Industrial Wastewater

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What is industrial wastewater pretreatment?

Industrial wastewater pretreatment is the treatment a factory performs before discharging wastewater to a municipal sewer or a centralized treatment plant. Its purpose is to remove or reduce pollutants that could harm pipes, treatment processes, workers, or the environment.

Typical pretreatment steps include screening, oil and grease removal, pH adjustment, chemical precipitation of metals, solids separation, and flow equalization. The required level depends on the industry and local discharge limits.

Why do factories need pretreatment?

Factories need pretreatment because industrial wastewater can contain pollutants that ordinary municipal plants are not designed to receive in high concentrations. These may include toxic metals, solvents, oils, acids, alkalis, high organic loads, heat, and suspended solids.

Pretreatment helps a factory comply with discharge permits, avoid fines or shutdowns, protect downstream equipment, and reduce environmental risk. It can also make water reuse or recycling more practical.

How to determine wastewater treatment capacity?

Treatment capacity is normally based on the wastewater flow and pollutant load the system must handle. Begin by measuring or estimating:

- Average daily flow, usually m^3/day
- Peak hourly or daily flow
- Variability by shift, batch, and season
- Influent pollutant concentrations, such as COD, BOD_5, TSS, oil and grease, nutrients, metals, and pH
- Required effluent-quality limits

Pollutant load is calculated as:

$$\text{Load (kg/day)} = \text{Flow } (m^3/\text{day}) \times \text{Concentration (mg/L)} \div 1{,}000$$

A treatment plant should be sized for expected peak conditions and include an appropriate allowance for operational variation and future production growth. Pilot tests or treatability studies are valuable where wastewater composition is complex.

COD vs BOD_5 — what is the difference?

COD and BOD_5 both indicate the strength of organic pollution in wastewater, but they measure it differently.

COD, or chemical oxygen demand, measures the oxygen equivalent needed to chemically oxidize pollutants. It is obtained quickly—often within a few hours—and can capture many biodegradable and non-biodegradable compounds.

BOD_5, or five-day biochemical oxygen demand, measures the oxygen consumed by microorganisms as they break down biodegradable organic matter over five days.

COD is usually higher than BOD_5. The COD/BOD_5 ratio helps indicate biodegradability: a lower ratio generally suggests wastewater is more suitable for biological treatment, while a high ratio may indicate refractory or toxic compounds.

What is DAF wastewater treatment?

DAF means dissolved air flotation. It is a physical-chemical treatment process used to remove suspended solids, oils, grease, and some organic matter from wastewater.

In a DAF system, air is dissolved in water under pressure and then released as tiny bubbles. These bubbles attach to particles and oil droplets, causing them to float to the surface. The floating sludge is skimmed off, while clarified water leaves the unit.

DAF is commonly used in food processing, dairies, slaughterhouses, pulp and paper, petrochemical operations, and industrial sites with oily or high-solids wastewater.

When is MBR appropriate?

An MBR, or membrane bioreactor, combines biological treatment with membrane filtration. It is appropriate when a facility needs very high-quality effluent, has limited site space, or plans to reuse treated water.

MBR systems can produce low-turbidity water and retain more biomass than conventional activated sludge systems. They are useful where discharge limits are strict or water reuse is valuable.

However, MBRs generally have higher energy, membrane-cleaning, and maintenance requirements. They are best selected after confirming that the wastewater is biologically treatable and that pretreatment can protect the membranes from oils, debris, scaling, and fouling.

Individual vs centralized wastewater treatment

Individual treatment means each factory owns and operates its own wastewater treatment plant. This gives the factory direct control over its effluent and may be necessary for isolated sites, high-strength wastewater, or strict site-specific requirements. The trade-off is higher capital cost, operating responsibility, and the need for skilled staff.

Centralized treatment collects wastewater from several factories and treats it at a common facility. It can reduce unit costs, simplify operations for individual businesses, and provide shared specialist expertise. However, it requires reliable sewer infrastructure, clear discharge standards, and pretreatment at each factory so that one user does not disrupt the whole system.

In many industrial parks, the most effective model is factory-level pretreatment followed by centralized biological and final treatment.