

Industrial wastewater: pollution and treatment

Industrial wastewater is the aqueous discard that results from substances having been dissolved or suspended in water, typically during the use of water in an industrial manufacturing process or the cleaning activities that take place along with that process.

Industrial wastewater treatment describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater may be reused or released to a sanitary sewer or to a surface water in the environment.



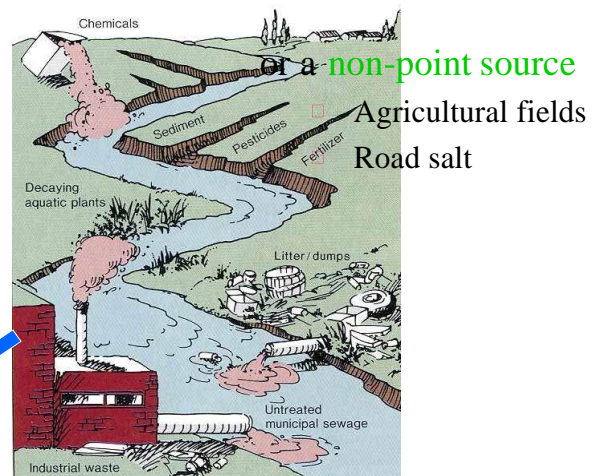
Impact of industrial wastewater

When metals, chemicals, and sewage are released or leak into the environment, they cause significant air, soil, and water pollution – the latter being one of the most devastating results. Often, untreated wastewater is wrongly released back into bodies of water due to lack of infrastructure or regulation. When this happens, lakes, rivers, and coastal waters can become significantly polluted. Pollutants like total organic carbon (TOC) and compounds containing nitrogen and phosphorous can lead directly to eutrophication, which can often be the death of a body of water.

- Pollution can affect both surface waters and groundwater
- be a detrimental threat to public health and ecosystem



Sources of industrial wastewater



Pollution can come from a
point source

Point Source: A point source is a single, identifiable source of pollution, such as a pipe or a drain. Industrial wastes are commonly discharged to rivers and the sea in this way. Sources of pollution which are close to the water sources are called point sources.

Non-point sources: Non-point sources of pollution are often termed ‘diffuse’ pollution. They refer to inputs and impacts which occur over a wide area and are not easily attributed to a single source. They are often associated with particular land uses, as opposed to individual point source discharges. Sources of pollution which are scattered and do not have any specific location are called non-point sources.

Point Sources	Non-point Sources
1. Pollutants are discharged directly into water bodies.	1. Pollutants are discharged away from water bodies and at various places.
2. Easy to treat the pollutants in the water treatment plant before they enter the water bodies	2. Difficult to treat the pollutants before they enter water bodies.
3. More harmful	3. Less harmful in comparison to point source water pollution.
4. For Example- Sewage outlets in the municipal area, power plants, oil wells, and underground coal mines close to water bodies.	4. For Example- Garden, roads, construction sites, runoff water from the field, etc.

