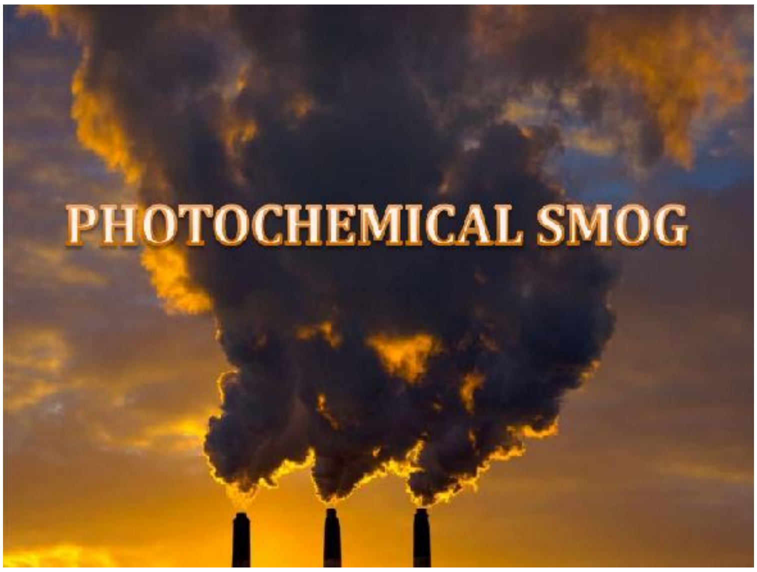

PHOTOCHEMICAL SMOG

Smog, community-wide polluted air. Its composition is variable. The term is derived from the words *smoke* and *fog*, but it is commonly used to describe the pall of automotive or industrial origin that lies over many cities. The term was probably first used in 1905 by H.A. Des Voeux to describe atmospheric conditions over many British towns. It was popularized in 1911 by Des Voeux's report to the ManchesterConference of the Smoke Abatement League of Great Britainon the more than 1,000 "smoke-fog" deaths that occurred in Glasgow and Edinburgh during the autumn of 1909.

At least two distinct types of smog are recognized: sulfurous smog and photochemical smog. Sulfurous smog, which is also called "London smog," results from a high concentration of sulfur oxides in the air and is caused by the use of sulfur-bearing fossil fuels, particularly coal. This type of smog is aggravated by dampness and a high concentration of suspended particulate matter in the air.

Photochemical smog, which is also known as "Los Angeles smog," occurs most prominently in urban areas that have large numbers of automobiles. It requires neither smoke nor fog. This type of smog has its origin in the nitrogenoxides and hydrocarbon vapours emitted by automobiles and other sources, which then undergo photochemical reactions in the lower atmosphere. The highly toxic gas ozone arises from the reaction of nitrogen oxides with hydrocarbon vapours in the presence of sunlight, and some nitrogen dioxide is produced from the reaction of nitrogen oxide with sunlight. The resulting smog causes a light brownish coloration of the atmosphere, reduced visibility, plant damage, irritation of the eyes, and respiratory distress. Surface-level ozone concentrations are considered unhealthy if they exceed 70 parts per billion for eight hours or longer; such conditions are fairly common in urban areas prone to photochemical smog.

Formation of Photochemical Smog

Step 1: People begin driving in the morning, nitrogen is burned or oxidized

$$N_2+O_2 \rightarrow 2NO(1)(1)N2+O2 \rightarrow 2NO$$

Oxidation number of N_2 is 0. The nitrogen in NO has acquired an oxidation number of +2.

Step 2: After a few hours, NO combines with O_2, in another oxidation reaction

$$2NO+O_2 \rightarrow 2NO_2(2)(2)2NO+O2 \rightarrow 2NO2$$

The nitrogen in NO has an oxidation number of +2. The nitrogen in NO_2 has an oxidation number of +4.

Step 3: Nitrogen dioxide absorbs light energy, resulting in a reduction reaction

$$NO_2 \rightarrow NO+O(3)(3)NO2 \rightarrow NO+O$$

The nitrogen in NO_2 has an oxidation number of +4 and the nitrogen in NO is +2.

Step 4: In sunlight, atomic oxygen combines with oxygen gas to form ozone

$$O+O_2 \rightarrow O_3(4)(4)O+O2 \rightarrow O3$$

Step 5: Reaction is temperature and sunlight dependent

$$O_3+NO \quad NO_2+O_2(5)(5)O3+NO \quad NO2+O2$$

Sulfurous smog

Sulfurous smog is also called *"London smog,"* (first formed in London).
Sulfurous smog results from a high concentration of *SULFUR OXIDES* in the air and is caused by the use of *sulfur-bearing fossil fuels, particularly coal* (Coal was the mains source of power in London during nineteenth century. The effects of coal burning were observed in early twentieth century).
This type of smog is aggravated by *dampness* and a *high concentration of suspended particulate matter* in the air.

Photochemical smog

Photochemical smog is also known as "Los Angeles smog".
Photochemical smog occurs most prominently in urban areas that have large numbers of automobiles (Nitrogen oxidesare the primary emissions).

Photochemical (summer smog) forms when pollutants such as nitrogen oxides (primary pollutant) and organic compounds (primary pollutants) react together in the presence of SUNLIGHT. A gas called OZONE (Secondary pollutant) is formed.

Nitrogen Dioxide + Sunlight + Hydrocarbons = Ozone (Ozone in stratosphere it is beneficial, but near the earth's surface it results in global warming as it is a greenhouse gas)

The resulting smog causes a light brownish coloration of the atmosphere, reduced visibility, plant damage, irritation of the eyes, and respiratory distress.

Comparison of Los Angeles and London smog

Characteristic	Los Angeles (Photochemical smog)	London (Classic smog)
Air temperature	24 to 32°C	-1 to 4°C
Relative humidity	< 70%	85% (+fog)
Visibility	< 0.8 to 1.6 km	< 30 m
Months of most frequent occurrence	August – September	December – January
Time of max. occurrence	Mid-day	Early morning
Major fuels	Oil	Coal and oil products
Principle components	O_3, NOx, CO, VOC	Particles (incl. soot), CO, S-compounds
Chemical condition	Oxidative	Reductive, acidic
Principal health effects	Lung function, cough, shortness of breath O_3) Temporary eye irritation (PAN Peroxyacetylnitrate)	Bronchial irritation, coughing (particles/SO_2)
Effects on materials	Rubber cracked (O_3)	Corrosion of many materials (iron, zinc, sandstone)
Effects on plants	Ozone damage many plants	SO_2, particles and acid fog damage many plants