Water Pollutant

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Sources of pollution

- Domestic wastewater
- Industrial wastewaters
- Agriculture runoff
- Storm water runoff
- Bathing, cloth washing, etc., in water bodies

Classification and Effect of water pollutants

- The various types of water pollutants can be classified in to following major categories:

- 1) Organic pollutants,
- 2) Pathogens,
- 3) Nutrients and agriculture runoff,
- 4) Suspended solids and sediments,
- 5) Inorganic pollutants (salts and metals),
- 6) Thermal Pollution
- 7) Radioactive pollutants.

Classification and Effect of water pollutants

- **ORGANIC POLLUTANTS:**

  - ***a) Oxygen Demanding wastes:*** The wastewaters such as, domestic and municipal sewage, wastewaters from food processing industries, canning industries, slaughter houses, paper and pulp mills, tanneries, etc., have considerable concentration of biodegradable organic compounds either in suspended, colloidal or dissolved form.

  - These wastes undergo degradation and decomposition by bacterial activity.

  - The dissolved oxygen available in the water body will be consumed for aerobic oxidation of organic matter present in the wastewater.

  - Hence, depletion of the DO will be a serious problem adversely affecting aquatic life, if the DO falls below 4.0 mg/L. This decrease of DO is an index of pollution.

Classification and Effect of water pollutants

b) Synthetic Organic Compounds

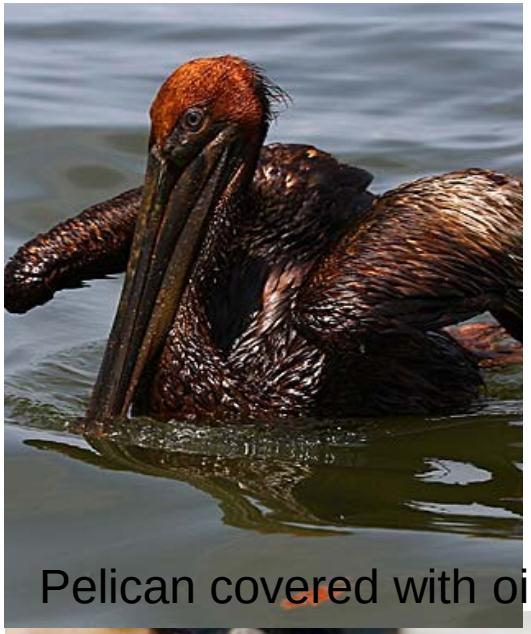
- Synthetic organic compounds are also likely to enter the ecosystem through various manmade activities such as production of these compounds, spillage during transportation, and their uses in different applications.
- **These include synthetic pesticides, synthetic detergents, food additives, pharmaceuticals, insecticides, paints, synthetic fibers, plastics, solvents and volatile organic compounds (VOCs).**
- Most of these compounds are **toxic and biorefractory organics** i.e., they are resistant to microbial degradation.
- Even concentration of some of these in traces may make water unfit for different uses.
- The detergents can form foams and volatile substances may cause explosion in sewers.
- Some of these compounds are exceedingly persistent and their stability to chemical reagents is also high.

Classification and Effect of water pollutants

c) Oil

- Oil is a natural product which results from the plant remains fossilized over millions of years, under marine conditions. It is a complex mixture of hydrocarbons and degradable under bacterial action.
- The biodegradation rate is different for different oils, tars being one of the slowest.
- Oil enters in to water through oil spills, leak from oil pipes, and wastewater from production and refineries.
- Being lighter than water it spreads over the surface of water, separating the contact of water with air, hence resulting in reduction of DO.
- This pollutant is also responsible for endangering water birds and coastal plants due to coating of oils and adversely affecting the normal activities.
- It also results in reduction of light transmission through surface waters, thereby reducing the photosynthetic activity of the aquatic plants.
- Oil includes polycyclic aromatic hydrocarbons (PAH), some of which are known to be carcinogenic.

Classification and Effect of water pollutants



Pelican covered with oil

Mexico Oil spill, 2010

Classification and Effect of water pollutants

2) PATHOGENS

- The pathogenic microorganisms enter in to water body through sewage discharge as a major source or through the wastewater from industries like slaughterhouses.

- Viruses and bacteria can cause water borne diseases, such as cholera, typhoid, dysentery, polio and infectious hepatitis in human.

Classification and Effect of water pollutants

3) NUTRIENTS

- The agriculture run-off, wastewater from fertilizer industry and sewage contains substantial concentration of nutrients like **nitrogen and phosphorous**.
- These wastewater supply nutrients to the plants and may **stimulate the growth of algae** and other aquatic weeds in receiving waters.
- Thus, the value of the water body is degraded.
- In long run, water body reduces DO, leads to **eutrophication** and ends up as a dead pool of water.
- People swimming in eutrophic waters containing **blue-green algae** can have **skin and eye irritation**, gastroenteritis and vomiting.
- High nitrogen levels in the water supply, causes a potential risk, especially to infants under six months. This is when the **methaemoglobin** results in a decrease in the oxygen carrying capacity of the blood as nitrate ions in the blood readily oxidize ferrous ions in the hemoglobin.

