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Department:Microbiology

Subject:Microbial ecology

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Viva assignment

Question:

Answer:

Waste water:

Wastewater is used water that has been affected by domestic, industrial and commercial use. The composition of all wastewaters is thus constantly changing and highly variable, which is why it is so difficult to pinpoint a singular definition of the word itself.

Composition of waste water:

The composition of wastewater is 99.9% water and the remaining 0.1% is what is removed. This 0.1% contains organic matter, microorganisms and inorganic compounds. Wastewater effluents are released to a variety of environments, such as lakes, ponds, streams, rivers, estuaries and oceans. Wastewater also includes storm runoff, as harmful substances wash off roads, parking lots and rooftops.

Types of wastewater:

There are two types of wastewater.

- Blackwater contains human waste and harmful pathogens.
- Greywater consists of water discharge from sources such as showers, sinks and washing machines. Although greywater is not clean enough to drink, it does not contain harmful pathogens.

Treatment of wastewater:

Why Treat Wastewater?

It's a matter of caring for our environment and for our own health. There are a lot of good reasons why keeping our water clean is an important priority:

FISHERIES: Clean water is critical to plants and animals that live in water. This is important to the fishing industry, sport fishing enthusiasts, and future generations.

WILDLIFE HABITATS: Our rivers and ocean waters teem with life that depends on shoreline, beaches and marshes. They are critical habitats for hundreds of species of fish and other aquatic life. Migratory water birds use the areas for resting and feeding.

RECREATION AND QUALITY OF LIFE: Water is a great play ground for us all. The scenic and recreational values of our waters are reasons many people choose to live where they do. Visitors are drawn to water activities such as swimming, fishing, boating and picnicking.

HEALTH CONCERNS: If it is not properly cleaned, water can carry disease. Since we live, work and play so close to water, harmful bacteria have to be removed to make water safe.

HOW DO CITIES TREAT WASTEWATER, TO MAKE IT SAFE FOR DISCHARGE?

There are several levels of wastewater treatment; these are primary, secondary and tertiary levels of treatment. Most municipal wastewater treatment facilities use primary and secondary levels of treatment, and some also use tertiary treatments. The type and order of treatment may vary from one treatment plant to another, but this diagram of the Ottawa-Carleton wastewater treatment plant illustrates the basic components.

The primary level of treatment uses screens and settling tanks to remove the majority of solids. This step is extremely important, because solids make up approximately 35 percent of the pollutants that must be removed.

The screens usually have openings of about 10 millimetres, which is small enough to remove sticks, garbage and other large materials from the wastewater. This material is removed and disposed of at the landfill.

The water is then put into settling tanks (or clarifiers), where it sits for several hours, allowing the sludge to settle and a scum to form on the top. The scum is then skimmed off the top, the sludge is removed from the bottom, and the partially treated wastewater moves on to the secondary treatment level. The primary treatment generally removes up to 50 percent of the Biological Oxygen Demand (BOD; these are substances that use up the oxygen in the water), around 90 percent of suspended solids, and up to 55 percent of fecal coliforms. While primary treatment removes a significant amount of harmful substances from wastewater, it is not enough to ensure that all harmful pollutants have been removed.

Secondary treatment of wastewater uses bacteria to digest the remaining pollutants. This is accomplished by forcefully mixing the wastewater with bacteria and oxygen. The oxygen helps the bacteria to digest the pollutants faster. The water is then taken to settling tanks where the sludge again settles, leaving the water 90 to 95 percent free of pollutants. The picture below shows the settling tanks in the Winnipeg Wastewater Treatment Plant. Secondary treatment removes about 85 to 90 percent of BOD and suspended solid, and about 90 to 99 percent of coliform bacteria.

Some treatment plants follow this with a sand filter, to remove additional pollutants. The water is then disinfected with chlorine, ozone, or ultraviolet light, and then discharged. For more information about any of the steps of the water treatment process, see the Chlorination fact sheet.

The sludge that is removed from the settling tanks and the scum that is skimmed off the top during the primary steps are treated separately from the water. Anaerobic bacteria (anaerobic bacteria do not require oxygen) feed off of the sludge for 10 to 20 days at temperatures around 38 degrees Celsius. This process decreases the odour and organic matter of the sludge, and creates a highly combustible gas of methane and carbon dioxide, which can be used as fuel to heat the treatment plant. Finally, the sludge is sent to a centrifuge, like the one shown in the picture below. A centrifuge is a machine that spins very quickly, forcing the liquid to separate

from the solid. The liquid can then be processed with the wastewater and the solid is used as fertilizer on fields.

