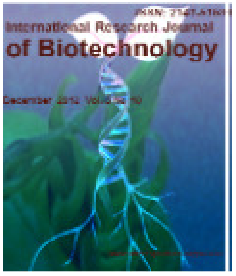

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Review

Sewage management and its benefits to man

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Sewage is water-carried wastes, in either solution or suspension that flow away from a community. It is also known as waste water flows or used water supply of the community. Sewage management deals with various ways sewage could be treated to the advantage of man. The processes involve collection of the sewage, treating, screening and disposing them in a way that it will not pose any hazards to man environmentally or health wise. Treatment could be primary, secondary or tertiary. In primary treatment, sewage flows through large tanks, commonly called "primary clarifiers" or "primary sedimentation tanks". The tanks are large enough that sludge can settle and floating material such as grease and oils can rise to the surface and be skimmed off. The main purpose of the primary treatment is to produce both a generally homogeneous liquid capable of being treated biologically and a sludge that can be separately treated or processed. Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). Screening involves straining to remove all large objects carried in the sewage stream, such as rags, sticks, tampons, cans, fruit, etc. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, whilst in smaller or less modern plants manually cleaned screen may be used. Details of other sewage management processes and benefits of this management are discussed in this paper

Keywords: Sewage, 1anagement, benefits, man.

INTRODUCTION

Sewage is water-carried wastes, in either solution or suspension that flow away from a community. It is also known as waste water flows or used water supply of the community. It is more than 99.9% pure water characterized by its volume or rate of flow, its physical condition, its chemical constituents, and the bacteriological organisms that it contains. Depending on their origin, wastewater can be classed as sanitary, commercial, industrial, or surface runoff.The spent water from residences and institutions, carrying body wastes, washing water, food preparation wastes, laundry wastes, and other waste products of normal living, are classed as domestic or sanitary sewage. Liquid-carried wastes from stores and service establishments serving the immediate community, termed commercial wastes, are included in the sanitary or domestic sewage category if their characteristics are similar to household flows (*http://www.answers.com/topic/sewage.)*

Wastes that result from an industrial process or the production or manufacture of goods are classed as industrial wastes. Their flows and strengths are usually more varied, intense, and concentrated than those of sanitary sewage. Surface runoff, also known as storm flow or overland flow, is that portion of precipitation that runs rapidly over the ground surface to a defined channel. Precipitation absorbs gases and particulates from the atmosphere, dissolves and leaches materials from vegetation and soil, suspends matter from the land, washes spills and debris from urban streets and highways, and carries all these pollutants as wastes in its flow to a collection point.Wastewater from all of these sources may carry pathogenic organisms that can transmit disease to humans and other animals; contain organic matter that can cause odor and nuisance problems; hold nutrients that may cause eutrophication of receiving water bodies; and can lead to eco-toxicology. Proper collection and safe, nuisance-free disposal of the liquid wastes of a community are legally recognized as a necessity in an urbanized, industrialized society.

Origins of sewage

Sewage is created by residences, institutions, hospitals and commercial and industrial establishments. Raw influent (sewage) includes household waste liquid from toilets, baths, showers, kitchens, sinks etc. is disposed of via sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into grey-water and black-water is becoming more common in the developed world, with grey-water being permitted to be used for watering plants or recycled for flushing toilets. A lot of sewage also includes some surface water from roofs or hard-standing areas. Municipal wastewater, therefore, includes residential, commercial, and industrial liquid waste discharges, and may include storm-water run-off. Sewage systems capable of handling storm-water are known as combined systems or combined sewers. Such systems are usually avoided since they complicate and thereby reduce the efficiency of sewage treatment plants owing to their seasonality. The variability in flow also leads to often larger than necessary, and subsequently more expensive, treatment facilities. In addition, heavy storms that contribute more flows than the treatment plant can handle may overwhelm the sewage treatment system, causing a spill or overflow. It is preferable to have a separate storm drain system for storm-water in areas that are developed with sewer systems.

As rainfall runs over the surface of roofs and the ground, it may pick up various contaminants, including soil particles and other sediment, heavy metals, organic compounds, animal waste, and oil and grease. Some jurisdictions require storm-water to receive some level of treatment before being discharged directly into waterways. Examples of treatment processes used for storm-water include sedimentation basins, wetlands, buried concrete vaults with various kinds of filters, and vortex separators (to remove coarse solids).

Sewage services

This involves collection of sewage, treatment and disposal.

Collection of sewage

Sewage collection and disposal systems transport sewage through cities and other inhabited areas to sewage treatment plants in order to protect public health and prevent disease. Sewage is treated in order to control water pollution before discharge to surface waters(Staley and Pierson, 1899 and Metcalf and Eddy,1922). A sewage system may convey the wastewater by gravity to a sewage treatment plant. Where pipeline excavation is difficult because of rock or there is limited topographic relief (i.e., due to flat terrain), gravity collection systems may not be practical and the sewage must be pumped through a pipeline to the treatment plant. In low-lying communities, wastewater may be conveyed by vacuum. Pipelines range in size from pipes of six inches (150 mm) in diameter to concrete-lined tunnels of up to thirty feet (10 m) in diameter.

Sewage can also be collected by low pressure pumps and vacuum systems. A low pressure system uses a small grinder pump located at each point of connection, typically a house or business. Vacuum sewer systems use differential atmospheric pressure to move the liquid to a central vacuum station. Typically, a vacuum sewer station can service approximately 1,200 homes before it becomes more cost-effective to build another station. A system of sewer pipes (sewers) collects sewage and takes it for treatment or disposal. The system of sewers is called sewerage or sewerage system. Where a main sewerage system has not been provided, sewage may be collected from homes by pipes into septic tanks or cesspits, where it may be treated or collected in vehicles and taken for treatment or disposal. Properly functioning septic tanks require emptying every 2-5 years depending, on the load of the system.

