Waste Water Treatment

BY

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Introduction

Wastewater treatment is the process of removing pollutants from municipal wastewater, which mainly contains domestic sewage plus a small amount of industrial wastewater. Physical, chemical, and biological processes are used to remove pollutants and produce treated wastewater (or treated effluent) that is safe enough to be released into the environment. The by-product of wastewater treatment is a semi-solid waste or slurry, called sewage sludge. The sludge must undergo further treatment before it is suitable for disposal or release to land. Wastewater treatment can also be referred to as wastewater treatment. However, the latter is a broader term that can also refer to industrial wastewater. For most cities, the sewer system will also carry a proportion of industrial effluent to a wastewater treatment plant, which typically receives pretreatment at the plants themselves to reduce the pollutant load. If the sewer system is a combined sewer, it will also carry urban runoff (storm water) to the wastewater treatment plant. The wastewater can travel to the treatment plants via pipes by liquefaction or by pumping. The first part of wastewater treatment typically involves a screen to filter out solids and large objects, which are then collected in landfills and disposed of in landfills. Fats and grease are also removed before primary wastewater treatment.

Wastewater Resources

Here are three main types of wastewater and all categories have several sources. It's important to know the sources of wastewater so you can determine what passes through your wastewater systems – whether as a homeowner or business – and implement effective sewage treatment plans. That way, you're investing in the protection of Australia's ecosystem.

Here are some sources of wastewater:

1. Domestic wastewater

Domestic wastewater refers to the water used throughout your home to service baths, showers, toilets, laundries, food preparation, and sinks. As you go about your daily activities, the composition and strength of your domestic wastewater will fluctuate. This is because your water usage, diet, habits, and overall lifestyle can cause hourly, daily, and seasonal changes to your water output. Domestic wastewater varies between households since some homes use more water per capita than others.

Domestic wastewater is considered a form of point source pollution – where waste reaches water from a single discharge or outfall pipe. Domestic wastewater usually flows to a single location – such as septic tanks – where the wastewater treatment process begins.

2. Industrial wastewater

Industrial wastewater is defined as polluted water that originates from industrial and manufacturing processes. It encompasses any waste that comes from production stages. Industrial wastewater is a by-product of several industries, including:

Oil and gas fracking

Chemical manufacturing

Industrial laundries

Food and beverage processing

Metal refining

Clothing manufacturing

Technological industries

Mining

Steel/iron production

Power plants

By contrast to domestic wastewater, industrial wastewater is a form of dispersed-source water pollution since waste enters the water from unconfined spaces. For example, farms are considered a form of dispersed source pollution because their surface run-off includes fertilizers, animal feces, silt, pesticides, and other chemicals.

This wastewater is more difficult to control and often requires the use of development standards and land-use plans to determine what waste originates from where.

3. Storm water

Stormwater is a form of wastewater in itself as it carries various pollutants after considerable rainfall. Some pollutants that may occur in urban stormwater include:

