it is now realized that sulfur compounds travel long distances in the upper atmosphere and can cause damage far from the original source. Therefore the objective must be to reduce total emissions.

4.Why sulphur oxides are formed during combustion process in engine?

SOx or sulphur oxides are formed during combustion process in the engine because of presence of sulphur content in the fuel.

5.List out the quality mentioned for fuel / oil

1. Fuel shall be free from inorganic acid.
2. Bunker delivery note must be maintained.
3. Bunker delivery note must be kept for three years.
4. Fuel oil sulphur content must never exceed 4.5.%
5. Parties of 1997 protocol must maintain a register of local suppliers of fuel oil.

Three marks question with answers.

1.Explain the factors to be considered while selecting the fabric media for bag Houses.

The bag material or fabric media is an important part of bag house design and selection, as it determines the life and effectiveness of the filter bag. Fabric filter media must be compatible both physically and chemically with the gas stream and system conditions. Selection of the correct bag material incorporates these factors:

(a) Particle size
(b) Operating temperature of the bag house
(c) Compatibility with gas stream chemistry, including:
(d) Moisture levels
(e) Acidity or alkalinity
(f) Electrostatic nature of the particles
(g) Abrasiveness of the particles
(h) Air-to-cloth ratio
(i) Fabric's resistance to cleaning energy
(j) Fabric's permeability to allow air to pass
(k) Fabric's flexibility to allow rippling or stretching
(l) Fabric cost

2.Describe the relative significance of emissions of SO_x and reduced sulfur compounds to the atmosphere.

Sulfur dioxide is an atmospheric pollutant that can adversely affect humans, plants, and materials. On conversion to H_2SO_4, it is the major contributor to acidic deposition and visibility reduction. Reduced sulfur compounds are minor pollutants that primarily cause malodor problems.

2. How are CO and CO_2 removed from the atmosphere?

Carbon monoxide is oxidized to CO_2. Carbon dioxide is absorbed by oceans and other bodies of water and can be taken up by plants.

3. List out the approaches for limiting emission.

(a) Choice of Fuel (b) Fuel Cleaning (c) Selection of Technology and Modifications (d) Emissions Control Technologies

4. How many types of Sox monitoring are there name them?

Ans - The three types of SOx monitoring systems are continuous stack monitoring, spot sampling, and surrogate monitoring.

Five marks question with answers.

1.How to reduce NOx from marine engine's exhaust?

Ans- Following are the methods to reduce NOx emission from ship:

1. **Humid Air Method**: In this method, water vapour is mixed in the combustion air before supplying it to the cylinder. Air from the T/C blower is passed through a cell that humidifies and chills the hot air taking moisture from the cooling water until air saturation is achieved. Generally saline sea water is utilized in this method by heating it with jacket water and turbo charger heat, and the left over brine is disposed back to the sea. This method can achieve reduction of NOx by 70-80%.

2. **Exhaust Gas Re circulation (EGR):** As the name suggests, some amount of engine exhaust gases are send back to the scavenge space to mix up with the air to be supplied to cylinder for combustion. This reduces the oxygen content of the air and hence reduces formation of NOx.

3. **Water Injection and Water emulsion**: In this method, water is added to reduce the temperature of combustion leading to low NOx emission. In water emulsion, fuel is blended with water and in water injection a separate fresh water injector is mounted in the cylinder head which injects water. This method has a drawback of increasing the specific fuel oil combustion with reduction in NOx by only 20-45%.

4. **High Scavenge Pressure and Compression Ratio:** With high scavenge pressure and compression ratio, large amount of air can be introduced inside the cylinder to lower combustion temperature and NOx emission.

5. **Selective Catalytic Reduction:** The SCR is the most efficient method to reduce NOx emissions from ships (up to 90-95% of reduction). In this method, low sulphur fuel oil is used and exhaust temperature is maintained above 300 deg C. The exhaust gas is mixed by water solution of urea and then it is passed through catalytic reactor. The only disadvantage of SCR is its expansive installation and operating cost.

6. **Two Stage Turbocharger**: ABB's latest two stage turbocharger can reduce the exhaust temperature in the intercoolers and also the NOx content in the emitted exhaust.

7. **Engine Component Modification:** It is better to design an engine which has a property to reduce the NOx formation during combustion process rather than investing on expensive secondary measures. Integration of slide valve type fuel injector with almost zero sack volume eliminates any chance of fuel dripping and after burning, leading to cylinder temperature and NOx formation.