Common sources of groundwater pollution

Table 11.1 Common sources of groundwater pollution and/or contamination

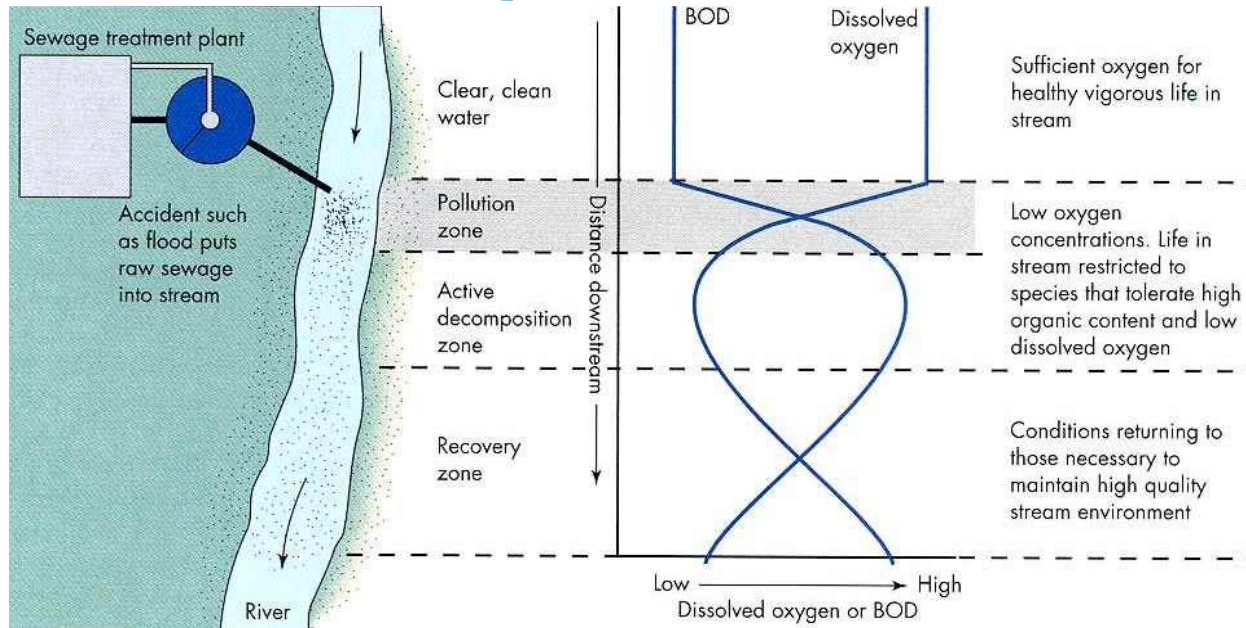
Leaks from storage tanks and pipes
 Leaks from waste disposal sites such as landfills
 Seepage from septic systems and cesspools
 Accidental spills and seepage (train or truck accidents, for example)
 Seepage from agricultural activities such as feedlots
 Intrusion of salt water into coastal aquifers
 Leaching and seepage from mine spoil piles and tailings
 Seepage from spray irrigation
 Improper operation of injection wells
 Seepage of acid water from mines
 Seepage of irrigation return flow
 Infiltration of urban, industrial, and agricultural runoff

Damage depends on:

- Nature of pollutant
- Quantity added
- Duration of addition
- Area affected
- Residence time
- Reservoir size
- Permeability
- Flow/plumes
- Flushing to clean

Most common industrial pollutants: BOD and COD

The relationship between BOD and O₂



Streams: Self Cleaning

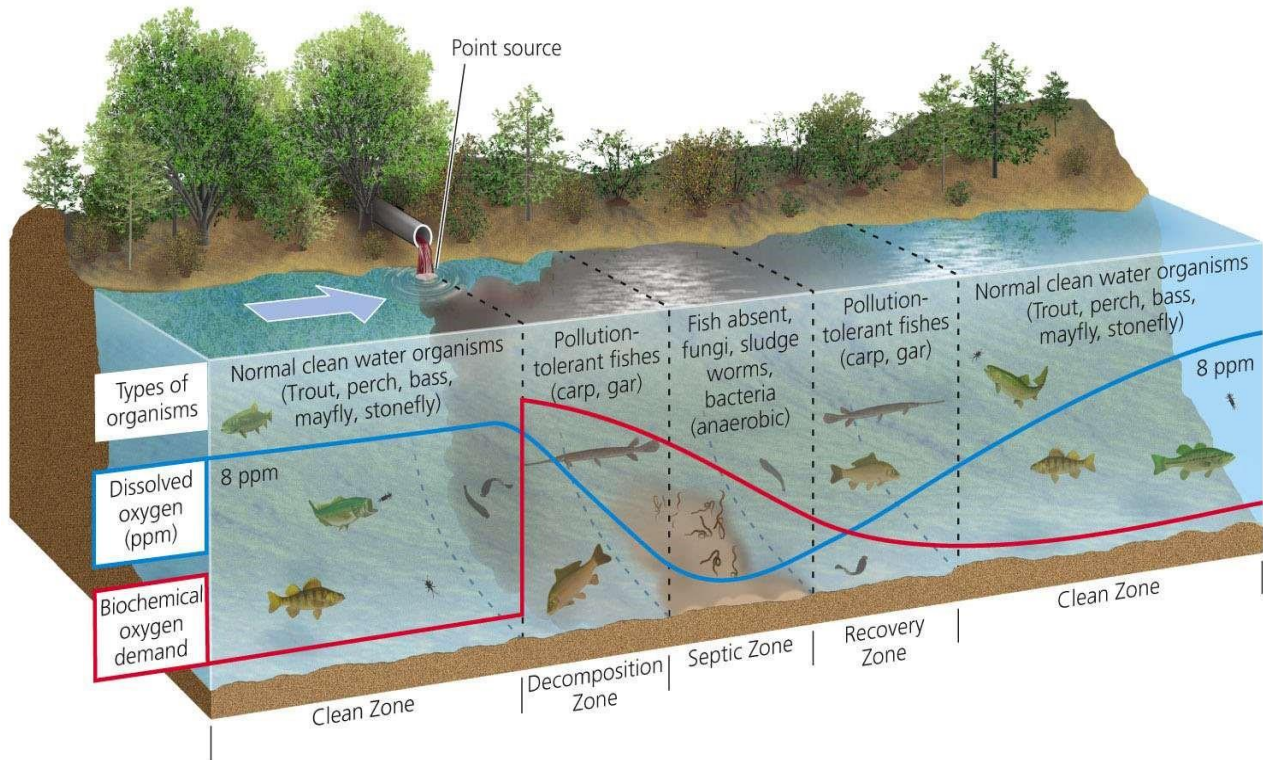
- A. Clean Zone**
 - DO high
 - BOD low
- B. Pollution enters stream**
- C. Decomposition Zone**
 - DECOMPOSITION increases to break down pollution
 - OXYGEN decreases as it is used up by decomposers
- D. Septic zone – DEAD ZONE - Hypoxic**
 - dissolved oxygen levels are very low and very few species can survive
- E. Recovery Zone**
 - Waste concentrations decrease
 - DO ↑, BOD ↓
- F. Clean Zone**
 - DO is high, BOD is low and normal biodiversity levels are present.

