Special Report

# Environmental Pollution — An Upcoming Threat

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Environmental pollution is the unfavorable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms. These changes may affect man directly or through his supplies of water and of agricultural and other biological products, his physical objects or possessions or his opportunities for recreation and appreciation of nature.

The term environment connotes the whole gamut of physical surroundings, i.e. land, air and water, along with the biotic components (all living forms), which is responsible for the plant and animal kingdom to survive and proliferate.

Environmental pollution is the result of increased production of waste products in industry, rapid urbanization, wanton and irresponsible use of natural resources, as well as unplanned sewage and waste disposal from cities.

## Industrial pollution

All pollutions are not necessarily industrial pollution. Industrial pollution is pollution which can be directly linked with industry, in contrast to other pollution sources. This form of pollution is one of the leading causes of pollution worldwide; in the United States, for example, the Environmental Protective Agency estimates that up to 50% of the nation's pollution is caused by industry. Because of its size and scope, industrial pollution is a serious problem for the entire planet, especially in nations which are rapidly industrializing, like China. (www.wisegeek.com/what-is-industrial-pollution. htm).

Pollution basically affects the atmosphere, hydrosphere and lithosphere. In other words, industrial pollution encompasses within its ambit air pollution, water pollution, land pollution, thermal pollution and, last but not the least, noise pollution.

Here an attempt has been done to cover the causes of industrial pollution (air, water and thermal) and prevention/ control thereof.

## Air pollution by industries

Air, water, food are basic requirements for survival. Other planets have sunlight, but the Earth is the only planet we know that has air and water. Without air and water, the Earth would be unable to sustain life.

Major sources of air pollution are thermal power plants, cement plants, mining and brick kilns. Air pollution causes myriad problems. Air pollution occurs in various industries where chimneys and other vent spew smoke, dust and gases like chlorine, carbon dioxide and sulphur dioxide. (Fig. 1 and 2)

The substances that cause air pollution are called air pollutants. Pollutants that are pumped into our atmosphere and directly pollute the air are called primary pollutants. Primary pollutant examples include carbon monoxide and sulfur dioxide from the combustion of coal.

Further pollution can arise if primary pollutants in the atmosphere undergo chemical reactions. The resulting compounds are called secondary pollutants. Photochemical smog is an example of this.

**Fig. 1: Air pollution by industries**

The term smog was first used in 1905 by Dr. H.A. Des Voeux to describe the conditions of fog that had soot or smoke

**ABOUT THE AUTHOR**

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Satish Kumar is a graduate in Chemistry, followed by a Masters in Business Administration.

He is currently Senior Manager Operations at Sunita Hydrocolloids P. Ltd., a joint venture company of Weatherford Int., USA.

He has 13 years of professional experience in Production and Operations, in development, up-scaling and commercialization of various chemically modified derivatives of guar, tamarind and starches.

Apart from this, he has been involved in development of environmental management and industrial safety in the organization.

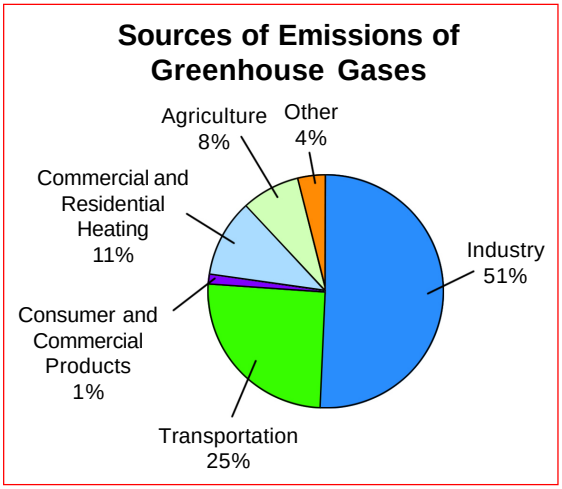


**Fig. 2: Emission sources and their percentage**

in it. Smog is a combination of various gases with water vapor and dust. A large part of the gases that form smog is produced when fuels are burnt. Smog forms when heat and sunlight react with these gases and fine particles in the air. So basically air pollution can be viewed in the light of gaseous air pollutant and particulate air pollutant.

Gaseous air pollutants are the pollutants resulting from the combustion of processes in various industries in form of carbon dioxide, carbon monoxide chlorine etc. Particulate air pollutants are pollutants like dust, ash, dirt etc.

## Prevention and control techniques of air pollution

### *Control techniques for particulate air pollutants*

Air pollution due to particulate air pollutants can be reasonably controlled by following methods:

*Bag filters*

Bag filters are every effective and remove very small particles, even less than one micrometer.

*Wet scrubbers or collectors*

There are several types of wet scrubbers available. These include spray tower, venture scrubbers and cyclonic scrubbers.

*Centrifugal collectors*

Cyclones and dynamic precipitators come in this category and offer economic solutions to emission problems primarily as pre-cleaners to reduce inlet loading to secondary collection devices.