Historical sewage conveyance

The historical focus of sewage treatment was on conveyance of raw sewage to a natural body of water, such as a river or ocean, where it would be satisfactorily diluted and dissipated. Early human habitations were often built next to water sources. Rivers could double as a crude form of natural sewage disposal. The Indus architects designed sewage disposal systems on a large scale, building networks of brick effluent drains following the lines of the streets. The drains were seven to ten feet wide, cut at two feet below ground level with U-shaped bottoms lined with loose brick easily taken up for cleaning. At the intersection of two drains, the sewage planners installed cesspools with steps leading down into them, for periodic cleaning. By 2700 B.C., these cities had standardized earthenware plumbing pipes with broad flanges for easy joining with asphalt to stop leaks.

Ancient systems

The first sanitation system has been found at the prehistoric Middle East and the surrounding areas. The first time an inverted siphon system was used, along with glass covered clay pipes, was in the palaces of Crete, Greece. It is still in working condition, after about 3000 years. Ancient Minoan civilization had stone sewers that were periodically flushed with clean water. Roman towns and garrisons in the United Kingdom between 46 BC and 400 CE had complex sewer networks sometimes constructed out of hollowed out Elm logs which were shaped so that they butted together with the down-stream pipe providing a socket for the upstream pip (Dick, (2002).

Higher population densities required more complex sewer collection and conveyance systems in order to maintain (somewhat) sanitary conditions in crowded cities. The ancient cities of Harappa and Mohenjo-daro of the Indus Valley civilization constructed complex networks of brick-lined sewage drains from around 2,600 BC and also had outdoor flush toilets connected to this network. The urban areas of the Indus Valley civilization provided public and private baths. Sewage was disposed through underground drains built with precisely laid bricks, and a sophisticated water management system with numerous reservoirs was established. In the drainage systems, drains from houses were connected to wider public drains((Rodda and Ubertini,2004). A significant development was the construction of a network of sewers to collect waste water, which began from the Indus Valley civilization. In some cities, including Rome and Istanbul (Constantinople), networked ancient sewer systems continue to function today as collection systems for those cities' modernized sewer systems. Instead of flowing to a river or the sea, the pipes have been re-routed to modern sewer treatment facilities.

The system remained without much progress until the 16th century, where, in England, Sir John Harington invented a device for Queen Elizabeth (his godmother) that released wastes into cesspools. However, many cities had no sewers and relied on nearby rivers or occasional rain to wash away sewage. In some cities, waste water simply ran down the streets, which had stepping stones to keep pedestrians out of the muck, and eventually drained as run-off into the local watershed. This was enough in early cities with few occupants, but the growth of cities quickly over-polluted streets and became a constant source of disease. Even as recently as the late 19th century, sewerage systems in parts of the highly industrialized United Kingdom were reported to be so inadequate that water-borne diseases such as cholera and typhoid were still common. In Merthyr Tydfil, a large town in South Wales, most houses discharged their sewage to individual cess-pits which persistently overflowed, causing the pavements to be awash with foul sewage.

Industrial Revolution era

As an outgrowth of the Industrial Revolution, many cities in Europe and North America grew in the 19th century, frequently leading to crowding and increasing concerns about public health (Burian *et al*, 2000). As part of a trend of municipal sanitation programs in the late 19th and 20th centuries, many cities constructed extensive sewer systems to help control outbreaks of disease (Staley and Pierson,1899). Initially, these systems discharged sewage directly to surface waters without treatment. As pollution of water bodies became a concern, cities added sewage treatment plants to their systems.

Design and analysis of collection systems

Design and sizing of sewage collection systems considers population served, commercial and industrial flows, flow peaking characteristics and wet weather flows. Combined sewer systems are designed to transport both storm water run-off and sewage in the same pipe. Besides the projected sewage flow, the size and characteristics of the watershed are the overriding design considerations for combined sewers. Often, combined sewers cannot handle the volume of run-off, resulting in combined sewer overflows and causing water pollution problems in nearby water bodies.

Separate sanitary sewer systems are designed to transport sewage alone. In communities served by separate sanitary sewers, another pipe system is constructed to convey storm water run-off directly to surface waters. Most municipal sewer systems constructed today are separate sewer systems. Although separate sewer systems are intended to transport only sewage, all sewer systems have some degree of inflow and infiltration of surface water and groundwater, which can lead to sanitary sewer overflows. Inflow and infiltration is highly affected by antecedent moisture conditions, which also represents an important design consideration in these systems.A sewer bed is a piece of land typically used by a municipality for the dumping of raw sewage. Usually, raw sewage was brought by truck or drawn by horses to be dumped, but the practice stopped back in the 1940s.

Sewage management

Sewage treatment

The objective of sewage treatment is to produce a disposable effluent without causing harm or trouble to the communities and prevent pollution(Khopka,2004). Sewage treatment, or domestic wastewater treatment, is the process of removing contaminants from wastewater and household sewage, both run-off (effluents) and domestic, to produce liquid and solid (sludge) suitable for discharge to the environment or for reuse. It is a unit process used to separate, modify, remove, and destroy objectionable, hazardous, and pathogenic substances carried by wastewater in solution or suspension in order to render the water fit and safe for intended uses. It is a form of waste management. A septic tank or other on-site wastewater treatment system such as bio-filters can be used to treat sewage close to where it is created. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge suitable for discharge or re-use back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds.