Clean zone: DO is high BOD is low very low pollution = normal life.

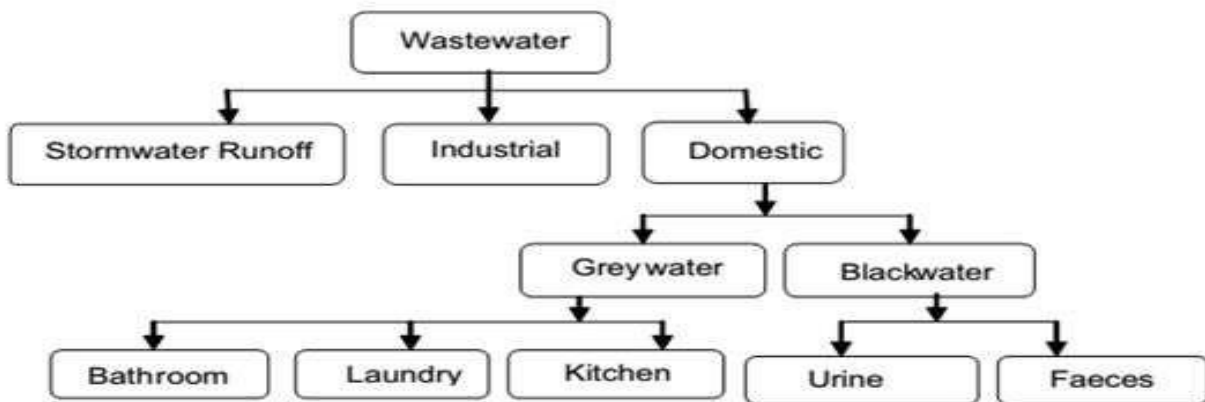
Decomposition zone: Bacteria are using DO to break down pollutants. DO is decreasing BOD is increasing = pollution tolerant life.

Septic zone: DO is too low (BOD very high) for fish to live as de-oxygenated water moves down stream.

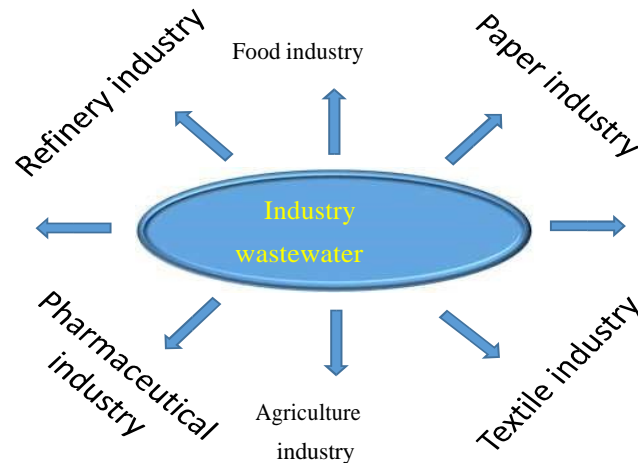
Recovery zone: DO starts to rise as BOD decreases due to pollution decreasing = pollution tolerant life



