

Air Pollution

- air is contaminated everywhere to some degree with smoke, haze, dust, odors, corrosive gasses and toxic compounds.
- air pollution is the most widespread environmental damage.
- 147 million metric tons of air pollution released each year by the US.
- the world releases about 2 billion metric tons a year.
- air quality has improved over the past 20 years in developed countries.
- developing countries however have higher air pollution sometimes ten times higher than the pollution levels considered safe for human health.

Natural Air pollution:

- natural fires-smoke
- Volcanoes- ash, acid mists, hydrogen sulfide and toxic gases.
- sea spray and decaying organics reactive sulfur compounds
- Trees and bushes- emit volatile organic compounds
- pollen, spores, viruses, bacteria also are air pollution
- the effects of natural contamination and human contamination can be the same

Human caused air pollution

- Primary pollutants- released directly from the source into the air in a harmful form.
- Secondary pollutants- changed into hazardous form after released into air by chemical reactions.
- Fugitive emissions- do not go through a smoke stack (most commonly dust from soil erosion, strip mining, rock crushing, and building construction)

-US clean Air Act of 1970- seven major pollutants for which maximum ambient air (air around us) levels are mandated - sulfur dioxide, carbon monoxide, particulates, hydrocarbons, nitrogen oxides, photochemical oxidants and lead

-Sulfur Compounds: about 114 million metric tons a year released from all sources. Humans release about 90% of the sulfur in the air in urban areas.

Natural sources: sea spray, erosion of sulfate containing dust, fumes from volcanoes. Most sulfur released because of humans- burning fuel (coal and oil) containing sulfur- China and US release the most sulfur because of their great amount of coal and oil burning

Sulfur dioxide- directly damaging to plants and animals. Once in the air it can turn into sulfur trioxide and react to water vapor contributing to acid rain.

Sulfate particles reduce visibility in US 80%. Reduction of SOX can be achieved with scrubbers and by burning coal low in sulfur.

Nitrogen compounds:

Nitrogen oxides- formed when nitrogen in fuel or combustion in air is heated to above 650 degrees C.

Total emissions about 230 million tons a year. About 60% is because of humans. Natural sources: lightening, fires and bacteria in soil. Anthropogenic sources: formed from auto exhaust and electrical power generation. NOX irritates the lungs, makes smog, is a potent greenhouse gas and makes acid rain. Reduction of NOX can be achieved with a catalytic converter.

Carbon Oxides:

Carbon Dioxide is causing global warming : about 3 billion tons accumulate in the atmosphere a year. The level of CO₂ is increasing .5%/year. 90% of CO₂ in air is consumed by photochemical reactions that produce ozone.

Carbon Monoxide: colorless, highly toxic gas. Produced by incomplete combustion of fuel. 1 billion metric tons released into atmosphere each year, half of that by humans (internal combustion engines). CO binds to hemoglobin reducing the oxygen in the blood. Can be deadly. It also is a respiratory irritant and strong oxidant. Reduction of CO can be achieved with a catalytic converter, emission testing/laws, oxygenated fuel and mass transit!

Metals and Halogens:

Lead emissions are about 2 millions tons a year, 2/3 of all metallic air pollution. Most of the lead is from leaded gasoline. About 20% of inner city children suffer from some kind of mental retardation because of lead poisoning. Radon is a radioactive gas found naturally in the bedrock that contains radioactively decaying Uranium. It can cause lung cancer.

Mercury: sources: coal burning power plants and waste incinerators.

-Biomagnification in aquatic ecosystems and birds. It is dangerous to eat higher trophic level fish. Mercury is a neurotoxin. Reduction can be achieved with an electrostatic precipitator (a charge is given to the particulate as it tries to leave a smokestack. A charged plate inside the chimney attracts the pollutant.)

More toxic metals: nickel, beryllium, cadmium, thallium, uranium, cesium, plutonium, arsenic.

Particulate Matter:

Aerosol- any system of solid particles or liquid droplets suspended in a gaseous medium.

Particulate material: dust, ash, soot, pollen, leaf mildew.

Can be natural: dust, volcanic ash can also be suspended in the air. Anthropogenic sources are from burning fossil fuels, car exhaust, asbestos, and cigarettes. Particulates irritate the lungs, diffuse into the blood and react with tissues. Sometimes it can cause cancer.

These seem to be the most apparent pollution because they reduce visibility. Reduction can be achieved by filtering, electrostatic precipitators and alternative energy.

Volatile Organic Compounds: (VOC's)

-Organic chemicals that exist as gases in air. 2/3 of the air toxins regulated by the Clean Air Act are VOCs.