Sewage water is a complex matrix, with many distinctive chemical characteristics. These include high concentrations of ammonium, nitrate, phosphorus, high conductivity (due to high dissolved solids), high alkalinity, with pH typically ranging between 7 and 8. Tri-halo-methanes are also likely to be present as a result of past disinfection. In developed countries sewage collection and treatment is typically subject to local, state and federal standards. Treatment removes unwanted constituents without affecting or altering the water molecules themselves, so that wastewater containing contaminants can be converted to safe drinking water. Stringent water quality and effluent standards have been developed that require reduction of suspended solids (turbidity), biochemical oxygen demand (related to degradable organics), and coliform organisms (indicators of fecal pollution); control of pH as well as the concentration of certain organic chemicals and heavy metals; and use of bioassays to guarantee safety of treated discharges to the environment.In all cases, the impurities, contaminants, and solids removed from all wastewater treatment processes must ultimately be collected, handled, and disposed off safely, without damage to humans or the environment.

Treatment processes are chosen on the basis of composition, characteristics, and concentration of materials present in solution or suspension. The processes are classified as pretreatment, preliminary, primary, secondary, or tertiary treatment, depending on type, sequence, and method of removal of the harmful and unacceptable constituents. Pretreatment processes equalize flows and loadings, and precondition wastewaters to neutralize or remove toxics and industrial wastes that could adversely affect sewers or inhibit operations of publicly owned treatment works. Preliminary treatment processes protect plant mechanical equipment; remove extraneous matter such as grit, trash, and debris; reduce odors; and render incoming sewage more amenable to subsequent treatment and handling.

Primary treatment employs mechanical and physical unit processes to separate and remove floatables and suspended solids and to prepare wastewater for biological treatment. Secondary treatment utilizes aerobic microorganisms in biological reactors to feed on dissolved and colloidal organic matter. As these microorganisms reduce biochemical oxygen demand and turbidity (suspended solids), they grow, multiply, and form an organic floc, which must be captured and removed in final settling tanks.

Tertiary treatment, or advanced treatment, removes specific residual substances, trace organic materials, nutrients, and other constituents that are not removed by biological processes. Most advanced wastewater treatment systems include de-nitrification and ammonia stripping, carbon adsorption of trace organics, and chemical precipitation. Evaporation, distillation, electro-dialysis, ultra-filtration, reverse osmosis, freeze drying, freeze-thaw, floatation, and land application, with particular emphasis on the increased use of natural and constructed wetlands, are being studied and utilized as methods for advanced wastewater treatment to improve the quality of the treated discharge to reduce unwanted effects on the receiving environment. On-site sewage treatment for individual homes or small institutions uses septic tanks, which provide separation of solids in a closed, buried unit. Effluent is discharged to subsurface absorption systems.

Process overview

Sewage can be treated close to where it is created (in septic tanks, bio-filters or aerobic treatment systems), or collected and transported via a network of pipes and pump stations to a municipal treatment plant. Sewage collection and treatment is typically subject to local, state and federal regulations and standards. Industrial sources of wastewater often require specialized treatment processes. Conventional sewage treatment may involve three stages, called primary, secondary and tertiary treatment.

Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom, while oil, grease and lighter solids

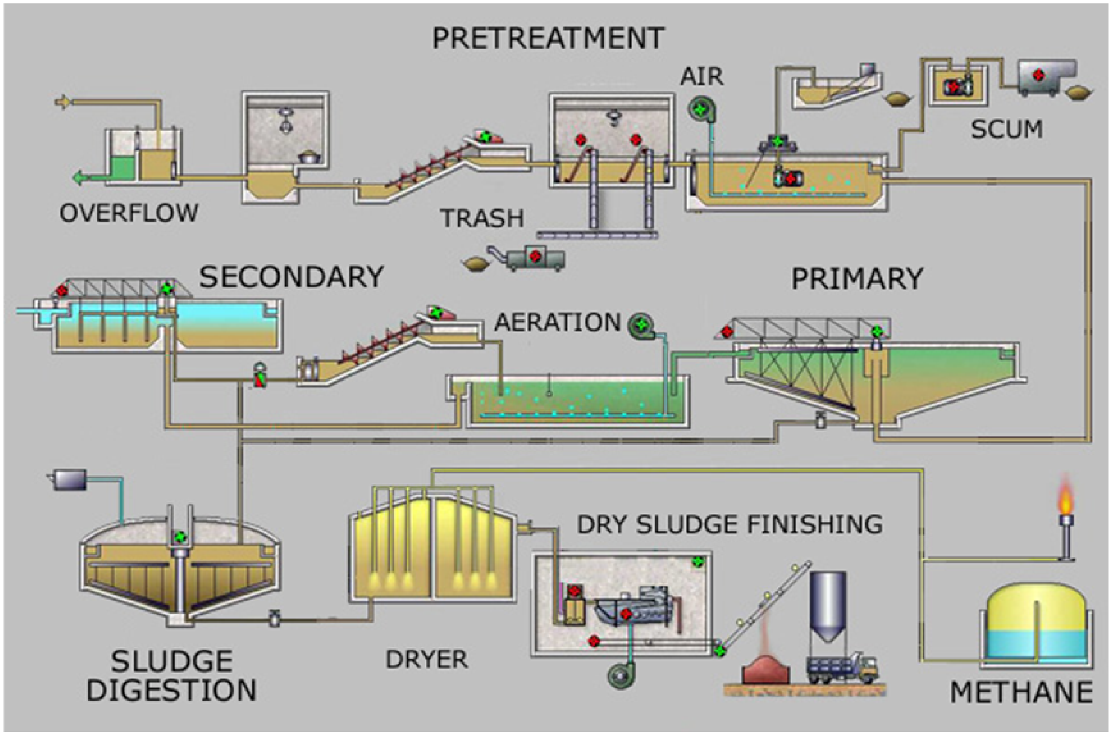


Figure 1. Process Flow Diagram for a typical large-scale treatment plant

float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Secondary treatment removes dissolved and suspended biological matter.

Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.

Tertiary treatment is sometimes defined as anything more than primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and micro-filtration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

Pre-treatment

Pre-treatment removes materials that can be easily collected from the raw wastewater before they damage or clog the pumps and skimmers of primary treatment clarifiers.

Screening

The influent sewage water is strained to remove all large objects carried in the sewage stream, such as rags, sticks, tampons, cans, fruit, etc. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, whilst in smaller or less modern plants manually cleaned screen may be used. The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and/or flow rate. The solids are collected and later disposed in a landfill or incinerated. (Figure 1)

Grit removal

Pre-treatment may include a sand or grit channel or chamber (sometimes called a de-gritter) where the velocity of the incoming wastewater is carefully controlled to allow sand, grit and stones to settle, while keeping the majority of the suspended organic material in the water column. Sometimes there is a sand washer (grit classifier) followed by a conveyor that transports the sand to a container for disposal. The contents from the sand catcher may be fed into the incinerator in a sludge processing plant, but in many cases, the sand and grit is sent to a landfill.

Primary treatment

In the primary sedimentation stage, sewage flows through large tanks, commonly called "primary clarifiers" or "primary sedimentation tanks". The tanks are large enough that sludge can settle and floating material such as grease and oils can rise to the surface and be skimmed off. The main purpose of the primary sedimentation stage is to produce both a generally homogeneous liquid capable of being treated biologically and a sludge that can be separately treated or processed. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank from where it can be pumped to further sludge treatment stages.

Secondary treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the biota require both oxygen and a substrate on which to live. There are a number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc. Secondary treatment systems are classified as fixed-film or suspended-growth.

Fixed-film or attached growth system treatment process including trickling filter and rotating biological contactors where the biomass grows on media and the sewage passes over its surface.In suspended-growth systems, such as activated sludge, the biomass is well mixed with the sewage and can be operated in a smaller space than fixed-film systems that treat the same amount of water. However, fixed-film systems are more able to cope with drastic changes in the amount of biological material and can provide higher removal rates for organic material and suspended solids than suspended growth systems.

Roughing filters are intended to treat particularly strong or variable organic loads, typically industrial, to allow them to then be treated by conventional secondary treatment processes. Characteristics include typically tall, circular filters filled with open synthetic filter media to which wastewater is applied at a relatively high rate. They are designed to allow high hydraulic loading and a high flow-through of air. On larger installations, air is forced through the media using blowers. The resultant wastewater is usually within the normal range for conventional treatment processes.

Activated sludge

It is a process dealing with the treatment of sewage and industrial waters (Tchobanoglous *et al*,203 and Beychok,1967). In general, activated sludge plants encompass a variety of mechanisms and processes that use dissolved oxygen to promote the growth of biological floc that substantially removes organic material. The process traps particulate material and can, under ideal conditions, convert ammonia to nitrite and nitrate and ultimately to nitrogen gas. Most biological oxidation processes for treating industrial wastewaters have in common the use of oxygen (or air) and microbial action. Surface-aerated basins achieve 80 to 90% removal of Biochemical Oxygen Demand with retention times of 1 to 10 days , and the basins may range in depth from 1.5 to 5.0 meters and use motor-driven aerators floating on the surface of the wastewater (Beychok,1971).

In an aerated basin system, the aerators provide two functions: they transfer air into the basins required by the biological oxidation reactions, and they provide the mixing required for dispersing the air and for contacting the reactants (that is, oxygen, wastewater and microbes).Typically, the floating surface aerators are rated to deliver the amount of air equivalent to 1.8 to 2.7 kg O_2/kW·h. However, they do not provide as good mixing as is normally achieved in activated sludge systems, hence, aerated basins do not achieve the same performance level as activated sludge units. Biological oxidation processes are sensitive to temperature and, between 0 °C and 40 °C, the rate of biological reactions increase with temperature. Most surface aerated vessels operate at between 4°C and 32°C. (Figure 2 and 3)

Trickling filter

In older plants and plants receiving more variable loads, trickling filter beds are used where the settled sewage liquor is spread onto the surface of a deep bed made up of coke (carbonized coal), limestone chips or specially fabricated plastic media. Such media must have high surface areas to support the biofilms that form. The liquor is distributed through perforated rotating arms radiating from a central pivot. The distributed liquor trickles through this bed and is collected in drains at the base. These drains also provide a source of air which percolates up through the bed, keeping it aerobic. Biological films of

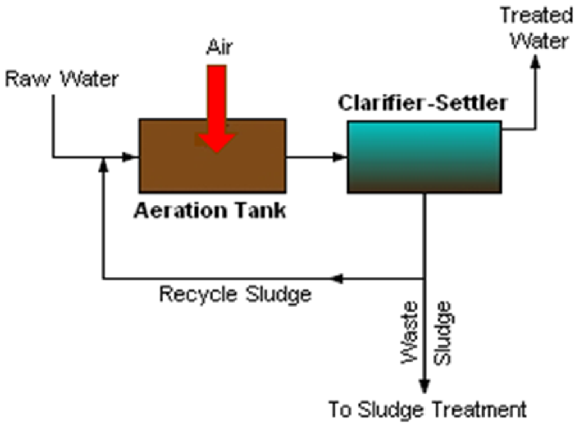


Figure 2. A generalized, schematic diagram of an activated sludge process.