Classification and Effect of water pollutants

4) SUSPENDED SOLIDS AND SEDIMENTS

- These comprise of **silt, sand and minerals** eroded from land.
- These appear in the water through the **surface runoff** during rainy season and through municipal sewers.
- This can lead to the **siltation, reduces storage capacities** of reservoirs.
- Presence of suspended solids can **block the sunlight penetration** in the water, which is required for the photosynthesis by bottom vegetation.
- **Deposition of the solids** in the quiescent stretches of the stream or ocean bottom can **impair the normal aquatic life** and affect the diversity of the aquatic ecosystem.
- If the deposited solids are **organic** in nature, they will undergo **decomposition** leading to development of anaerobic conditions.
- Finer suspended solids such as **silt and coal dust may injure the gills** of fishes and cause asphyxiation.

Classification and Effect of water pollutants

5) INORGANIC POLLUTANTS

- Apart from the organic matter discharged in the water body through sewage and industrial wastes, high concentration of heavy metals and other inorganic pollutants contaminate the water.
- These compounds are **non-biodegradable and persist in the environment.**
- These pollutants include **mineral acids, inorganic salts, trace elements, metals, metals compounds, complexes of metals with organic compounds, cyanides, sulphates**, etc.
- The **accumulation of heavy metals** may have adverse effect on aquatic flora and fauna and may constitute a public health problem where contaminated organisms are used for food.
- Algal growth due to nitrogen and phosphorous compounds can be observed.
- Metals in high concentration can be toxic to biota e.g. Hg, Cu, Cd, Pb, As, and Se. Copper greater than 0.1 mg/L is toxic to microbes.

Classification and Effect of water pollutants

6) THERMAL POLLUTION

- Considerable thermal pollution results due to discharge of hot water from **thermal power plants, nuclear power plants**, and industries where water is used as coolant.
- As a result of hot water discharge, the temperature of water body increases, which **reduces the DO** content of the water.
- This **alters the spectrum of organisms**, which can adopt to live at that temperature and DO level.
- When organic matter is also present, the **bacterial action increases** due to rise in temperature, hence, resulting in rapid decrease of DO.
- The discharge of hot water leads to the **thermal stratification** in the water body, where hot water will remain on the top.

Classification and Effect of water pollutants

7) RADIOACTIVE POLLUTANTS

- Radioactive materials originate from the following:
  - Mining and processing of ores,
  - Use in research, agriculture, medical and industrial activities, such as I^{131}, P^{32}, Co^{60}, Ca^{45}, S^{35}, C^{14}, etc.
  - Radioactive discharge from nuclear power plants and nuclear reactors, e.g., Sr^{90}, Cesium Cs^{137}, Plutonium Pu^{248}.
  - Uses and testing of nuclear weapons
  - These isotopes are toxic to the life forms; they accumulate in the bones, teeth and can cause serious disorders.
  - The safe concentration for lifetime consumption is 1×10^{-7} microcuries per ml.

Terminologies used in wastewater treatment

- **Unit operations**: Invloves contaminant removal by physical forces.

- **Unit processes**: Involves biological and/or chemical reactions.

- **Reactor:** Refers to the vessel or containment structure along with all of its appurtenances, in which the unit operation or process takes place. Although, unit operation or unit processes are natural phenomenon, they may be accelerated, initiated or controlled by altering environment in the reactor.

- **Wastewater treatment System**: Combination of unit operations or unit processes designed to reduce certain constituents of wastewater to an acceptable level. Many different combinations are possible depending upon the type of pollutant present.

Terminologies used in wastewater treatment

- **Municipal Wastewater treatment:** Often divided into primary, secondary and tertiary sub-systems.
  - Primary treatment: Removal of solids materials from the incoming wastewater (Screen, grit chamber, PST)
  - Secondary treatment: Usually consists of biological conversion of dissolved and colloidal organic matter into biomass that can subsequently be removed by sedimentation.
  - Sometimes primary and secondary treatment can be accomplished together, e.g. oxidation pond and aerated lagoon.

- **Tertiary treatment**: Most often involves further removal of suspended solids, removal of nutrients, pathogens, etc.
  - Combinations of physical unit operation and biological and/or chemical processes are used.