Tertiary (or advanced) treatment removes dissolved substances, such as colour, metals, organic chemicals and nutrients like phosphorus and nitrogen. There are a number of physical, chemical and biological treatment processes that are used for tertiary treatment. One of the biological treatment processes is called Biological Nutrient Removal (BNR).

In this treatment plant, wastewater first undergoes primary and secondary treatment. For the tertiary treatment, the BNR process occurs in the bioreactors.

BNR process:

The BNR process uses bacteria in different conditions in several tanks, to digest the contaminants in the water. The three tanks have unique environments, with different amounts of oxygen. As the water has passes through the three tanks, the phosphorus is removed and the ammonia is broken down into nitrate and nitrogen gas, which other bacterial processes can not do. The BNR process can remove over 90 percent of phosphates, while traditional processes remove much less than 90 percent. The water spends approximately nine hours in the bioreactors, before entering the secondary clarifier, which is a settling tank, where the bacteria-laden sludge settles to the bottom of the tank.

HOW DO SMALL COMMUNITIES TREAT WASTEWATER, TO MAKE IT SAFE FOR DISCHARGE?

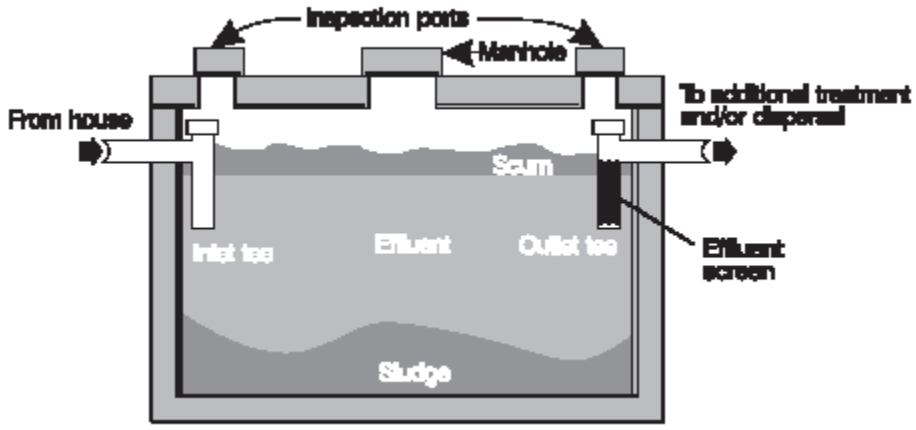
In small communities, wastewater treatment facilities may consist of individual septic systems, simple collection systems that directly discharge effluent to surface waters, or municipal lagoons that are emptied annually. These facilities usually treat and disperse the waste as close as possible to its source, thus minimizing operational costs and maintenance requirements. The longer the waste can sit in a lagoon before being discharged, the less likely it will be to contaminate drinking water sources. Some communities store the waste in lagoons, but others release the waste directly into water sources.

Lagoons are reservoirs in the ground that store waste for a time until it is discharged, either to the soil or a water body. Shallow lagoons, that are less than 1.5 metres deep, are used for primary treatment, which allows the solid waste to settle to the bottom of the lagoon over a period of 6 to 20 days. Shallow lagoons, however, cannot effectively remove the majority of contaminants that pose problems for ground and surface waters. Deep lagoons, which are more than three metres deep, can provide long-term storage and treatment for six months to one year. Many lagoons in small communities are emptied once per year. Rural communities often make use of surrounding land to dispose of wastewater. When the soil is adequate, and there are no water sources nearby, the bacteria in the soil can remove and break down the contaminants in wastewater. Due to the availability of land in many rural areas, this can be an effective method to treat wastewater. However, there are other communities that dispose of waste in a way that threatens the quality of the lake, river or groundwater source that provides drinking water.

The Environmental Protection Agency estimates that between 10 and 20 percent of small community wastewater treatment facilities in the United States are not operating properly; state water quality agencies have identified malfunctioning wastewater treatment systems as the second greatest threat to water quality (after underground storage tanks). When the inadequate wastewater treatments are combined with ineffective drinking water treatment, the result is a serious contamination issue for a great number of rural communities.

Rural communities typically find it difficult to install and maintain wastewater treatment operations. And while many communities have inadequate methods of treating wastewater, there are some communities that are leading the way with innovative methods of treatment and water conservation measures. In several Arctic communities, including Iqaluit, Nunavut, the high cost of water has led to wastewater treatments that allow water to be reused. Wastewater is passed through a septic tank, filtered, and disinfected with ozone treatment; it is then reused for non-consumptive uses, such as toilets and laundry. These conservation measures allow them to reuse up to 55 percent of wastewater, while decreasing pressure on wastewater treatment and storage

processes. For more information about water conservation, including the ways in which rural and First Nations communities are leading efforts to reduce water use.