Petroleum residues

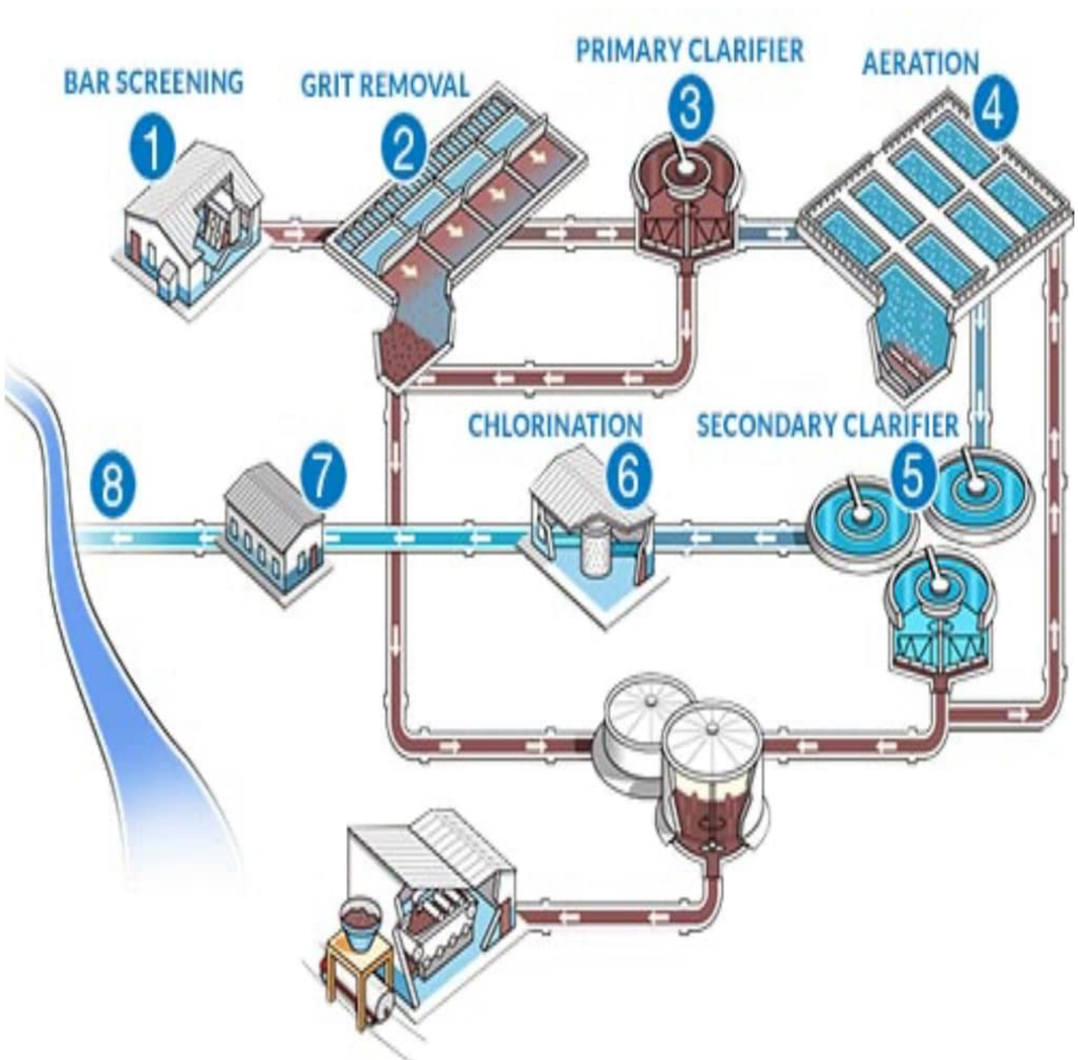
Sand

Road deicing chemicals

These pollutants usually enter stormwater from both agricultural and urban locations. That is, stormwater drains collect water from roof runoff, gutters, gardens, roads, and parks. This form of wastewater is also a dispersed source of pollution since stormwater enters local creeks, lakes, rivers, or streams from various locations.

The Wastewater Treatment Process

Eight Stages of the Wastewater Process



Stage One- Bar Screening

Removal of large items from the influent to prevent damage to the facility's pumps, valves and other equipment.

The process of treating and reclaiming water from wastewater (any water that has been used in homes, such as flushing toilets, washing dishes, or bathing, and some water from industrial use and storm sewers) starts with the expectation that after it is treated it will be clean enough to reenter the environment.

The quality of the water is dictated by the Environmental Protection Agency (EPA) and the Clean Water Act, and wastewater facilities operate to specified permits by National Pollutant Discharge Elimination System (NPDES). According to the EPA, The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Under the CWA, EPA sets wastewater standards for industry. The EPA has also developed national water quality criteria recommendations for pollutants in surface waters. EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges.

As an example of expected standards, the Biochemical Oxygen Demand (BOD) of average wastewater effluent is 200 mg/L and the effluent after treatment is expected to be >30 mg/L. It is crucial a wastewater facility meets these expectations or risk stiff penalty.

The physical process of wastewater treatment begins with screening out large items that have found their way into the sewer system, and if not removed, can damage pumps and impede water flow. A bar screen is usually used to remove large items from the influent and ultimately taken to a landfill.

Mechanical Bar Screen

Stage Two — Screening

Removal of grit by flowing the influent over/through a grit chamber.

Fine grit that finds its way into the influent needs to be removed to prevent the damage of pumps and equipment downstream (or impact water flow). Too small to be screened out, this grit needs to be removed from the grit chamber. There are several types of grit chambers (horizontal, aerated or vortex) which control the flow of water, allowing the heavier grit to fall to the bottom of the chamber; the water and organic material continue to flow to the next stage in the process. The grit is physically removed from the bottom of the chamber and discarded.

Stage Three — Primary Clarifier

Initial separation of solid organic matter from wastewater.

Solids known as organics/sludge sink to the bottom of the tank and are pumped to a sludge digester or sludge processing area, dried and hauled away. Proper settling rates are a key indicator for how well the clarifier is operating. Adjusting flow rate into the clarifier can help the operator adjust the settling rates and efficiency.

