Air Pollution: Analysis Of Sources And Impacts Of Pollutants

Air is essential for the survival of humankind, consequently, this crucial asset must be kept clean since it's the elixir of life. However, in this developing world with a booming population, this fundamental asset is getting pollution by human activities. Air pollution is a mixture of both particles and gases that can reach harmful concentrations both indoors and outdoors. Air pollution results in the creation of dangerous issues starting from respiratory issues, coughing, to sudden death. Around 90% of the total population is breathing in pollutant air, which kills a large number of individuals every year. Reasons for air pollution are both natural(eg. volcanic eruption, backwoods fire, dust storms, etc.) and man-made(eg. control plants, production lines, vehicles, etc.). One needs to think about the impacts and outcomes of pollutant air, and in this way needs to devise out methods and mechanisms to counter air pollution. Air pollution is the main reason for environmental change. Investigation of air pollution must be done for better analysis of sources and impacts of pollutants. One cannot stop air pollution by any means, yet can attempt to reduce it with successful and efficient strategies. The study of air pollution was invented with the intent to prevent it. Hence, the subject of air pollution is of prime significance.

Summary:

Introduction:

Earth is the only planet in the solar system that supports life. The primary explanation for this uncommon element of our planet is the way that a layer of gases called the environment that encloses it. However, the quality of the atmosphere has been deteriorating day by day due to a variety of polluting agents, which are both common and synthetic.

Structure Of Atmosphere:

The atmosphere is a complex mixture of gases constituting nitrogen and oxygen as its main segments. Based on the temperature profiles, the atmosphere is classified as four basic regions. The troposphere being the primary layer extending 9km at the poles to 17km at the equators. The vast majority of the climatic mass is established in this layer for i.e. 80%. As the elevation increments, there is a decline in temperature, which results decrement of water vapor weight. The primary driver of air contamination in the troposphere is a disturbance at low heights, which causes pollution dispersion. The planetary boundary layer (PBL) is directly affected by the influenced by its contact with the ground surface. A major gap in PBL depth could be seen ranging from 50 - 2000 meters, due to pollutant dispersion at low elevations within different climatic conditions. The second basic layer of the atmosphere is Stratosphere, which ranges from the troposphere to 50Km. This layer is all the more near ozone layer because of which there is an inverted pattern of temperature in this layer when contrasted with the troposphere, i.e. temperature here increases with height. This layer is relatively less violent because of a hotter temperature profile, and consequently, a less pollutant dispersion takes place here. This bottom zone of the Stratosphere is the main region for commercial air vehicles since the bottom zone of the Stratosphere provides minimal drag due to reduced turbulence.

The third layer of the atmosphere is Mesosphere. This layer ranges from 50Km - 80Km in altitude. Most of the meteoroids that collide with the earth are mostly absorbed and melted in this layer and are not able to cross this layer. The last layer of atmosphere to consider is the Thermosphere, which extends over a range of 80Km- 350Km based on the rate of solar activity in a region. Temperatures in this layer could reach a peak value of 1500°C.

Transport Of Air:

Based on the movement of air it can be categorized as ambient air or outdoor environment, and indoor environment. Out of all the four layers of the atmosphere, the two layers which are all the more near earth's surface for example troposphere and Stratosphere are increasingly pervasive to air contamination. Pollutant mixing is a common phenomenon in the troposphere due to its expanding temperature profile. At the point when these dispersed/mixed contaminations ascend to the stratosphere, they become stable because of the diminishing temperature profile of the Stratosphere. The major reaction in this layer is the conversion of oxygen gas to Ozone photochemically in the presence of sunlight. It has been observed, that because of the revolution of earth and uneven dissemination of sun based radiation, the air pollutants are not subjected to a single area and hence they are transboundary in nature. This accounts for the global transport of ambient air. Apart from the global movement of air, the regional movement of air is dominated by pressure zones. Air moves from a high-pressurized area to low pressure area. The local movement of air the nearby development of air is primarily because the temperature contrasts between land and water. During the day, cleaner air moves from se towards land, which in turn is polluted by human activities. There is a reverse movement of the polluted air from land to sea in the evening, which in turn also disturb the water ecosystem. Understanding this phenomenon is an important criterion for coping with air pollution in coastal areas.

In addition, indoor air quality significantly affects human wellbeing. For example, designing of a ventilation framework in a structure affects its temperature, humidity and ventilation. Care must be taken while designing such frameworks, keeping in mind that it should not hinder with life of people that will reside there, nor depriving them of the quality air available to them. The pressure difference is caused by temperature differences in different parts of the building. Such systems are called HVAC (Heating, Ventilation, and Air Conditioning). If possible, natural ventilation should be preferred over mechanical ventilation in such buildings.