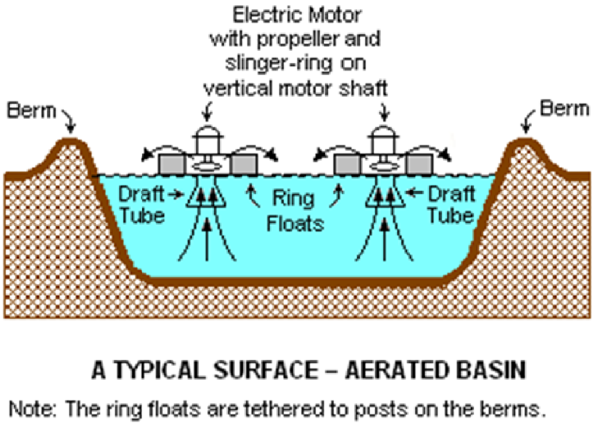


Figure 3. A Typical Surface-Aerated Basin (using motor-driven floating aerators)

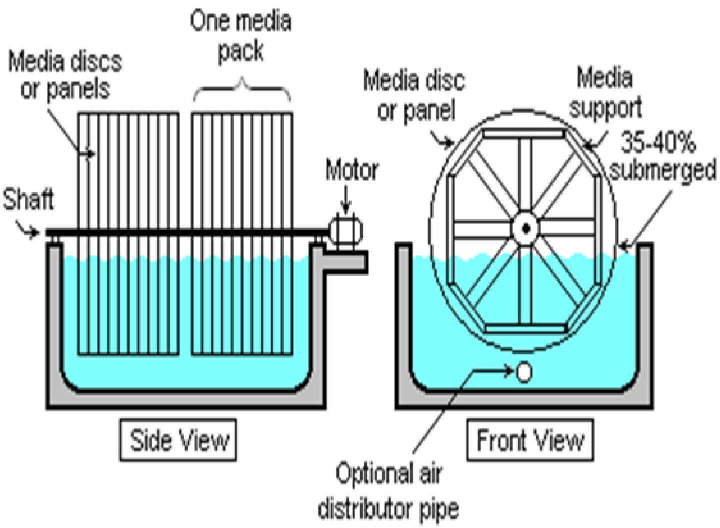
bacteria, protozoa and fungi form on the media's surfaces and eat or otherwise reduce the organic content. This biofilm is grazed by insect larvae and worms which help maintain an optimal thickness. Overloading of beds increases the thickness of the film, leading to clogging of the filter media and ponding on the surface. (Figure 4)

Biological aerated filters

Biological Aerated (or Anoxic) Filter (BAF) or Bio-filters combine filtration with biological carbon reduction, nitrification or de-nitrification. BAF usually includes a reactor filled with a filter media. The media is either in suspension or supported by a gravel layer at the foot of the filter. The dual purpose of this media is to support highly active biomass that is attached to it and to filter suspended solids. Carbon reduction and ammonia conversion occurs in aerobic mode, and sometimes achieved in a single reactor, while nitrate conversion occurs in anoxic mode. BAF is operated either in up-flow or down-flow configuration depending on design specified by manufacturer.

Membrane bioreactors

Membrane bioreactors (MBR) combine activated sludge treatment with a membrane liquid-solid separation process. The membrane component uses low pressure micro-filtration or ultra filtration membranes and eliminates the need for clarification and tertiary filtration. The membranes are typically immersed in the aeration tank (however, some applications utilize a separate membrane tank). One of the key benefits of a membrane bioreactor system is that it effectively overcomes the



Filter beds (oxidizing beds)

Figure 4. Schematic diagram of a typical rotating biological contactor (RBC).

Figure 5. Secondary Sedimentation tank at a rural treatment plant.

limitations associated with poor settling of sludge in conventional activated sludge (CAS) processes. The technology permits bioreactor operation with considerably higher mixed liquor suspended solids (MLSS) concentration than CAS systems, which are limited by sludge settling. The process is typically operated at MLSS in the range of 8,000–12,000 mg/L, while CAS are operated in the range of 2,000–3,000 mg/L. The elevated biomass concentration in the membrane bioreactor process allows for very effective removal of both soluble and particulate biodegradable materials at higher loading rates. Increased Sludge Retention Times (SRTs)—usually exceeding 15 days—ensure complete nitrification even in extremely cold weather.

The cost of building and operating a MBR is usually higher than conventional wastewater treatment. However, as the technology has become increasingly popular and has gained wider acceptance throughout the industry, the life-cycle costs have been steadily decreasing. The small footprint of MBR systems, and the high quality effluent produced, makes them particularly useful for water reuse applications.

Secondary sedimentation

The final step in the secondary treatment stage is to settle out the biological floc or filter material and produce sewage water containing very low levels of organic material and suspended matter.

Rotating biological contactors

Rotating biological contactors (RBCs) are mechanical secondary treatment systems which are robust and capable of withstanding surges in organic load. The rotating disks support the growth of bacteria and micro-organisms present in the sewage, which breakdown and stabilize organic pollutants. To be successful, micro-organisms need both oxygen to live and food to grow. Oxygen is obtained from the atmosphere as the disks rotate. As the micro-organisms grow, they build up on the media until they are sloughed off due to shear forces provided by the rotating discs in the sewage. Effluent from the RBC is then passed through final clarifiers where the micro-organisms in suspension settle as sludge. The sludge is withdrawn from the clarifier for further treatment.

A functionally similar biological filtering system has become popular as part of home aquarium filtration and purification. The aquarium water is drawn up out of the tank and then cascaded over a freely spinning corrugated fiber-mesh wheel before passing through a media filter and back into the aquarium. The spinning mesh-wheel develops a bio-film coating of microorganisms that feed on the suspended wastes in the aquarium water and are also exposed to the atmosphere as the wheel rotates. This is especially good at removing waste urea and ammonia urinated into the aquarium water by the fish and other animals.