After grit removal, the influent enters large primary clarifiers that separate out between 25% and 50% of the solids in the influent. These large clarifiers (75 feet in diameter, 7½ inches at the edges and 10½ feet in the center as an example) allow for the heavy solids to sink to the bottom and the cleaner influent to flow. The effectiveness of the primary clarification is a matter of appropriate water flow. If the water flow is too fast, the solids don't have time to sink to the bottom resulting in negative impact on water quality downstream. If the water flow is too slow, it impacts the process up stream.

The solids that fall to the bottom of the clarifier are known as sludge and pumped out regularly to ensure it doesn’t impact the process of separation. The sludge is then discarded after any water is removed and commonly used as fertilizer.

Clarifier System

Stage Four — Aeration

Air is pumped into the aeration tank/basin to encourage conversion of NH_3 to NO_3 and provide oxygen for bacteria to continue to propagate and grow.

Once converted to NO_3, the bacteria remove/strip oxygen molecules from the nitrate molecules and the nitrogen 👎 is given off as N_2↑ (nitrogen gas).

At the heart of the wastewater treatment process is the encouragement and acceleration of the natural process of bacteria, breaking down organic material. This begins in the aeration tank. The primary function of the aeration tank is to pump oxygen into the tank to encourage the breakdown of any organic material (and the growth of the bacteria), as well as ensure there is enough time for the organic material to be broken down. Aeration can be accomplished with pumping and defusing air into the tank or through aggressive agitation that adds air to the water. This process is managed to offer the best conditions for bacterial growth. Oxygen gas [O_2] levels below 2 ppm will kill off the bacteria, reducing efficiency of the plant. Dissolved oxygen monitoring at this stage of the plant is critical. Ammonia and nitrate measurements are common to measure how efficient the bacteria are in converting NH_3 to N_2↑.

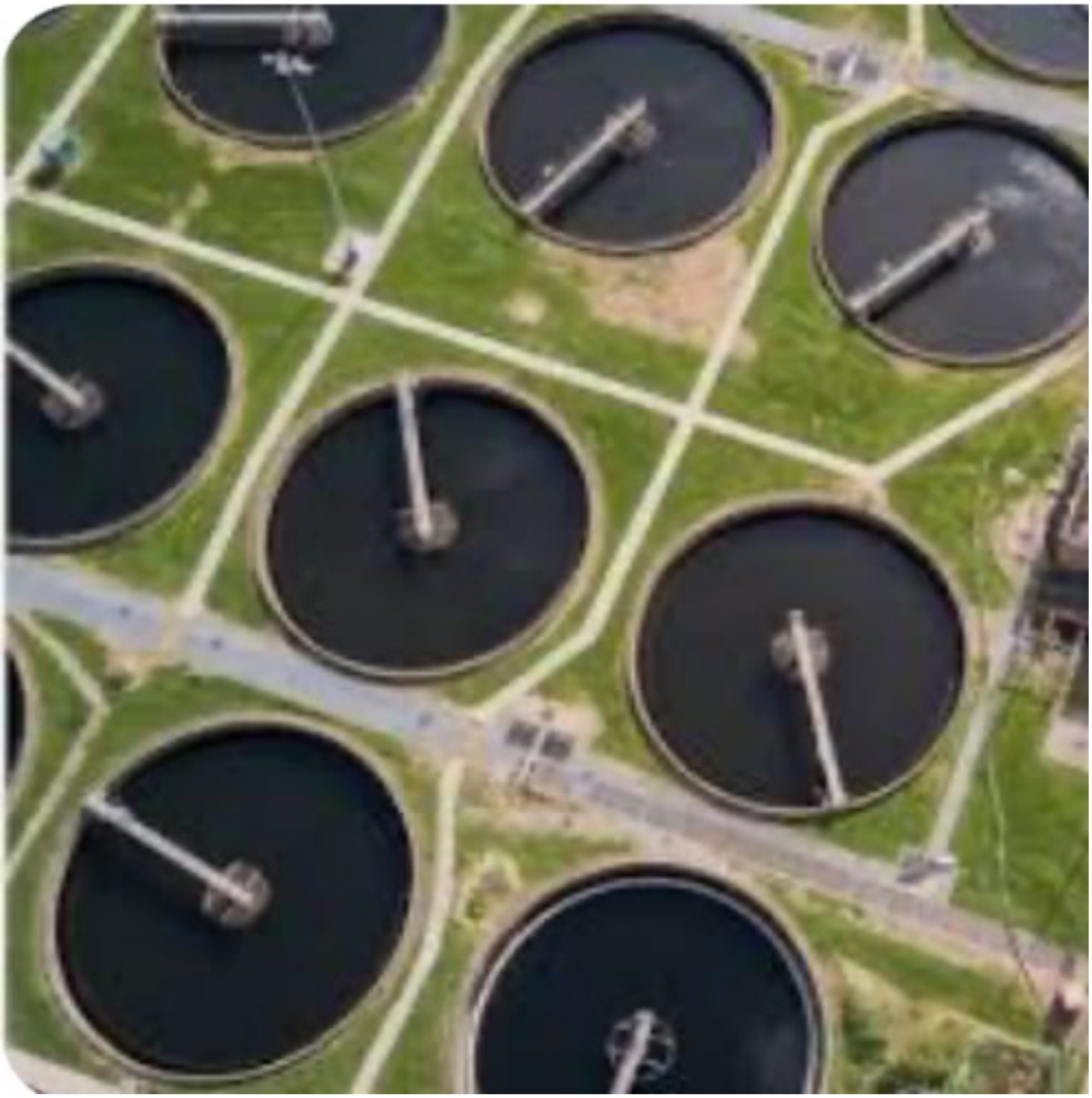
A key parameter to measure in wastewater treatment is Biochemical Oxygen Demand (BOD). BOD is a surrogate indicator for the amount of organic material present and is used to determine the effectiveness of organic material breakdown. There are a number of other tests used to ensure optimal organic material breakdown (and BOD reduction) such as measuring pH, temperature, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Hydraulic Retention Time (flow rate), Solids Retention Time (amount of time the bacteria is in the aeration chamber) and Mixed Liquor Suspended Solids. Ongoing and accurate monitoring is crucial to ensure the final required effluent BOD.