Types of wastewater



Sources of Industrial wastewater



Characteristics of industrial wastewater

- Vary from industry to industry, vary from process to process.
- Have too high quality of suspended solids, dissolved organics and inorganic solids, BOD, alkalinity or acidity
- Cannot always be treated easily by the normal method of treating domestic wastewater

Physical characteristics of wastewater

Electrical Conductivity (EC)

- Indicates the salt content

Total solids (TS)

- Mass remain after evaporation at 103-105°C

Total Dissolved Solids (TDS)

- Comprise inorganic salts and small amounts of organic matter dissolved in water

Total Suspended solids (TSS)

- Comprises solid particles suspended (but not dissolved) in water

Chemical characteristics of wastewater

Biochemical oxygen demand (BOD)

- Indicates the amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water in a defined time period.

Chemical oxygen demand (COD)

- Indicates the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant.

Total Organic Compound (TOC)

NH₄-N and NO₃-N

- Show dissolved nitrogen.

Kjeldhal Nitrogen

- A measurement of organically-bound ammonia nitrogen.

Total-P

- Reflects the amount of all forms of phosphorous in a sample.

Types of industrial wastewater

• Inorganic industrial wastewater

Is produced mainly in the coal and steel industry, in the nonmetallic minerals industry, and in commercial enterprises and industries for the surface processing of metals.

Contain a large proportion of suspended matter, which can be eliminated by sedimentation.

• Organic industrial wastewater

Is produced mainly in chemical industries and large-scale chemical works, which mainly use organic substances for chemical reactions. Contain organic substances having various origins and properties.

Can only be removed by special pretreatment of the wastewater, followed by biological treatment.

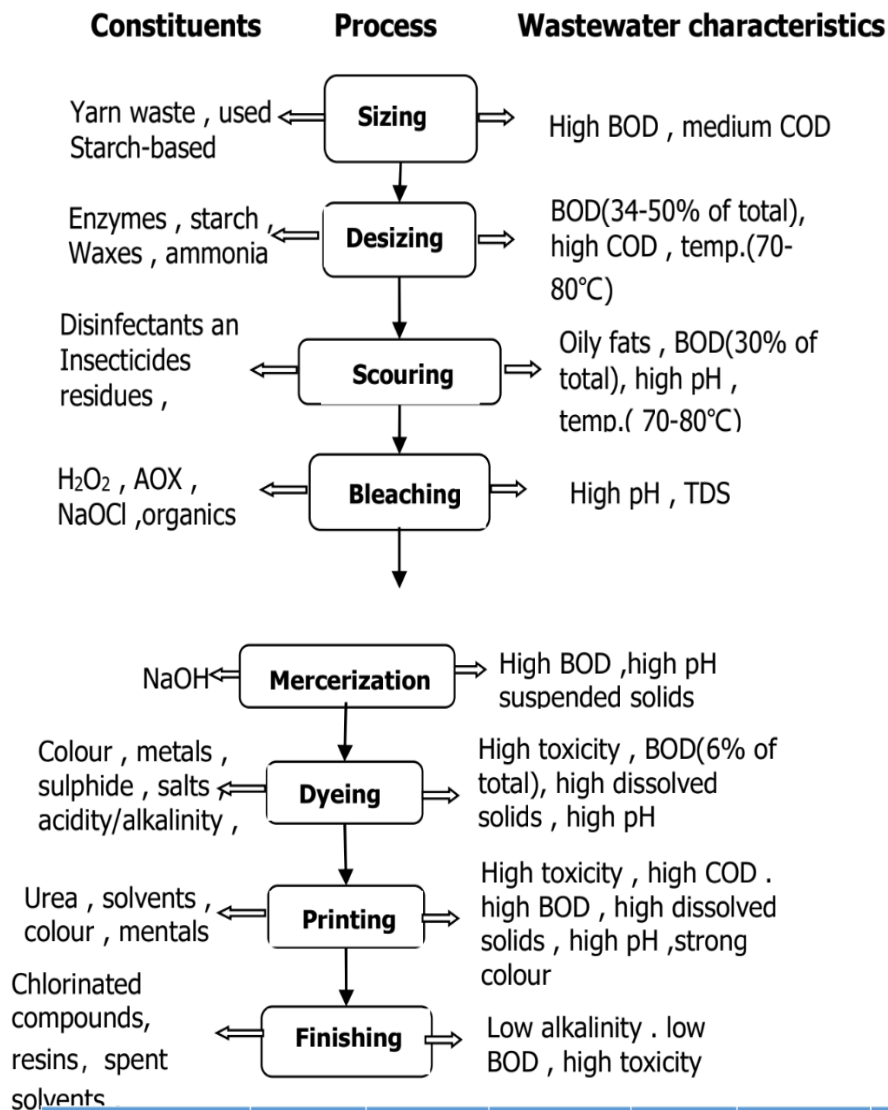
Typical pollution loads industrial wastewater