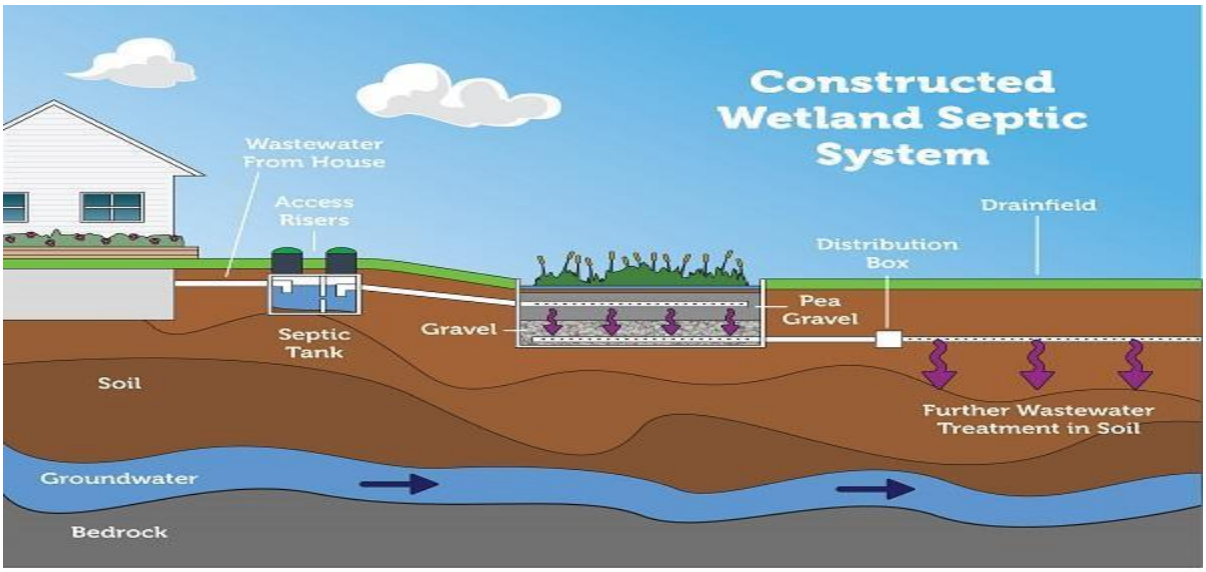


Here are a few things that you can do to care for your septic system:

- Do not use your drain or toilet as a garbage disposal; avoid putting dental floss, diapers, coffee grounds and paper towel down the drain, as they can clog up your septic system.
- Spread your loads of laundry out over the week. When too much water is added to the septic tank, it does not have time to treat wastes, and you could be flooding your drainfield with wastewater.
- Plant grass on your drainfield, but keep trees and shrubs away from it, because roots can clog the system and cause damage.
- Do not drive on your drainfield, because this can compact the soil and damage the septic system components.

ARE THERE ANY “NATURAL” WAYS TO TREAT WASTEWATER?

If nature itself can cleanse water, then imitating nature’s processes may be the most effective and sustainable ways of treating wastewater. A great deal of water renewal occurs naturally in wetlands. Constructed wetlands consist of a lined cell, which the water flows into. Plants are planted in the cell and the roots filter the contaminants out of the water. Below is a diagram of a constructed wetland. Notice that many of the processes in a wetland are similar to the Biological



Please note: Septic systems vary. Diagram is not to scale.

RAPID INFILTRATION:

Another natural method is called rapid infiltration, which is a process where a basin is filled with wastewater, which has already gone through a pre-treatment. The ground acts as a filter and removes the pollutants from the water. This method is similar to what happens in a septic system. A third "natural" process is overland flow, which is used in regions of nearly impermeable ground. The water flows down a sloped surface that is planted with thick grasses. Because the soil is highly impermeable, the water is forced through the vegetation, which effectively removes the pollutants.

SLOW RATE IRRIGATION:

Slow rate irrigation is a process that uses a portion of land, and allows the water to flow slowly enough that the land's capacity to infiltrate the water and remove the impurities is not overburdened.

Silviculture is similar to slow rate irrigation, in that it uses a large amount of land to treat wastewater, by planting crops or trees that will flourish during the treatment process. Aquiculture uses aquatic plant and animal species to treat wastewater, similar to the constructed wetland process.

There are also alternative separation systems that can conserve water. One such system separates blackwater (from toilets) from greywater (from showers and dishwashers), so that greywater can be minimally treated and used for watering the lawn. As well, there are incinerating, chemical, or composting toilets that release the waste when it is safe.