Air Pollutants:

Air pollution is the presentation of a substance (i.e., pollutant) in a noticeable amount that is dangerous to humans and the environment. Air pollutants may be natural (e.g. volcano eruption) or man-made. Pollutants can be any of the three forms i.e. solid, liquid or gaseous. The human health impact caused by air pollution may include difficulty in breathing, wheezing, wheezing, respiratory and cardiac conditions. Some of the major pollutants include Nitrogen Dioxide, which is a reddish-brown toxic gas with a characteristic sharp, biting odour. A major source of Nitrogen Dioxide gas is fuel combustion. Particulate matter (PM) is also a major kind of pollutant. It refers to fine particles (solid or liquid) with a diameter of 10 micrometres or less, which can be either man-made or natural. Natural particulates constitute those from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. The burning of fossil fuels in vehicles, power plants, construction and various industrial processes produces man-

made particulates. Large (PM10) cause problems in respiration as they produce cloggy throat and nose. Fine particles (PM2.5) make their way deeper in the bloodstream and affect many organs. Ground-level Ozone is another polluting agent, which is produced by a photochemical reaction driven by sunlight. The concentration of ozone is maximum throughout the day. The concentration of ozone decreases at night since there is no sunlight. Ozone is a powerful oxidizing agent that reacts with various substances present in the atmosphere to form toxic compounds. Ozone accounts for many respiratory problems like lung inflammation, breathing difficulties, etc. The recommended air quality standard for ozone is 100mg/m3 by WHO. The partial combustion of fossil fuels in vehicles produces carbon monoxide, which is another major polluting agent. The WHO air quality standard for CO is 30mg/m3. Apart from these there are many more pollutants like carbon dioxide (CO2), Chlorofluorocarbons (CFCs), ammonia (NH3), peroxyacetylnitrate (PAN), persistent organic pollutants (POPs), toxic metals (lead, cadmium, copper), etc. whose usage is regularly checked by government to control their overshooting usage.

Emission Estimation And Control:

Emission is the amount of a pollutant a source releases in the air. Air Pollution sources are summed up into four sorts, i.e. point source(eg. single heater), line source(eg. vehicles on street), territory source(eg. timberland fire), volume source(eg. oil refineries). Further, they could be classified as stationary or mobile. There are five fundamental techniques used for estimation of the presence of a pollutant in the air includes a Technique for direct estimation, which is done utilizing stationary or mobile sensors. Strategy for mass equalization is finished by figuring contrast between the calculating inflow and outflow in a system. Mathematical modelling of chemical and physical processes does Method of process modelling. Method of emission factor modelling which is the ratio of emission and pollutant source intensity. Method of expert judgment, which incorporates estimation by experience and information. Out of these five recorded strategies, the strategy for direct estimation is generally utilized and gives the most accurate and results, while at the same time being most expensive, whereas the technique of expert judgment is the cheapest and is least utilized since it is a theoretical concept and isn't essentially dependable.

The strategies to control air pollution incorporate Prevention, which deals with the use of clean and green fuels, and energy. Secondly, there are regulatory monitoring solutions set up by the government that monitor records and analyze the air quality of a region. A typical market arrangement incorporates exchanging of carbon credits among different nations to accomplish a worldwide-sustained development. Air can be purified using some of the equipment for commercial use including cyclone, scrubber, baghouse and electrostatic precipitator. In the cyclone, a mixture of suspended gas particles is fed tangentially to the inlet at high pressure and velocity, which creates a spiral flow movement and the suspended particles are forced towards the wall due to the centrifugal force generated, these particles collide with the wall move downwards due to spiral flow and are collected at the bottom. In a scrubber, a scrubbing liquid(usually water) comes into contact with a gas stream having dust particles. The greater the contact of gas and liquid streams is there, the higher is the efficiency of the scrubber. In the Baghouse filter, air containing dust particles enters the baghouse, which contains bags that act as filters, very high efficiencies can be achieved using the baghouse filter ranging up to 99 %, and hence it can be used to separate very fine pollutants. In Electrostatic Precipitator, electrostatic forces are used to separate dust particles from the exhaust gas. The contaminated

gas is made to flow through the passage formed by discharge and collecting electrode, as a result, the airborne particle receives a negative charge and the charged particles are attracted to the grounded or positively charged electrodes when they pass through the ionized field between the electrodes.

Air Quality Modelling:

Air Quality Index(AQI) represents the level of pollution in the air or Air Pollution Index(API), which comprises of 6 levels ranging from good(0 AQI) to hazardous(500 AQI). The overall air pollution index for a site or region is determined by the concentration of the five highest polluting agents: O3, PM2.5, PM10, NO2 and SO2. Air quality is modelled by air dispersion models, which include mathematical equations describing physical and chemical processes of air and its pollutants, and is solved by numerical methods on modern computers. These models can be used to estimate or predict the concentration of air pollutants emitted from various sources. Government agencies use these models to make sure that the new industrial plants that are being set up in an area are in compliance with the relevant air quality standards. These models also find use in emergency planning and cases of accidental release of chemicals like evacuation or sheltering for persons in the downwind direction.

Dispersion models vary depending on the mathematics used to develop the model. Some examples of dispersion models include, The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system, Global Forecasting System (GFS) real-time data updated every 3 hours, The Community Multi-scale Air Quality (CMAQ) modelling system. Countries like the UK and Europe use these models for the determination of air pollution and to analyze cloud-scale interactions between clouds and chemistry.

Conclusion:

Reduction of air pollutants is necessary to adopt a healthy lifestyle. The main reason behind the study of air pollution is to prevent it and to counter different condition related issues. Hence, the study of air pollution is of uttermost importance. To solve the problem of air pollution, it's necessary to understand the issues and look for ways to counter them.