*Electrostatic precipitators*

An electrostatic precipitator (ESP) or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream. In contrast to wet scrubbers, which apply energy directly to the flowing fluid medium, an ESP applies energy only to the particulate matter being collected and therefore is very efficient in its consumption of energy (in the form of electricity).

*Gravity settlers*

These are fitted at the exit of fumes (vents, chimneys). They are used for removing particles over 50 micrometers.

### *Control techniques for gaseous pollutant*

Air pollution due to gaseous air pollutants can be reasonably controlled by following methods:

*By process of incineration*

Incinerators can be of either direct flame type or catalytic type.

**Table 1**
**Indian Standards for ambient air quality**

| Pollutants | Time weighted average | Concentration in ambient air | | |
|---|---|---|---|---|
| | | Industrial areas | Residential (rural & other) areas | Sensitive areas |
| Sulphur dioxide ($SO_2$) | Annual | 80 | 60 | 15 |
| | Average 24 hours | 120 | 80 | 30 |
| Oxides of nitrogen ($NO_x$) | Annual | 80 | 60 | 15 |
| | Average 24 hours | 120 | 80 | 30 |
| Suspended particulate matter (SPM) | Annual | 360 | 140 | 70 |
| | Average 24 hours | 500 | 200 | 100 |
| Respirable particulate matter (RSPM) (Size < 10 µg/m$^3$) | Annual | 120 | 60 | 60 |
| | Average 24 hours | 150 | 100 | 75 |
| Lead (Pb) | Annual | 1.0 | 0.75 | 0.50 |
| | Average 24 hours | 1.5 | 1.0 | 0.75 |
| Carbon monoxide (CO) | 8 hours | 5.0 mg/m$^3$ | 2.0 mg/m$^3$ | 1 mg/m$^3$ |
| | 1 hour | 10.0 mg/m$^3$ | 4.0 mg/m$^3$ | 2.0 mg/m$^3$ |

All values in µg/m$^3$ (microgram per cubic meter of ambient air) unless otherwise indicated.

*By process of adsorption*

In this method, gaseous pollutants are passed through the layers of adsorbent materials, for example, activated carbon, silica gel etc.

*By process of absorption*

In this technique, gaseous pollutants get absorbed in a suitable liquid. The selection of liquid is done on the basis of nature of gaseous pollutant.

## Water pollution by industries

When toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water, whereby the quality of the water deteriorates, affecting aquatic ecosystems. Pollutants can also seep down and affect the groundwater deposits.

Industrial waste and effluents cause water and land pollution (Fig 3 and 4). The waste or effluent generated by different industries are neither similar in character nor in bulk (quantity). Hence the type and degree of treatment can vary from industry to industry. Industrial waste treatment should aim at reducing the toxicity and the bulk of effluent waste.

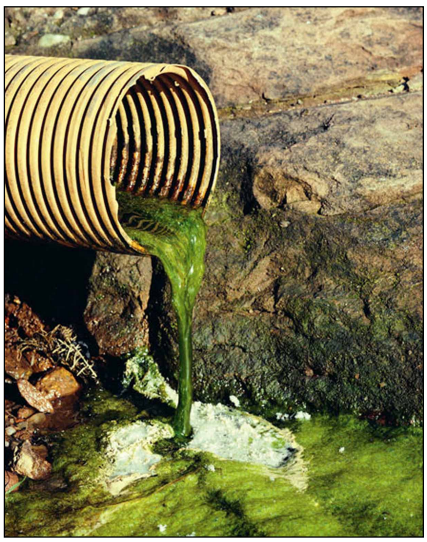

**Fig. 3: Disposal of untreated water**

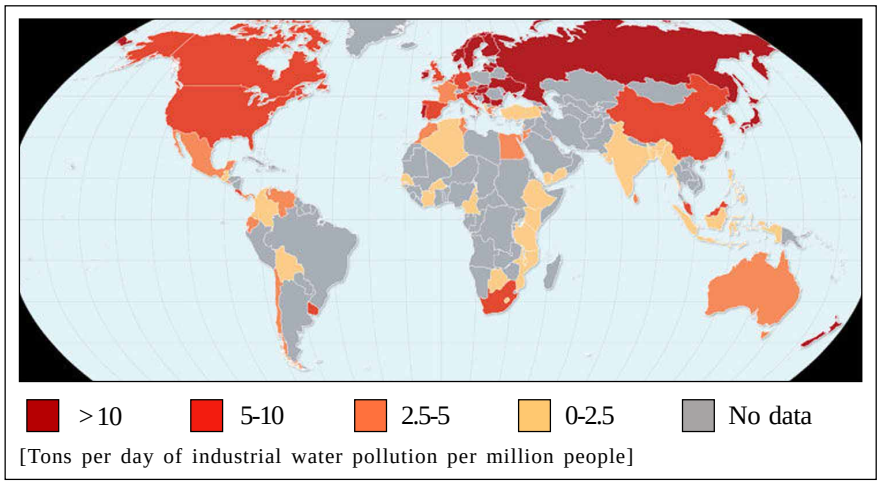


**Fig. 4: Industrial water pollution (World Resources Institute)**

## Prevention and control techniques of water pollution

The treatment of waste water can be done by using chemical methods combined with biological solutions. The adopted method should be cost efficient and effective. Satisfactory disposal of wastewater, whether by surface, sub-surface methods or dilution, is dependent on its treatment prior to disposal.