2. Explain the major emissions control method of Sox .

The two major emissions control methods are sorbent injection and flue gas desulfurization-

• Sorbent injection involves adding an alkali compound to the coal combustion gases for reaction with the sulfur dioxide. Typical calcium sorbents include lime and variants of lime. Sodium-based compounds are also used. Sorbent injection processes remove 30–60% of sulfur oxide emissions.

• Flue gas desulfurization may be carried out using either of two basic FGD systems: regenerable and throwaway. Both methods may include wet or dry processes. Currently, more than 90% of utility FGD systems use a wet throwaway system process.

3. Write short notes on monitoring system of Sox.

The three types of SOx monitoring systems are continuous stack monitoring, spot sampling, and surrogate monitoring. Continuous stack monitoring (CSM) involves sophisticated equipment that requires trained operators and careful maintenance. Spot sampling is performed by drawing gas samples from the stack at regular intervals. Surrogate monitoring uses operating parameters such as fuel sulfur content.

4. Explain Adsorption.

This is one of the most commonly used methods, especially for controlling emissions from small sources. It can be physical adsorption or chemisorptions. The later is rarely used for the VOC emission control because, it involves a less-reversible chemical bonding of the adsorbate (pollutant) and the adsorbing solid (packing) and is relatively expensive. Physical adsorption uses the Van der Waals force, giving the advantage of reversibility and regeneration due to the weaker bonding of the gas and adsorbent material. The adsorbed material can be either recovered or incinerated. Regeneration is usually accomplished by heating or extraction/displacement.
Activated carbon is a commonly used adsorbent because of its high surface area and material hardness. It has between 800 and 1200 m^2/g of surface area. In general, activated carbon and other adsorbents such as hollow aluminum spheres coated with a catalyst can be employed in a fixed, moving or fluidized bed system.

Fluidized bed systems, though more expensive to build and operate, yield high contacting with low pressure loss and regeneration can be accomplished within the system. The fixed beds are less expensive and provide longer packing life, but provide less contacting per unit length and require a larger pressure loss; because they are regenerated individually. Moving beds have properties between fixed and fluidized beds. The useful life of activated carbon can be determined using break through curves.

Regeneration can be achieved by contact with a hot, inert gas, contact with a low pressure gas stream and pressure reduction over the bed. Steam desorption is the most commonly used process for regeneration.

5. Explain incineration.

Incineration or combustion is another common VOC control technology. Complete combustion or oxidation of pure hydrocarbons produces carbon dioxide and water. Sulfur and nitrogen compounds produce acid gases and limited air supply results in the formation of carbon monoxide. Complex organic compounds may not oxidize completely in the residence time and

ash may form. Most VOC oxidation must be done at high temperature, unless catalysts are involved.

Flares, thermal oxidizers and catalytic converters all use oxidation chemistry to treat VOC emissions. Flares mostly treat moderate to high temperature concentrations. All of the heat produced by the combustion process is lost when the flares are used. Most thermal oxidizers treat emission streams with maximum VOC concentrations of 25% of the LEL (lower explosive limit). Catalyst beds especially when used to enhance the oxidation of VOCs (usually noble metals like platinum and palladium) must be able to withstand high temperatures and must be designed so that a minimum pressure drop is created when the gas passes through the bed. For example by using catalytic converters, thermal oxidation of the by-products of the incomplete engine combustion can be safely accomplished at temperatures much lower than would be required without the aid of catalysis.

Fill in the blanks:

1. Adsorption is a surface-based process ------while involves the whole volume of the material.
2. SOx or sulphur oxides are formed during combustion process in the engine because of presence of in the fuel.
3. Activated carbon is a commonly used adsorbent because of its.
4. Incineration or combustion is another common----------
5. Choice of Fuel and Fuel Cleaning is one of the approaches for -------
6. The bag material or fabric media determines the life and----- of the filter bag.
7. In physical adsorption processes, the capacity of an adsorbent decreases as the temperature of the system -------
8. --------is a type of Sox monitoring sampling.
9. VOC oxidation must be done at high , ------unless -------are involved.
10. The fixed beds are ----------and provide longer packing life.

Q. NO	Ans
1	absorption
2	sulphur content
3	high surface area
4	VOC control technology.
5	limiting emission.
6	effectiveness
7	increases.
8	Spot sampling
9	temperaturecatalysts
10	less expensive

Multiple Choice Questions:

1. The Air (Prevention and Control of Pollution) act of Government of India came in to force in
   a) 1976 b) 1981 c) 1986 d) 1991

