

SMOG : A HAZARDOUS AIR POLLUTANT

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Abstract

The word smog is derived from two words smoke and fog to refer to smoky fog to its opacity and odour! It is a type of air pollutant mainly consists of gases like oxides of sulphur and nitrogen, fog, smoke or particulate matter.

Particulate matter are type of particles having varying size from 0.1 micron to 10 micron present in atmosphere. In general the word particulate is generally used to describe the particles of colloidal dimensions present in aerosols. The particulate matter results in atmosphere from nature itself as well as various human activities such as metallurgical operations and combustion of coal results in organic particulate matters, automobile exhausts are responsible for organic particulate matter, Thus smog may be smoke, fog and particulate matter with oxide of sulphur and nitrogen.

In Dec. 1930 in Meuse Valley of Belgium in 1952 London smog in Donora pennsylvania, in 1950 Los Angeles smog (photochemical smog) are some well known hazardous smog which resulted in death of thousands of people and making several thousand people ill.

Beside these smog can be seen in many cities throughout the world and in winters it also appears in NCR. Out of these mentioned smog London smog and Los-Angeles smog are discussed here briefly.

London Smog : This type of smog was first observed in London in Dec. 1952 so it is called London smog. The other name of this smog is classical smog, industrial smog or sulphurous smog. It was the most severe air pollution in which 5000 people were killed. It was a choking smog as it chemically contains a reducing mixture of oxides of sulphur, the mixture of smoke, fog. It occurs during temperature inversion. The temperature in troposphere region of atmosphere fairly decreases steadily with increasing altitude from ground temperature of 15°C to a temperature of about -56°C change of temperature with height is called increasing altitude, it is called negative lapse rate. In tropopause (a region between 10-20 km height) a transition from positive to negative lapse rate occurs which is called temperature inversion. This smog is generally worst in early morning and worsens shortly after sunrise. This is probably due to photochemically induced oxidation of SO₂ into SO₃ and subsequent combination with moisture to form acidic aerosol (Sulphuric acid aerosol). Particulate of smoke from coal combustion provide condensation sites to condense fog droplets. The main culprit of smog is sulphur dioxide which combines with H₂S and NH₃ and produce sulphites which are important toxicants of smog. Sulphate haze (Sulphate deposition on synthetic deposits of varying composition containing mainly NaCl, NaNO₃ were exposed to SO₂ air gas mixture at concentration typical for heavily polluted atmosphere under haze conditions) normally considered to be a green house gas in responsible for climate cooling.

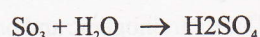
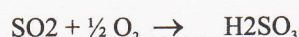
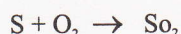
Sulphates are found to lower the temperature in two ways-

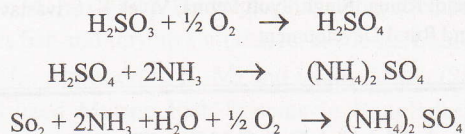
by reflecting away the incoming solar radiation.

by boosting the number of cloud droplets it increases cloud reflectivity.

Only the regional cooling takes place as the temperature decreases due to sulphate aerosol which regional and SO₂ stays only in the area which is engulfed by it.

Chemical reactions occur in whole process can be summarized as below :





SO₂ in presence of sunlight or particulate matter gets converted into SO₃ which gives H₂SO₃ with moisture present in fog and rain rapidly in H₂SO₄ in presence of metal ions. SO₂ also combines with ammonia in moist air forming ammonium sulphate. Smog is an example how SO₂ is hazardous when it gets mixed with SO₃ and particulate matter.

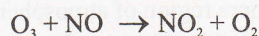
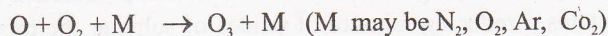
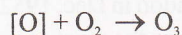
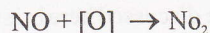
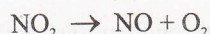
Los Angeles or Photo chemical Smog

In 1950 a photochemical smog was experienced by people of Los-Angeles in California which was totally different from London Smog in nature and its harmful effect on living beings. It breaks in afternoon and worst in sunshine. The main components of this smog are unsaturated hydro- carbons, some sulphur compounds and oxides of nitrogen. Various inorganic and organic components present in this smog are-

- (a) Inorganic gases like ozone, oxides of nitrogen (Nox), hydrogen per oxide and carbon mono oxide.
- (b) Organic substances like organic per oxides, organic hydro per oxides, per oxyacetyl nitrate (PAN), per oxy benzoyl nitrate (PBN), per oxy propionyl nitrate (PPN), acetyl per oxide, ethyl hydro per oxide, per acetic acid, n-butyl hydro per oxide, ter- butyl hydro per oxide, ozone in atmosphere etc. Ozone is formed in atmosphere due to chemical reactions between pollutants like SO₂, NO₂ and aldehydes in presence of UV light. Ozone plays active role in photochemical smog. The following reactions take place during this process which explain the variation concentration of NO, NO₂, O₃ in different parts of a day. In early morning NO concentration is at peak which decreases after sometimes and NO₂ concentration increases.

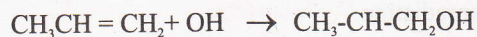
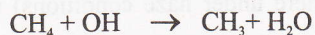


The photolytic dissociation of NO₂ increases NO concentration in atmosphere.



At high concentration NO₂ causes haze. Both NO₂ and O₃ formed above react with unburnt hydrocarbons present in air to form formaldehyde, PAN, acrobin etc.

Various organic compounds like hydrocarbons, aldehydes and ketones undergo photo chemical oxidation during photochemical smog as below:-



Thus the chemical reactions occur in photochemical smog result an increase in concentration of hazardous substances, free radicals in atmosphere.

Harmful Effect

Lower concentration of O₃ in photochemical smog causes irritation of lungs and difficulty in breathing.

The polynuclear aromatic hydrocarbons (PAN) are carcinogenic and particulate matter (fog, mist, dust etc.) present in smog

duce visibility, damage crops and live stocks and cracking of rubber goods. It also causes corrosion of metal stoves, building materials etc.

All these compounds particularly ozone and PAN produce irritation in the eyes and also on the respiratory system causing breathing problems. Irritation of eye is also caused due to formaldehyde and acrolein. Ozone and Nitric oxide irritate nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.

Control To control photochemical smog formation following methods must be adopted-

In automobiles the catalytic converters are fitted so that CO and hydrocarbons are oxidized to CO₂ and H₂O in presence of an oxidation catalyst (Pt or Pd metal).

No must be reduced to N₂ by using a reducing catalyst. A dual catalyst system is provided with both types of catalyst.

Spraying certain compounds into the atmosphere to generate free radicals that readily combined with the free radicals that initiate the reaction forming toxic compounds of photochemical smog.

Certain plants such as Pinus, Juniperus, Pyrus, Vitis etc. can metabolise oxides of Nitrogen so plantation of such trees should be done.

References

“Environmental Chemistry” by Anil Kumar De

Environmental Chemistry by B.K. Sharma.

Chemistry of Environment by Bailey and Strong.

Environmental Chemistry by S.C. Bhatia.

Environmental Chemistry by Banerji.

<http://en.m.wikipedia.org>

/wiki/smog

Weekly magazines, newspapers etc.