
Air Pollution

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I. The Atmosphere

A mixture of gases held to the earth by gravity

A. Layers

- 1. Troposphere - 7 miles high**
 - Temp decreases with increasing altitude
 - Weather processes, vertical mixing
- 2. Stratosphere - 7 to 30 miles high**
 - Temp increases with increasing altitude (UV absorbed)
 - Calm, little vertical mixing
- 3. Mesosphere**

B. Composition

Nitrogen gas	78%
Oxygen gas	21%
Argon	< 1%
Carbon dioxide	< 1 %
Water vapor	variable 1 to 3%

II. Air Pollutants

Substances added to the atmosphere in sufficient amounts to cause undesirable effects on animals, vegetation or materials

A. Major substances discharged by man

carbon monoxide	nitrogen oxides
volatile organics	sulfur oxides
particulates	

B. Sources of pollutants

Transportation - almost half

Stationary source fuel combustion (electrical generating plants)

Industrial

C. Clean Air Act of 1970

III. Carbon Monoxide

A. Colorless, odorless, tasteless gas - most comes from natural sources (methane oxidation)

B. Product of incomplete combustion of carbon fuel



C. Major human source is motor vehicle exhaust.

Catalytic converter helps to change CO to CO₂

D. Toxicity in humans related to greater affinity of CO for hemoglobin than oxygen

E. Removal

1. Soil microbes

2. Natural change to CO₂ with O₂ in air

Summary - CO is a problem only in high concentration urban areas

IV. Nitrogen oxides

N_2O	nitrous oxide
NO	nitric oxide
NO_2	nitrogen dioxide

Most are produced by natural sources - bacterial action.

A. Fuel combustion



B. NO_2 effects - respiratory problems, acid rain, component of smog

C. Difficult to remove

Catalytic converters use rhodium now to catalyze

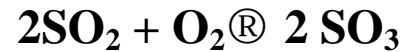


Summary - NO_2 is a dangerous NO_x compound. Most NO_x produced in nature, but manmade sources are concentrated.

V. Sulfur Oxides

SO₂ and SO₃, almost half come from man

A. SO_x are produced primarily by the burning of coal



B. Removal

Add limestone and “scrub” exhaust gas



C. Problems

- 1. Vegetation**
 - 2. Humans - Irritation of respiratory system**
 - 3. Industrial smog (London type)**
 - 4. Acid rain**
 - **Impact depends on the buffering action of the ecosystem**
 - **Effects**
 - a. leaching action puts metal ions into water and affects vegetation**
 - b. corrosion**
- $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 \text{ (more soluble)} + \text{CO}_2 + \text{H}_2\text{O}$**

Summary - Although equal amounts produced by nature and by man, man's production of SO_x causes many problems.

VI. Particulates

Small liq or solid particles

A. Examples - tobacco smoke, cement dust, oil smoke, coal dust, auto exhaust, fly ash, asbestos fiber

B. Effects

- 1. Light scattering**
- 2. Health effects in respiratory system (SiO₂ asbestos fiber)**
 - particles toxic**
 - particles carry toxic materials**

VII. VOC (Volatile Organic Compounds)

- **Most emitted by natural sources - methane and terpenes from trees**

- **Man-made problems -**

Gasoline

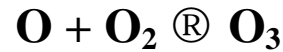
Organic solvents (oil based paints)

VIII. Global Problems

A. Ozone - O₃

Ozone is a secondary pollutant produced by the interaction of primary pollutants (those emitted by natural or man-made sources).

1. Production in the troposphere



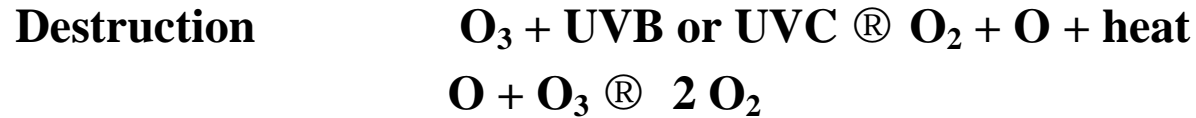
a. Volatile organic compounds (VOC's) unbalance this cycle by:



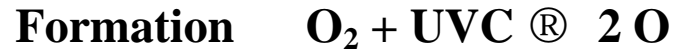
These molecules are the primary components of photochemical smog.

b. Ozone irritates the membranes of the nose and throat, damages crops and degrades materials such as rubber and plastics

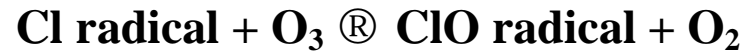
2. Ozone in the stratosphere (relatively high concentration at the top of the stratosphere)



These reactions protect us from the harmful effects of UVB.



3. CFC's (chlorofluorocarbons) can catalyze the breakdown of ozone



The Cl radical is then free to destroy more ozone molecules until by chance it terminates with another radical. One Cl radical can destroy over 100,000 ozone molecules.

B. The Greenhouse Effect

The idea that increasing levels of carbon dioxide, CFC's and others (methane) are leading to global warming

- 1. Incoming visible light from the sun is reflected (1/3) and absorbed (2/3). Much of the radiation that is absorbed is converted to IR and finally reemitted to maintain the heat balance.**
- 2. Water vapor, CO₂, CFC's, and other molecules absorb the IR radiation in the atmosphere and do not allow the heat energy to escape, thus increasing the temperature. This mechanism is responsible for the high temp on Venus, the hottest planet in the solar system. The low level of CO₂ in our atmosphere helps to keep our planet at a livable temp.**

Since the level of CO₂ in our atmosphere is increasing from the burning of fossil fuels, this means that the world's average temp should be increasing. It appears that this is actually occurring. The changes are small and many factors do come into play. For example, all the greenhouse gases are increasing but the particulate concentration is also increasing which would decrease the temp by reflection of the sun's radiation.