Wastewater treatment, however, can also be organized or categorized by the nature of the treatment process operation being used; for example, physical, chemical or biological. Examples of these treatment steps are shown below. A complete treatment system may consist of the application of a number of physical, chemical and biological processes to the wastewater.

### *Physical methods*

Physical methods include processes where no gross chemical or biological changes are carried out and strictly physical phenomena are used to improve or treat the wastewater. This involves sedimentation, screening, aeration, filtration and skimming, degasification and equalization.

### *Chemical process*

Chemical process commonly used in many industrial wastewater treatment operations is neutralization. Neutralization consists of the addition of acid or base to adjust pH levels back to neutrality. Since lime is a base, it is sometimes used in the neutralization of acid wastes.

Chemical treatment consists of using some chemical reaction or reactions to improve the water quality. Probably the most commonly used chemical process is chlorination. Chlorine, a strong oxidizing chemical, is used to kill bacteria and to slow down the rate of decomposition of the wastewater.

### *Biological treatment*

Biological treatment methods use microorganisms, mostly bacteria, in the biochemical decomposition of wastewaters to stable end products. More microorganisms or sludges are formed and a portion of the waste is converted to carbon dioxide, water and other end products. Generally, biological treatment methods can be divided into aerobic and anaerobic methods, based on availability of dissolved oxygen.

The treated water should be in line with the specification of the treated water quality norms specified by government.

**Table 2**
**Indian standards for treated water quality**

| Test | Specification |
|---|---|
| pH | 5.5 to 9 |
| Suspended solids (mg/l) | < 100 |
| Total dissolved solids (mg/l) | 1500-2000 |
| Oil and grease (mg/l) | < 10 |
| COD (mg/l) | <250 |
| BOD (mg/l) | < 30 |
| Ammoniacal nitrogen (mg/l) | < 5 |

*Chemical oxygen demand (COD)*

COD is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. COD is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$), which is used in combination with boiling sulphuric acid ($H_2SO_4$). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

*Biochemical Oxygen Demand or Biological Oxygen Demand (BOD)*

BOD is a chemical procedure for determining how fast biological organisms use up oxygen in a body of water. It is used in water quality management and assessment, ecology and environmental science. BOD is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source.

## Thermal pollution by industries

Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence. A common cause of thermal pollution is use of water as a coolant by power plants and industrial manufacturers.

When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature impacts organisms by (a) decreasing oxygen supply, and (b) affecting ecosystem composition.

Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers. This affects fish (particularly their eggs and larvae), macro invertebrates and river productivity.

## Environmental laws related with water and air pollution in India

### *The Water (Prevention and Control of Pollution) Act, 1974*

The main objective of the act is to provide for the prevention and control of water pollution and maintaining or restoring of wholesomeness of water. This act has vested enough powers to the state pollution control boards. This act prohibits persons from disposal of any pollutant into a stream or well or a sewer or on land beyond the permissible limits laid down by the state pollution control board.

Further the act lays down that, without the previous concern of the state pollution control board, no person should start making any new discharge or sewage or start using new or altered outlet for sewage discharge or take any steps to establish any industry or operations, which are likely to discharge trade effluent or sewage into a stream or well or sewer or on land.

### *The Air (Prevention and Control of Pollution) Act, 1981*

The purpose of the act is to provide for the prevention, control and abatement of air pollution. This act also takes into its ambit noise pollution. In this act enough powers have been vested with state pollution control board.

The act envisages that the consent of the board is essential to establish any industry. The said consent would lay down conditions pertaining to the pollution control equipment so far as their specification and norms are concerned.

### *The Environment Protection Act, 1986*

This act aims to provide protection of the environment on a very wide scale. This act has taken into its ambit the problems of waste, microorganism, hazardous chemical etc.

This act lays down emissions and effluent standards of various industries, the standards with respect to other pollutants including hazardous wastes. It has empowered the state pollution control board to impose stricter standard in case of specified category of industries which the state pollution control board deem fit. The act further stipulates that no industrial activity is to be undertaken involving hazardous chemicals without preparing a safety report. However new industries are to prepare safety report within five years of it commissioning. In case of industries handling certain specified chemicals, the act further envisages that up-to-date onsite emergency plan must be prepared and maintained to cope with major accidents.

## CONCLUSIONS

In sum up, the time has now come to aim to create a culture where fundamental environmental considerations are part of everyday business decisions.

While we continue to manage fundamental emissions, our motive should be towards sustainability, changing/performing /managing our daily activities in such a way, so as to avoid waste at source, rather than simply treating the waste and emissions that arise.