- **Suspended solids:** Lead to the development of sludge deposits and anaerobic conditions.
- **Organic Substances:** Deplete DO of stream and impose great load on secondary treatment unit.
- **Inorganic substances:** Cause eutrophication of water bodies, increase dissolved solids content and be harmful to aquatic life.
- **Acids and alkalies:** Affect the aquatic life of receiving water body and cause serious problem in operation of treatment units.
- **Toxic Substances:** Cause problems in the biological treatments.
- **Color producing substances:** Impart objectionable color in the receiving water bodies
- **Oils:** Hinder self-purification and cause problem in oxygen diffusion

Water Pollutants in the Industrial Sector

Sector	Pollutants
Iron and steel	BOD, COD, oil, metals, acids, phenols, and cyanide
Textiles and leather	BOD, solids, sulfates and chromium
Pulp and paper	BOD, COD, solids, Chlorinated organic compounds
Petrochemicals and refineries	BOD, COD, oils, , phenols, and chromium
Chemicals	COD, organic chemicals, heavy metals, SS, and cyanide
Non-ferrous metals	Fluorine and SS
Microelectronics	COD, and organic chemicals
Mining	SS, metals, acids and salts

Textile wastewater: major pollutants at various stages of manufacturing



The most significant environmental impacts are caused by: salts, detergents and organic acids.

(Sarayu, K. 2012)

Industries	pH	COD mg·L ⁻¹	BOD ₅ mg·L ⁻¹	TSS mg·L ⁻¹	Chloride mg·L ⁻¹	Sulfate mg·L ⁻¹	Phenol mg·L ⁻¹	Oil and grease mg·L ⁻¹
Composites industries	5.5-11.0	600-1400	350-600	300-500	700-1200	300-700	0.5-2.0	5-15
Processing industries	7.0-8.5	470-900	230-450	300-500	300-900	200-1000	0.5-2.0	5-10
Woolen industries	7.0-11.0	220-700	160-350	160-380	-	-	-	-

Activate Wind

Pollutants released from pulp and paper industry

Processes	
Raw material preparation	Suspended solids including bark particles, fiber pigments, dirt, grit, BOD, and COD.
Pulping	Color, bark particles, soluble wood materials, resin acids, fatty acids, AOX, VOCs, BOD, COD, and dissolved inorganics.
Bleaching	Dissolved lignin, color, COD, carbohydrate, inorganic chlorines, AOX, EOX, VOCs, chlorophenols, and halogenated hydrocarbons.
Paper-making	Particulate wastes, organic and inorganic compounds, COD, and BOD.

Problems of handling industrial wastewater

- **Use of outdated technologies:** some industries still rely on old technologies to produce products that generate large amount of wastewater.
- **Presence of large number of small scale industries:** many small scale industries and factories often escape environment regulations and discharge wastewater without inefficacy.
- **Unplanned industrial growth:** in most industrial townships, unplanned growth took place wherein those companies do not provide proper waste disposal sites and disregard for pollution control rules and norms, which lead to water pollution.
- **Lack of strict policies:** lack of effective policies and poor enforcement drive, resulted in mass scale pollution that affected lives of many people.
- **Inefficiency wastewater treatment:** not treated adequately before discharging it into rivers or lakes.
- **Vary characteristics:** characteristics of industrial wastewater highly varied from different process and the pollutants is complex.
- **Lack of investment and management:** Some enterprises do not invest enough to maintain the long-term stable operation.