Unit operation, Unit processes, and Systems for Wastewater Treatment

Contaminant	**Unit operation, Unit process or treatment**
Suspended Solids Oil and grease	Sedimentation, Screening and Comminution, Filtration variations, Flotation, Chemical-polymer addition, coagulation/ sedimentation, Land treatment system Flotation, skimming tank, cross flow plate separator
Biodegradable organics	Activated sludge process, Fixed film reactors (Trickling filter, RBC), Lagoon and oxidation pond variations, Intermittent sand filtration, Land treatment systems, Anaerobic processes (UASB reactor, Anaerobic filter, AFBR), Physical chemical systems.
Pathogens	Chlorination, Hypochlorination, Ozonation, Land treatment systems
Nutrients: Nitrogen	Biochemical nitrification and denitrification (either suspended or fixed film), Ammonia stripping, Ion exchange, Breakpoint chlorination, Land treatment system
Phosphorous	Metal-salt addition, Lime coagulation / sedimentation, Biological-chemical phosphorous removal, Land treatment systems.
Refractory organics	Carbon adsorption, Tertiary ozonation, Photocatalytic conversion and biological treatment, Land treatment systems, electrochemical coagulation
Heavy metals	Chemical precipitation, Ion exchange, phytoremediation
Dissolved inorganic solids	Ion exchange, Reverse osmosis, Electrodialysis, Membrane filtration (UF, NF, RO)

Summary of industrial wastewater, origin, characteristics and treatment

Industries	Origin of major wastes	Major characteristics	Major treatment and disposal
Canning	Trimming, juicing, blenching of fruits & vegetables	High SS, Colloidal & dissolved organic matter	Screening, lagooning, soil absorption or spray irrigation
Dairy	Dilution of whole milk, separated milk, butter milk & whey	High dissolved organic matter, mainly protein fat & lactose, high SS	Biological treatment, UASB reactor, aeration, TF, ASP
Brewery & distillery (spent wash)	Steeping & pressing of grains, residue from distillation of alcohol, condensate from stillage evaporation	High dissolved organic matter, colour, high sulphate, high chloride	Netralization, equalization, Methane Recovery, Anaerobic treatment, ASP, biological treatments, ponds and lagoon
Sugar (Black strap molasses)	Transfer, screening & juicing waters, drainage from lime sludge, condensates after evaporators, juice, extracted sugar	High in SS, organic matter	Biological treatment and reuse of treated water, UASB, ASP, Ponds/Lagoon, etc.

Summary of industrial wastewater, origin, characteristics and treatment

Industries	Origin of major wastes	Major characteristics	Major treatment and disposal
Pharma-ceuticals	Mycelium (fungus filaments), spent filtrate and wash water	High in SS, TDS, High COD/BOD, acidic or alkaline	Chemical, biological treatment
Textile	Cooking of fibers, desizing of fabric, bleaching, dying (hypochlorite or peroxide)	High alkalinity, High BOD, colour, high SS	Neutralization, flotation, Chemical and biological treatment
Tannery or leather goods	Washing, Unhairing, soaking, liming, deliming, bating, pickling, degreesing, tanning, dyeing and stuffing	High total solids, salts, sulphides, chromium, BOD, strong colour	Equalization, sedimentation or chemical precipitation, biological treatment
Pulp and paper (Black liquor)	Cooking, refining, washing of fibers, screening of paper pulp (Kraft process using Na_2SO_4, NaOH, Na_2S; Sulphite process using Mg & Ca bisulphite and acid; alkali process using NaOH or lime)	High or low pH, colour, high SS, high BOD, high COD/BOD ratio, high TDS & inorganic fillers	Settling, Chemical recovery, lime treatment for colour, biological treatment

Summary of industrial wastewater, origin, characteristics and treatment

Industries	Origin of major wastes	Major characteristics	Major treatment and disposal
Steel	Coking of coal, washing of blast furnace flue gases, pickling of steel	Low pH, phenol, ore coke, limestone, oils, low ss, high cyanide, high nitrogen	Neutralization, recovery & reuse, chemical coagulation, Biological treatment
Fertilizer	Synthesis of ammonia & urea	High nitrogen content	Biological treatment
Oil refineries	Drilling muds, salt, oil, misc. oil from refining	High TDS, high BOD, phenol, sulphur compounds, emulsified oil	Oil separation, chemical treatment, biological treatment
Nuclear power plant and radioactive materials	Processing of ores, laundering of contaminated cloths, research lab wastes, processing fuels, power plant cooling water	Radioactive elements. acidic	Concentration and containment or dilution and dispersion

More than 104 industrial category identified by CPCB http://www.cpcb.nic.in

Toxic chemicals from some selected industries

Industry :	**Toxic polluents**
Fertilisers:	Ammonia, arsenic
Coke ovens:	Phenols, cyanide, thiocyanate, ammonia
Metullurgicals:	Heavy metals, e.g. Cu, Cd, Zn
Electroplating:	Hexavulent chromium, cadmium, copper, zinc
Synthetic wool:	Acrylonitrile, acetonitrile, HCN
Petrochemicals:	Phenol, Heavy metals, cyanide