Tertiary treatment

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "effluent polishing “CAS systems, which are limited by sludge settling. The process is typically operated at MLSS in the range of 8,000–12,000 mg/L, while CAS is operated in the range of 2,000–3,000 mg/L. The elevated biomass concentration in the membrane bioreactor process allows for very effective removal of both soluble and particulate biodegradable materials at higher loading rates. Increased Sludge Retention Times (SRTs)—usually exceeding 15 days—ensure complete nitrification even in extremely cold weather.

Filtration

Sand filtration removes much of the residual suspended matter. Filtration over activated carbon removes residual toxins.

Lagooning

Lagooning provides settlement and further biological improvement through storage in large man-made ponds or lagoons. These lagoons are highly aerobic and colonization by native macrophytes, especially reeds, is often encouraged. Small filter feeding invertebrates such as Daphnia and species of Rotifera greatly assist in treatment by removing fine particulates.

Constructed wetlands

Constructed wetlands include engineered reed-beds and a range of similar methodologies, all of which provide a high degree of aerobic biological improvement and can often be used instead of secondary treatment, for small communities.

Nutrient removal

Water nitrification itself is a two-step aerobic process, each step facilitated by a different type of bacteria. The oxidation of ammonia (NH3) to nitrite (NO2−) is most often facilitated by Nitrosomonas spp. (nitroso referring to the formation of a nitroso functional group). Nitrite oxidation to nitrate (NO3−), though traditionally believed to be facilitated by Nitrobacter spp. (nitro referring to the formation of a nitro functional group), is now known to be facilitated in the environment almost exclusively by Nitrospira spp. De-nitrification requires anoxic conditions to encourage the appropriate biological communities to form. It is facilitated by a wide diversity of bacteria. Sand filters, lagooning and reed-beds can all be used to reduce nitrogen, but the activated sludge process (if designed well) can do the job the most easily. Since de-nitrification is the reduction of nitrate to di-nitrogen gas, an electron donor is needed, and can be done, depending on the wastewater, organic matter (from faeces), sulfide, or an added donor like methanol. Sometimes the conversion of toxic ammonia to nitrate alone is referred to as tertiary treatment. Many sewage treatment plants use axial flow pumps to transfer the nitrified mixed liquor from the aeration zone to the anoxic zone for de-nitrification. These pumps are often referred to as Internal Mixed Liquor Recycle pumps (IMLR pumps).

Phosphorus removal

Phosphorus removal is important as it is a limiting nutrient for algal growth in many fresh water systems. It is also particularly important for water re-use systems where high phosphorus concentrations may lead to fouling of downstream equipment such as reverse osmosis. Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. In this process, specific bacteria called polyphosphate accumulating organisms (PAOs), are selectively enriched and accumulate large quantities of phosphorus within their cells (up to 20% of their mass). When the biomass enriched in these bacteria is separated from the treated water, these bio-solids have a high fertilizer value.

Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride), aluminum (e.g. alum), or lime. This may lead to excessive sludge productions as hydroxides precipitate and the added chemicals can be expensive. Chemical phosphorus removal requires significantly smaller equipment footprint than biological removal is easier to operate, and is often more reliable than biological phosphorus removal. Once removed, phosphorus, in the form of a phosphate rich sludge, may be stored in a land filled or resold for use in fertilizer production.

Disinfection

The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment. The effectiveness of disinfection depends on the quality of the water being treated (e.g., cloudiness, pH, etc.), the type of disinfection being used, the disinfectant dosage (concentration and time), and other environmental variables. Cloudy water will be treated less successfully since solid matter can shield organisms, especially, from ultraviolet light or if contact times are low. Generally, short contact times, low doses and high flows militate against effective disinfection. Common methods of disinfection include ozone, chlorine, or ultraviolet light. Chloramine, which is used for drinking water, is not used in wastewater treatment because of its persistence. Chlorination remains the most common form of wastewater disinfection in North America and in Nigeria due to its low cost and long-term history of effectiveness. One disadvantage is that chlorination of residual organic material can generate chlorinated-organic compounds that may be carcinogenic or harmful to the environment. Residual chlorine or chloramines may also be capable of chlorinating organic material in the natural aquatic environment. Further, because residual chlorine is toxic to aquatic species, the treated effluent must also be chemically de-chlorinated, adding to the complexity and cost of treatment.

Ultraviolet (UV) light can be used instead of chlorine, iodine, or other chemicals. As no chemicals are used, the treated water has no adverse effect on organisms that later consume it, as may be the case with other methods. UV radiation causes damage to the genetic structure of bacteria, viruses, and other pathogens, making them incapable of reproduction. The key disadvantages of UV disinfection are the need for frequent lamp maintenance and replacement, and the need for a highly treated effluent to ensure that the target microorganisms are not shielded from the UV radiation (i.e., any solids present in the treated effluent may protect microorganisms from the UV light).Ozone O_3 is generated by passing oxygen O_2 through a high voltage potential, resulting in a third oxygen atom becoming attached and forming O_3. Ozone is very unstable and reactive, and oxidizes most organic materials it comes in contact with, thereby destroying many pathogenic microorganisms. Ozone is considered to be safer than chlorine because, unlike chlorine which has to be stored on site (highly poisonous in the event of an accidental release), ozone is generated onsite as needed. Ozonation also produces fewer disinfection by-products than chlorination. A disadvantage of ozone disinfection is the high cost of the ozone generation equipment and the requirements for special operators.