2. Major pollutant causing Acid rain
   a) SO_4 b) SPM c) HC d) CO_2

3. In cyclones particulate separation is due to
   a) Centrifugal force b) gravitational force c) both d) none of these

4. Which of the following is not a filter cleaning machine
   a) Shaking b) reverse air flow c) pulse jet d) washing

5. The process developed to reduce SO2 emission in sulfuric acid production is
   a) DCDA b) DADC c) ACDC d) DCAD

6. Which of the following is not an absorbent of NO_X
   a) Lime b) Silica c) Magnesium Hydroxide d) Sulfuric acid

7. As per guidelines, minimum height of stack in India is
   a) 10m b) 20m c) 30m d) 40m

8. . "The velocity of air going in the sampling probe nozzle equal to the velocity of the undisturbed air at that point" this principal is called
   a) Proportional sampling b) Isokinetic sampling c) grab sampling d) none of the above

9. Velocity of flue gas in stack can be measured by
   a) Pitot tube b) pyrometer c) venture meter d) Multi meter

10. Thermocouple used for monitoring stacks with flue gases of very high temperature is
    a) Copper/constantan b) Iron/constantan c) Platinum/Platinum & Rhodium d) none of these

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	b	a	a	c	a	b	a	b	a	a

Unit 5

Two marks question with answers.

1. Define Sampling?

The way in which we select a sample of individuals to be research participants is critical. How we select participants (random sampling) will determine the population to which we may generalize our research findings.

2. What is Air Quality Management?

Air quality management refers to all the activities a regulatory authority undertakes to help protect human health and the environment from the harmful effects of air pollution. The process of managing air quality can be illustrated as a cycle of inter-related elements.

3.What are CO Emission standards?

Emission standards set quantitative limits on the permissible amount of specific air pollutants that may be released from specific sources over specific timeframes. They are generally designed to achieve air quality standards and to protect human life.

4. Define stack sampling?

Stack sampling Techniques: Stack sampling or source sampling may be definedas 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.

5.What is the air pollutant?

Criteria air pollutants' is a term used internationally to describe air pollutants that have been regulated and are used as indicators of air quality. The regulations or standards are based on criteria that relate to health and/or environmental effects. One key feature of criteria air pollutants is that they are generally widely distributed across the country.

Three marks question with answers.

1.Describe control of air pollution?

The State Government may, after consultation with the State Board, by notification in the Official Gazette, declare in such manner as may be prescribed, any area or areas within the State as air pollution control area or areas for the purposes of this Act. (2) The State Government may, after consultation with the State Board, by notification in the Official Gazette. (3) If the State Government, after consultation with the State Board, is of opinion that the use of any fuel, other than an approved fuel, in any air pollution control area or part thereof, may cause or is likely to cause air pollution, it may, by notification in the Official Gazette, prohibit the use of such fuel in such area or part thereof with effect from such date (being not less months from the date of publication of the notification) as may be specified in the notification.

2.What are the objects and reasons of act 47 of 1987?

The Air (Prevention and Control of Pollution) Act, 1981, was enacted under Art. 253 of the Constitution to implement the decisions taken at the United Nations Conference on Human Environment held at Stockholm in June 1972, in which India participated.The Air Act is implemented by the Central and State Governments and the Central and State Boards. Over the past few years, the implementing agencies have experienced some administrative and practical difficulties in effectively implementing the provisions of this Act and has brought these to the notice of Government. The ways and means to remove these difficulties have been thoroughly examined in consultation with the concerned Central Government departments, the State Government and the Central and State Boards. Taking into account the views expressed. Government has decided to make certain amendments to the Act in order to remove such difficulties.

3.Describe Penalty for contravention of certain provisions of this Act

Whoever contravenes any of the provisions of this Act or any order or directions issued there under, for which no penalty has been elsewhere provided in this Act, shall be punishable with imprisonment for a term which may extend to three months or with fine which may extend to ten thousand rupees or with both, and in the case of continuing contravention, with an additional fine which may extend to five thousand rupees for every day during which such contravention continues after conviction for the first such contravention.

4. Where Do I Go to Get References to Title III Hazardous Air Pollutants (HAPs)?

During the presentation on Defining Hazardous Air Pollutants (HAPs), we discussed the methodology EPA uses to define the Clean Air Act Amendments of 1990, Title III, HAPs by

boiling point (BP) and vapor pressure (vp). EPA uses eight categories to define HAPs according to vapor pressure:

Very Volatile Organic Compounds [VVOC] (vp> 380 mm Hg)

Very Volatile Inorganic Compounds [VVINC] (vp> 380 mm Hg)

Volatile Organic Compounds [VOC] (vp 0.1 to 380 mm Hg)

Volatile Inorganics [VINC] (vp 0.1 to 380 mm Hg)

Semi-volatile Organics [SVOC] (vp 10-1 to 10-7 mm Hg)

Semi-volatile Inorganics [SVINC] (vp 10-1 to 10-7 mm Hg)

