

Understanding Waste Management – Part 3

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Air Pollution

Introduction to Air Pollution

While in popular terminology "air" is often conflated with "oxygen," air actually consists of oxygen and a mixture of other gases, such as nitrogen (which makes approx. 79% of air), carbon dioxide and rare gases, and methane etc. In fact, every breath you take for example contains methane, a gas that could kill you if you breathe too much of it. In addition to supplying the oxygen you need to survive, air is an important part of several essential cycles that also make life on Earth possible.

Imagine not being able to hear a screaming jet engine a foot away from your ear. That's what would happen if air did not exist. People can hear sound only because air carries sound waves from one point to another.

Earth's atmosphere helps protect you from X-rays, cosmic rays and other particles that bombard the planet. Earth's ozone layer helps reduce the amount of harmful ultraviolet radiation that reaches the surface. Air also reduces the possibility that meteorites and asteroids could level a city. Most space rocks vaporize in the air before they reach the ground, where they can cause destruction. Earth's atmosphere also helps moderate temperatures so that its surface isn't too hot or too cold to support life.

Without air, average temperatures on Earth would plummet to below freezing. During the day, the planet gets warm as it absorbs energy from the sun. Through a process called the greenhouse effect, carbon dioxide and other greenhouse gases absorb some of the infrared radiation the earth releases as it cools. This heat in the atmosphere causes the earth's surface to warm as well.

What is Air Pollution

Air pollution can be defined as the presence of toxic chemicals or compounds (including those of biological origin) in the air, at levels that pose a health risk. In an even broader sense, air pollution means the presence of chemicals or compounds in the air which are usually not present and which lower the quality of the air or cause detrimental changes to the quality of life (such as the damaging of the ozone layer or causing global warming).

Air pollution is probably one of the most serious environmental problems confronting our civilization today. Most often, it is caused by human activities such as mining, construction, transportation, industrial work, agriculture, smelting, etc. However, natural processes such as volcanic eruptions and wildfires may also pollute the air, but their occurrence is rare and they usually have a local effect, unlike human activities that are ubiquitous causes of air pollution and contribute to the global pollution of the air every single day.

The chemical compounds that lower the air quality are usually referred to as air pollutants. These compounds may be found in the air in two major forms:

1. in a gaseous form (as gases),
2. In a solid form (as particulate matter suspended in the air).

Present day scenario

According to the Indian scenario 11 of the 12 cities with the highest levels are located there. Kanpur, India, population 3 million, tops the list with a yearly average of 319 micrograms per cubic meter of PM2.5, the most hazardous particle commonly measured.

The WHO doesn't treat its data as a ranking but rather a measurement of where risks are. But it's clear from the report that India is one of the riskiest countries in the world to breathe, up there with Bangladesh and Georgia. When it comes to comparing PM10 measurements of the world's largest cities, India's capital Delhi comes in with an annual average of 292, ahead of Cairo (284), Dhaka (147), Mumbai (104), and Beijing (92), the Washington Post noted.

Frequent unhealthy levels of pollution from sources ranging from vehicles to the burning of coal and wood for cooking, dust storms, or forest fires affect most of the country. India's hills and mountains also act as basins that trap toxic air over vast swaths of the country, sometimes making the air too dangerous to breathe.

Delhi, India's capital region, home to nearly 19 million people, is notorious for choking air that is now turning the iconic white marble walls of the Taj Mahal green.

Two-thirds of India's population still lives outside of cities, and 80 percent of these households rely on biomass like wood and dung for cooking and heating. Agricultural practices like burning crop stubble also remain widespread.

This smoke can then waft over major cities such as Chennai and Mumbai, where it commingles with traffic exhaust, factory emissions, and construction dust. It can also get trapped by inland by features like hills and mountains, leaving few areas in the country where Indians can breathe easy.

The Effects of Air Pollution on Human Health

Air pollution has serious effects on the human health. Depending on the level of exposure and the type of pollutant inhaled, these effects can vary, ranging from simple symptoms like coughing and the irritation of the respiratory tract to acute conditions like asthma and chronic lung diseases. Long-term exposure to particulate matter, sulphur dioxide, and nitrogen dioxide led to cognitive declines in study participants as they aged. Less-educated men were particularly impacted and had low verbal and math test scores.

Previous studies have found that female brains on average have more white matter than male brains, meaning damage to white matter would put males, with lesser white matter, more at risk of experiencing cognitive declines.

All of the blood that leaves the lungs goes through the heart, where it's then pumped out to the rest of the body. Costa suspects this triggers the immune system, causing inflammation. Over time, he says, too many toxic particles could cause too much inflammation, which may accelerate how quickly the brain ages.

Costa, who until recently worked at the U.S. Environmental Protection agency, says particulate matter, which is generated by anything from wild residue to fossil fuel combustion, is largely thought to be the air pollutant most dangerous to health. But pinpointing the impacts of any one particle can be difficult because regions with poor air quality often have more than one type of pollutant.

Methods to prevent / reduce air pollution

With increase in economic and industrial activity, the pollutant discharge in the air is also increasing. To reduce this flow of pollutants into the air, certain engineering and technological measures are prevalent and effective nowadays. Some of the common ones are briefly mentioned below:

1. An **electrostatic precipitator (ESP)** is a filtration device that removes fine particles, like dust and smoke, from a flowing gas using the force of an induced electrostatic charge minimally impeding the flow of gases through the unit.
2. A **baghouse**, bag filter or fabric filter is an air pollution control device and dust collector that removes particulates out of air or gas released from commercial processes or combustion for electricity generation. Power plants, steel mills, pharmaceutical producers, food manufacturers, chemical producers and other industrial companies often use baghouses to control emission of air pollutants. Functioning baghouses typically have a particulate collection efficiency of 99% or better, even when particle size is very small.
3. A **cyclonic separation** is a method of removing particulates from an air, gas or liquid stream, without the use of filters, through vortex separation. Rotational effects and gravity are used to separate mixtures of solids and fluids. The method can also be used to separate fine droplets of liquid from a gaseous stream.
4. **Wet scrubber** is a control device depends on the industrial process conditions and the nature of the air pollutants involved. Inlet gas characteristics and dust properties (if particles are present) are of primary importance. Scrubbers can be designed to collect particulate matter and/or gaseous pollutants.
5. **Dry scrubber**: The dry and semi-dry systems usually consist of a reaction area with additive supply, possibly a conditioning phase (as in the semi-dry method) and a dust collector (ESP, fabric filter).

Future Focus & Scenario

As the human population and its associated economic activity is increasing rapidly, Air is also becoming a precious resource which is under pressure. As air is essential to sustaining biological life on the earth, it's a serious challenge to the civilisation.

Various technology and engineering initiatives are in progress throughout the world to ensure that air quality is protected. These include emphasis of use of solar and wind energy to generate electricity, developing mass system for transport etc which will reduce dependence on fossil fuels.

This is a wide topic and will require many articles to describe the various developments , hence we limit our description here.

Bye till the next issue.