Package plants and batch reactors

Package plants may be referred to as high charged or low charged. This refers to the way the biological load is processed. In high charged systems, the biological stage is presented with a high organic load and the combined floc and organic material is then oxygenated for a few hours before being charged again with a new load. In the low charged system the biological stage contains a low organic load and is combined with flocculate for a relatively long time. In order to use less space, treat difficult waste, deal with intermittent flow or achieve higher environmental standards, a number of designs of hybrid treatment plants have been produced. Such plants often combine all or at least two stages of the three main treatment stages into one combined stage. One type of system that combines secondary treatment and settlement is the sequencing batch reactor (SBR). Typically, activated sludge is mixed with raw incoming sewage and mixed and aerated. The resultant mixture is then allowed to settle producing a high quality effluent. The settled sludge is run off and re-aerated before a proportion is returned to the head-works.

The disadvantage of such processes is that precise control of timing, mixing and aeration is required. This precision is usually achieved by computer controls linked to many sensors in the plant. Such a complex, fragile system is unsuited to places where such controls may be unreliable, or poorly maintained, or where the power supply may be intermittent.

Sludge treatment

Sewage sludge treatment describes the processes used to manage and dispose of the sludges produced during sewage treatment. The sludge accumulated in a wastewater treatment process must be treated and disposed off in a safe and effective manner. The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting. Incineration is also used albeit to a much lesser degree.

When a liquid sludge is produced, further treatment may be required to make it suitable for final disposal. Typically, sludges are thickened (dewatered) to reduce the volumes transported off-site for disposal. There is no process which completely eliminates the need to dispose of bio-solids. There is, however, an additional step some cities are taking to superheat the wastewater sludge and convert it into small pelletized granules that are high in nitrogen and other organic materials. In New York City, for example, several sewage treatment plants have dewatering facilities that use large centrifuges along with the addition of chemicals such as polymer to further remove liquid from the sludge. The removed fluid, called concentrate, is typically reintroduced into the wastewater process. The product which is left is called "cake”, which is picked up by companies which turn it into fertilizer pellets. This product could be sold to local farmers and turf farms as a soil amendment or fertilizer, reducing the amount of space required to dispose of sludge in landfills.

Choice of a wastewater solid treatment method depends on the amount of solids generated and other site-specific conditions. However, generally, composting is most often applied to smaller-scale applications, followed by aerobic digestion and then anaerobic digestion for the larger-scale municipal applications.

DIGESTION

Many sludges are treated using a variety of digestion techniques, the purpose of which is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting.

Anaerobic digestion

Anaerobic digestion is a bacterial process that is carried out in the absence of oxygen. The process can either be thermophilic digestion, in which sludge is fermented in tanks at a temperature of 55°C or mesophilic, at a temperature of around 36°C.Though it allows shorter retention time, thus smaller tanks, thermophilic digestion is more expensive in terms of energy consumption for heating the sludge. Anaerobic digestion generates biogas with a high proportion of methane that may be used to both heat the tank and run engines or micro-turbines for other on-site processes. In large treatment plants, sufficient energy can be generated in this way to produce more electricity than the machines require. The methane generation is a key advantage of the anaerobic process. Its key disadvantage is the long time required for the process (up to 30 days) and the high capital cost.

Under laboratory conditions, it is possible to directly generate useful amounts of electricity from organic sludge using naturally occurring electrochemically active bacteria. Potentially, this technique could lead to an ecologically positive form of power generation, but in order to be effective such a microbial fuel cell must maximize the contact area between the effluent and the bacteria-coated anode surface, which could severely hamper through put.

Aerobic digestion

Aerobic digestion is a bacterial process occurring in the presence of oxygen. Under aerobic conditions, bacteria rapidly consume organic matter and convert it into carbon dioxide. Once there is a lack of organic matter, bacteria die and are used as food by other bacteria. This stage of the process is known as endogenous respiration. Reduction of solids occurs in this phase. As the aerobic digestion occurs much faster than anaerobic digestion, the capital costs of aerobic digestion are lower. However, the operating costs are characteristically much greater for aerobic digestion because of energy costs for aeration needed to add oxygen to the process. Aerobic digestion can be achieved by using jet aerators to oxidize the sludge.

Composting

Composting is also an aerobic process that involves mixing the wastewater solids with sources of carbon such as sawdust, straw or wood chips. In the presence of oxygen, bacteria digest both the wastewater solids and the added carbon source and, in doing so, produce a large amount of heat. Anaerobic and aerobic digestion processes can result in the destruction of disease-causing microorganisms and parasites to a sufficient level to allow the resulting digested solids to be safely applied to land used as a soil amendment material (with similar benefits to peat) or used for agriculture as a fertilizer, provided that levels of toxic constituents are sufficiently low.

Thermal de-polymerization

Thermal de-polymerization uses hydrous pyrolysis to convert reduced complex organics to oil. The pre-macerated, grit-reduced sludge is heated to 250°C and compressed to 40 MPa. The hydrogen in the water inserts itself between chemical bonds in natural polymers such as fats, proteins and cellulose. The oxygen of the water combines with carbon, hydrogen and metals. The result is oil, light combustible gases such as methane, propane and butane, water with soluble salts, carbon dioxide, and a small residue of inert insoluble material that resembles powdered rock and char. All organisms and many organic toxins are destroyed. Inorganic salts such as nitrates and phosphates remain in the water after treatment at sufficiently high levels that further treatment is required.

The energy from decompressing the material is recovered, and the process heat and pressure is usually powered from the light combustible gases. The oil is usually treated further to make a refined useful light grade of oil, such as no. 2 diesel and no. 4 heating oil, and then sold. The choice of a wastewater solid treatment method depends on the amount of solids generated and other site-specific conditions. However, in general, composting is most often applied to smaller-scale applications, followed by aerobic digestion and then lastly anaerobic digestion for the larger-scale municipal applications.