Stage Five — Secondary Clarifier

Treated wastewater is pumped into a secondary clarifier to allow any remaining organic sediment to settle out of treated water flow.

As the influent exits the aeration process, it flows into a secondary clarifier where, like the primary clarifier, any very small solids (or fines) sink to the bottom of the tank. These small solids are called activated sludge and consist mostly of active bacteria. Part of this activated sludge is returned to the aeration tank to increase the bacterial concentration, help in propagation, and accelerate the breakdown of organic material. The excess is discarded.

The water that flows from the secondary clarifier has substantially reduced organic material and should be approaching expected effluent specifications.



Stage Six — Chlorination (Disinfection)

Chlorine is added to kill any remaining bacteria in the contact chamber.

With the enhanced concentration of bacteria as part of the aeration stage, there is a need to test the outgoing effluent for bacteria presence or absence and to disinfect the water. This ensures that higher than specified concentrations of bacteria are not released into the environment. Chlorination is the most common and inexpensive type of disinfection, but ozone and UV disinfection are also increasing in popularity. If chorine is used, it is important to test for free-chlorine levels to ensure they are acceptable levels before being released into the environment.

Stage Seven — Water Analysis & Testing

Testing for proper pH level, ammonia, nitrates, phosphates, dissolved oxygen, and residual chlorine levels to conform to the plant's NPDES permit are critical to the plant's performance.

Although testing is continuous throughout the wastewater treatment process to ensure optimal water flow, clarification and aeration, final testing is done to make sure the effluent leaving the plant meets permit specifications. Plants that don`t meet permit discharge levels are subject to fines and possible incarceration of the operator in charge.

Stage Eight — Effluent Disposal

After meeting all permit specifications, clean water is reintroduced into the environment.

Although testing is continuous throughout the wastewater treatment process to ensure optimal water flow, clarification and aeration, final testing is done to make sure the effluent leaving the plant meets permit specifications. Plants that don`t meet permit discharge levels are subject to fines and possible incarceration of the operator in charge.

Clean Water

Conclusions

Why Is Wastewater Treatment Important?

The world's eight billion people create a lot of wastewater — another word for sewage — enough that the natural water purification process is insufficient on its own to remove the harmful chemicals that cause disease in not just people but flora, fish and wildlife.

Wastewater treatment removes contaminants and suspended solids from wastewater; this treated, potable water can then be dispatched back into the ecosystem free from man-made contaminants.

Why do we treat wastewater? Without treatment, the amount of wastewater in the environment would cause devastation. It does so, in fact, in developing nations: Globally, over 80 percent of all wastewaters is discharged without treatment. This leads to mass illness and severe disruption of the food chain.

Untreated wastewater poses significant health risks, accounting for 1.7 million deaths annually —over 90 percent of those in developing nations1.

Remark:

Photos resource from the Internet.