

Water Pollution

Prof. Amitava Gangopadhyay
Professor, Environmental Engineering Division,
Department of Civil Engineering
Jadavpur University

Water pollution can be defined as alteration in physical, chemical or biological characteristics of water, making it unsuitable for designated best use in its natural state. World Health Organization (WHO) has defined water pollution as inclusion of any foreign material either from natural or other sources into a water body, thereby changing the natural qualities of water and making it unusable for its intended purpose.

Sources of Water Pollution

Sources of water pollution may be natural or anthropogenic.

Natural Sources

Gases and materials emanating from natural volcanic eruption, minerals present in soil, waste created by living organisms present in water may be considered as natural sources.

Anthropogenic Sources

The anthropogenic sources are: a) Household b) Commerce c) Industries d) Agriculture e) Offshore oil drilling and Oil spills etc. Wastewater generated from different types of human activities when disposed off in water body cause water pollution.

Household Source

Household wastewater is generated from various use of water for domestic purposes. It includes both sullage (bathroom and kitchen wastewater) and sewage (wastewater from water closet). The common organic materials found in sullage are food remnants, soaps and synthetic detergents. Many detergents contain phosphates. Sewage contains suspended as well as dissolved organic and inorganic matter, pathogenic bacteria and viruses derived from human faeces. When sewage is subjected to treatment up to secondary level, suspended solids and organic matters are removed to a great extent. The treated effluent contains inorganic matters, mostly nutrients.

Commercial Source

Commercial sources of wastewater generation are laundry, restaurants, shopping mall etc. The nature of constituents will be more or less same as that of household waste but the quantity generated in one commercial unit will be much more than individual household.

Industrial Waste

Industries are varied in nature and constituents of industrial wastewater also vary widely from industry to industry. Industries dealing with chemicals will contribute different chemicals (organic or inorganic) to waste water. Similarly, industries like pulp and paper, food processing, distillery, pesticide, dairy etc. produce waste materials comprising organic compounds. When effluents from these industries are discharged to a surface water body the water environment will either get contaminated by chemicals or dissolved oxygen level of the water body will be depleted to a considerable low level because of bacterial oxygen demand while stabilizing organic matter for their respiration and synthesis.

The chemicals or metal particles released from industries get into the surface and ground water, disturbing the ecosystem and they have severe adverse effects on human, plant and animal health. The heavy metals like cadmium, lead, manganese, mercury, copper, chromium are considered most harmful.

Agricultural Source

The fertilizers, pesticides etc. used in agriculture is carried by the rain water, known as surface runoff which meets the surface source polluting the same. This source of pollution is considered as non-point source as the pollution is generated over the entire agricultural field.

Offshore Drilling and Oil spills

The oil spills while exploring oil and gas under seabed cause pollution in marine environment. Routine discharges from ships also cause marine pollution. Crude oil while being transported across oceans in tankers, due to accidents or leakages oil spills onto the water and causes the degradation of aquatic and marine environment.

Radioactive Wastes

Wastewater generated from the nuclear power stations, during nuclear tests, uranium ore processing, research laboratories using radioisotopes, hospitals using isotopes for diagnostic and therapeutic purposes cause pollution by introducing radioactive substances in the water environment.

Thermal Pollution

The cooling water required in thermal power stations becomes hot and when discharged in water environment cause thermal pollution. The hot water makes the temperature of aquatic environment rise resulting in depletion of dissolved oxygen level, which endangers the aquatic system.

Effects of Water Pollution

Man, aquatic species, and environment are mostly affected by water pollution.

Effects on Man

Pathogenic bacteria and many disease-causing viruses present in a water body due to pollution from municipal wastewater may be attributed to for several water-borne ailments like cholera, typhoid, diarrhea, dysentery, hepatitis, polio and jaundice.

Heavy metals (lead, mercury, cadmium etc.), pesticides, cyanides and many other organic and inorganic compounds present in wastewater polluting a water body cause various types of diseases. Water soluble methyl mercury is formed by bacterial action in water environment when mercury is dumped into water and accumulates in fish. When people eat this fish the disease called Minamata (after the name of Minamata bay in Japan) disease is caused. People suffer from numbness of body parts, vision and hearing problems and abnormal mental behavior. Pollution by the heavy metal, cadmium, causes the disease called Itai-Itai by the people of Japan.