Non-volatile Organics [NVOC] (vp < 10-7 mm Hg)

Non-volatile Inorganics [NVINC] (vp < 10-7 mm H

5. Has FTIR Been Used in Stack Testing?

FTIR has been used as both emission and process monitoring at primary/secondary aluminum facilities, secondary lead, asphalt roofing, Portland cement plants, wool fiberglass/mineral wool facilities and utilities. FTIR use has been validated for the determination of over 37 hazardous air pollutants (HAPs) directly, with an additional 18 HAPs through sample concentration. EPA presently maintains a spectra library on the Internet. FTIR is presently being used to quantitate emissions from a variety of sources. Under 40 CFR Part 63, Appendix A, FTIR is being proposed (tentative: under consideration) for three methods. They are:

Method 318: Formaldehyde, Phenol, and Methanol Determination by FTIR;

Method 320: Generic Extractive FTIR Method for Industrial Emissions; and

Method 321: FTIR For HCl From Portland Cement Kilns.

Five marks question with answers.

1. What does sampling train consists.

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.

2.List out the important considerations for accurate representative sample collection.

The important considerations for accurate representative sample collection include:

Accurate measurement of pressure, moisture, humidity and gas composition.
The selection of suitable locations for sampling.
Determination of the traverse point required for a velocity and temperature profile across the cross section of the stack and sampling for particulate matter.
The measurement of the rate of flow of gas or air through the stack.
Selection of suitable sampling train.
Accurate isokinetic sampling rate essential for particulate sampling.
Accurate measurement of weight and volume of samples collected.

3.List out the objectives of sampling the atmosphere.

To identify specific industrial and other sources of pollution
To determine the degree of air pollution control required for existing industries
To identify and control pollution from vehicular emission
To assess health hazards and potential damage to property
To collect data for formulating and testing air pollution models.

4.Explain stack sampling.

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.

5 Write short notes on Air Pollution Control Act

The Air Pollution Control Act of 1955 was the first Clean Air Act enacted by Congress to address the national environmental problem of air pollution on July 14, 1955. This was "an act to provide research and technical assistance relating to air pollution control". The act "left states principally in charge of prevention and control of air pollution at the source". The act declared that air pollution was a danger to public health and welfare, but preserved the "primary responsibilities and rights of the states and local government in controlling air pollution". The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board.

.

Multiple Choice Questions:

1.The pollution standard index (PSI) scale has span from
0-200 b) 0-300 c) 0-400 d) 0-500

2.Which of the following is an organic gas
Hydrocarbons b) Aldehydes c) Ketones d) Ammonia

3.Which of the following is/ are organic gas(es)
Carbon monoxide b) hydrogen sulphide c) chlorine d) all the above

4.The major contributor of carbon monoxide is
Motor vehicle b) industrial processes c) stationary fuel combustion d) none of above

5.Fugitive emissions consist of
Street dust b) dust from construction activities c) dust from cultivation d) all the above

6.Ozone is formed in the upper atmosphere by a photochemical reaction with
Ultra violet solar radiation b) infra red radiation c) visible light d) all the above

7.The threshold concentration of sulphur dioxide in any industrial activity should not be permitted beyond

2ppm b) 3ppm c) 4ppm d) 5ppm
8.The threshold limit of benzene is
15ppm b) 20 ppm c) 25 ppm d) 30 ppm

9.Which of the following is used as antiknock compound in gasoline
Tetramethyl lead b) Tetraethyl lead c) Trimethyl lead d) Triethyl lead

10.Which of the following is a fermentation product of molasses
Methanol b) Formaldeyde c) Ammonia d) Acetone

Q.NO	1	2	3	4	5	6	7	8	9	10
Ans	C	d	a	c	c	c	d	a	a	c

Fill in the blanks

1. The Pollution Standard Index (PSI) scale has span from

2. Write the inorganic gas (example) ----------

3. The major contributor of Carbon monoxide is ------

4. Fugitive emissions consist of----------.

5. Ozone of found in -------

6. Ozone is formed in the upper atmosphere by a photochemical reaction with -------

7. The principal source of volatile organics (Hydrocarbons) is -----

8. The function of automobile catalytic converter is to control emissions of ------

9. The threshold concentration of sulphur dioxide in any industrial activity should not be permitted beyond ------

10. The boiler flue gas is source of ------

Q. NO	Ans
1	0-500
2	Carbon monoxide, Hydrogen sulphide
3	vehicle
4	Street dust, Dust from construction activities
5	Stratosphere
6	Ultra violet solar radiation
7	Industrial processes
8	carbon monoxide and hydrogen
9	5ppm
10	NO