-Plants are the largest source

- Benzene, toluene, formaldehyde, vinyl chloride and other chemicals are released into the air by human activities through mainly unburned or partially burned hydrocarbons from transportation. They are also caused by power plants, chemical plants, oil refineries, oil based paint, cheap 70's carpets and furniture and dry cleaning solvents. They can cause asthma and respiratory disease also some are carcinogenic and neurotoxins.

Photochemical oxidants- from secondary atmospheric reactions driven by the sun. Creates smog and ozone which damages buildings, vegetation, eyes and lungs.

INDOOR AIR POLLUTION:

- It has been found that indoor concentration of toxic pollutants are often higher than outdoors.

- Smoking is the most severe air pollutant. 400,000 people die each year from

Emphysema, heart attacks, lung cancer, strokes, and other diseases caused by smoking. (20% of all mortality in US)

- Leading cause of death for women because of advertising in the '50's
- These deaths cause us \$100 billion a year; eliminating smoking would save more lives than any other pollution control.

Concentration of benzene, carbon tetrachloride, formaldehyde, and styrene has been found to be 70 times higher in indoor air than outdoor air. Yikes!

- Less developed countries burn for cooking and heat- because of poor ventilation and cooking fires there is a large amount of indoor air pollution especially particulates. women and children are most affected.
- Levels of carbon monoxide, particulates, aldehydes and toxic chemicals can be 100 times greater than the safe outdoor concentrations in US

Sick Building: a building in which a number of people adverse health effects related to the time spent in the building. These symptoms disappear when they go outside.

Climate:

Temperature inversions: occur when a stable layer of warmer air overlays cooler air, reversing the normal temperature decline with increasing height and preventing convection currents from dispersing pollutants. This is really bad if the pollutants then build up.

Can occur when:

- a cold air mass slides under an adjacent warmer air mass -or-
- Cool air subsides down a mountain slope to displace warmer air in the valley below.

Long range transport:

Many pollutants can be carried long distances by the wind currents.

- some of the most toxic and corrosive materials brought by long range transport are secondary pollutants.
- areas considered the cleanest in the world still have pollutants in the air.

Stratospheric Ozone:

- it was discovered in 1985 that the ozone levels in the stratosphere over the South Pole were dropping during September and October as the sun comes out after the polar winter has been happening since the 1960s.

- this hole was the largest ever found and is now spreading to other parts of the world. About 10% of ozone disappears during the spring.

- This is dangerous because ozone filters out UV light and without it organisms would be exposed to life threatening radiation. Skin cancers increase.

- CFC's (Chlorofluorocarbons) are suspected to be the major cause of ozone loss. known as Freon. When discovered they were regarded as nontoxic, nonflammable and cheaply produced. But because they are so stable they remain in atmosphere for decades. When they are diffused into the stratosphere they release chlorine atoms which destroy the ozone.

- CFC's have been banned and minimized

Effects of air pollution:

-50,000 Americans die prematurely because of illnesses related to air pollution. (5-10 year decrease in life span)

Bronchitis: persistent inflammation of bronchi and bronchioles that causes mucus build up, painful cough, and involuntary muscle spasms that constrict airways.

- Bronchitis can lead to emphysema- an irreversible obstructive lung disease in which airways become permanently constricted and alveoli are damaged or even destroyed.
- Smoking is the leading cause of both these diseases.

Plants:

-Pollutants can be directly toxic damaging to the sensitive cell membranes of plants.

Within a few days of exposure mottling can occur and plant eventually dies.

-damage because of pollutants can be hard to distinguish from insect damage.

-environmental factors can have synergistic effects: injury caused by exposure to each factor individually is less than together at the same together.

Acid Rain- normal pH of rain is about 5.6. Most acid rain in NPZ is due to coal- burning plants upwind. The pH scale is logarithmic.

Aquatic effects: acid in water effects fish- to protect their gills fish produce a mucus lining over their gills and eventually suffocate themselves. Acid shock is especially bad in the spring run off from melting snow.

Kills life in lakes and other aquatic ecosystems- usually the small fry and older fish die first.

-Forest damage:- seedling production, tree density, and viability of spruce-fir trees at high elevations have declined about 50% because of air pollution. Plants waxing coating is destroyed, they have an increased vulnerability to insects, and they take up heavy metals in the soil that were previously inert at a higher pH.

Visibility has been reduced greatly. Even National Parks are effected by air pollution. Acid rain can be reduced by limiting fossil fuel use and alternative energy. Lime is added to acidic lakes but that is a temporary solution. Just increasing the size of smoke stacks is a bad idea!