Effects on Animals, Marine Life and Vegetation

Eutrophication

Due to introduction of nutrients and chemicals through discharge of domestic sewage, industrial effluents, and fertilizers from agricultural field, the process of eutrophication takes place. Phenomenal growth of phytoplankton and algae is caused due to nutrient accumulation, thereby reducing the penetration of oxygen, light and heat into the water body.

Biomagnification

Increasing the concentration of various toxic substances along the food chain is commonly known as biomagnification. Toxic substances at the level of primary producers get concentrated at each higher level as they move up the food chain. The phenomenon of concentrated toxic deposition at the higher level is known as bio-accumulation. Acute diseases manifest in the higher species due to concentrated toxic substances.

Control of Water Pollution

For control of water pollution both point and non-point sources of water pollution should be properly assessed and attended to.

Point Sources

It is considered mandatory that before disposal the wastewater generated from the point sources (municipal or industrial) is to be treated to conform to the standards laid down by the regulating authority to control water pollution.

Treatment Plants

Three stages of treatment are suggested for treating municipal wastewater and industrial wastewaters containing non-toxic and biodegradable organic compounds. The three stages of treatment are i) Primary Treatment ii) Secondary Treatment iii) Tertiary Treatment. Industrial wastewaters containing toxic or non-biodegradable substances are to be subjected to chemical treatment.

Primary Treatment

In primary treatment, wastewater is passed through screens, grit chamber and primary clarifiers in order to remove large size particles, inorganic grit particles and the settleable solids (both organic and inorganic). The solids deposited at the bottom of the primary clarifier are known as primary sludge.

Secondary Treatment

In secondary treatment of wastewater, the organic matter is biologically degraded by micro-organisms under aerobic, anoxic or anaerobic condition. In aerobic condition bacteria grows in presence of dissolved oxygen present in water environment, in anoxic condition no dissolved oxygen is present but oxygen available in the combined state (nitrate, sulphate, carbon dioxide etc.) is used by the bacteria, while in anaerobic condition bacteria grows in absence of any form of oxygen.

The biomass thus formed in the reactor is settled in a secondary clarifier. The secondary sludge after being combined with primary sludge is subjected to further treatment in sludge digester. The effluent from the secondary clarifier after being subjected to disinfection is discharged either to a land or to a water body. In anaerobic digester, the combined sludge is further degraded by micro-organisms in anaerobic environment, where methane gas is generated. Methane may be used as fuel or may be converted to energy.

Tertiary treatment

In this method, inorganic substances viz. nitrogen, phosphorus etc. are removed. Land treatment of effluent from secondary clarifier after biological treatment may be considered as tertiary treatment.

Non-Point Sources

A water body may be safeguarded against pollution from non-point sources if the following measures are meticulously taken.

- i) Run-off of manure is diverted to a basin for settling and subsequent use of nutrient rich water as fertilizer in agricultural field is ensured.
- ii) Surface run-off generated due to rain should not be mixed up with wastewater.
- iii) Judicious use of agro-chemicals like bio-fertilizers and bio-pesticides will reduce surface run-off and leaching.

Control of Marine Pollution

There are several options to minimize marine pollution.

- i) *Using less toxic offshore drilling fluids.*
- ii) *Cleaning onboard prior to discharge* is also a rapidly developing technology.
- iii) *Shipment of wastes ashore* for recycling, landfill or incineration is one of the options for dealing with the large accumulations of contaminated drill cuttings.
- iv) *Offshore cuttings re-injection (CRI)* is a waste disposal technique where drill cuttings and other oilfields wastes are mixed with water to form slurry and pumped at high pressure down an injection well.

Central Pollution Control Board (CPCB) has set up the standards to protect the water resources for various uses. The Prevention of Water Pollution Act, 1974 has regulation to control water pollution.

Many advanced countries are thinking of zero level water pollution. They are contemplating to reuse and recycle cent percent treated effluent to the industrial processes resulting in zero discharge to the surface water body. Similar is the case with other point sources of wastewater generation. But so far non-point sources are concerned attempts are being made to reduce the pollution both quantitatively and qualitatively.