Incineration

Incineration of sludge is less common due to air emissions concerns and the supplemental fuel (typically natural gas or fuel oil) required to burn the low calorific value sludge and vaporize residual water. Stepped multiple hearth incinerators with high residence time as well as fluidized bed incinerators are the most common systems used to combust wastewater sludge.

Treatment in the receiving environment

Many processes in a wastewater treatment plant are designed to mimic the natural treatment processes that occur in the environment, whether that environment is a natural water body or the ground. If not overloaded, bacteria in the environment will consume organic contaminants, although this will reduce the levels of oxygen in the water and may significantly change the overall ecology of the receiving water. Native bacterial populations feed on the organic contaminants, and the numbers of disease-causing microorganisms are reduced by natural environmental conditions such as predation or exposure to ultraviolet radiation. Consequently, in cases where the receiving environment provides a high level of dilution, a high degree of wastewater treatment may not be required.

However, recent evidence has demonstrated that very low levels of certain contaminants in wastewater, including hormones (from animal husbandry and residue from human hormonal contraception methods) and synthetic materials such as phthalates that mimic hormones in their action, can have an unpredictable adverse impact on the natural biota, and potentially on humans if the water is re-used for drinking water(Beychok, 1967). In the US and EU, uncontrolled discharges of wastewater to the environment are not permitted under law, and strict water quality requirements are to be met. A significant threat in the coming decades will be the increasing uncontrolled discharges of wastewater within rapidly developing countries.

Sewage treatment in developing countries

There are few reliable figures on the share of the wastewater collected in sewers that is being treated in the world. In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only. In Latin America about 15% of collected wastewater passes through treatment plants (with varying levels of actual treatment). In Venezuela, a below average country in South America with respect to wastewater treatment, 97 percent of the country’s sewage is discharged raw into the environment (ATSPCWCR (1998).

WBSCWT (2001) reported that in Peoples Republic of China, 55% of sewage is discharged without treatment. In a relatively developed Middle Eastern country such as Iran, Tehran's majority of population has totally untreated sewage injected to the city’s groundwater (Tajrishy and Abrishamchi,2005). Israel has also aggressively pursued the use of treated sewer water for irrigation. In 2008, agriculture in Israel consumed 500 million cubic metres of portable water and an equal amount of treated sewer water. The country plans to provide a further 200 million cubic metres of recycled sewer water and build more desalination plants to supply even more water. Most of sub-Saharan Africa is without wastewater treatment.

Water utilities in developing countries are, reportedly, chronically under-funded because of low water tariffs, the inexistence of sanitation tariffs in many cases, low billing efficiency (i.e. many users that are billed do not pay) and poor operational efficiency (i.e. there are overly high levels of staff; there are high physical losses, and many users have illegal connections and are thus not being billed). In addition, wastewater treatment typically is the process within the utility that receives the least attention, partly because enforcement of environmental standards is poor.

As a result of all these factors, operation and maintenance of many wastewater treatment plants is poor. This is evidenced by the frequent breakdown of equipment, shutdown of electrically operated equipment due to power outages or to reduce costs, and sedimentation due to lack of sludge removal. Developing countries as diverse as Egypt, Algeria, China or Colombia have invested substantial sums in wastewater treatment without achieving a significant impact in terms of environmental improvement. Even if wastewater treatment plants are properly operating, it can be argued that the environmental impact is limited in cases where the assimilative capacity of the receiving waters (ocean with strong currents or large rivers) is high, as it is often the case.

Sewage sludge treatment

Coarse primary solids and secondary bio-solids accumulated in a wastewater treatment process must be treated and disposed of in a safe and effective manner. This material may be inadvertently contaminated with toxic organic and inorganic compounds (e.g. heavy metals).When a liquid sludge is produced, further treatment may be required to make it suitable for final disposal. Typically, sludges are thickened (de-watered) to reduce the volumes transported off-site for disposal. Processes for reducing water content include lagooning in drying beds to produce a cake that can be applied to land or incinerated; pressing, where sludge is mechanically filtered, often through cloth screens to produce a firm cake; and centrifugation where the sludge is thickened, by centrifuging it, separating the solid and liquid.

Sludges can be disposed off by liquid injection to land or by disposal in a landfill. There are concerns about sludge incineration because of air pollutants in the emissions, along with the high cost of supplemental fuel, making this a less attractive and less commonly constructed means of sludge treatment and disposal. There is no process which completely eliminates the requirements for disposal of bio-solids. In South Australia, after centrifugation, the sludge is completely dried by sunlight. The nutrient rich bio-solids are then provided to farmers free-of-charge to use as a natural fertilizer. This method has reduced the amount of landfill generated by the process each year. In the very large metropolitan areas of Southern California, inland communities return sewage sludge to the sewer system of communities at lower elevations to be reprocessed at a few very large treatment plants on the Pacific coast. This reduces the required size of interceptor sewers and allows local recycling of treated waste-water while retaining the economy of a single sludge processing facility.

Sewage disposal or water disposal

Sewage disposal

This is the ultimate return of used water to the environment. The origin, composition, and quantity of waste are related to existing life patterns. Methods of waste disposal date from ancient times, and sanitary sewers have been found in the ruins of the pre-historic cities of Crete and the ancient Assyrian cities. Storm-water sewers built by the Romans are still in service today. Although the primary function of these was drainage, the Roman practice of dumping refuse in the streets caused significant quantities of organic matter to be carried along with the rainwater runoff. Towards the end of the Middle Ages, below-ground privy vaults and, later, cesspools were developed. When these containers became full, sanitation workers removed the deposit at the owner's expense. The wastes were used as fertilizer at nearby farms or were dumped into watercourses or onto vacant land. A few centuries later, there was renewed construction of storm sewers, mostly in the form of open channels or street gutters. At first, disposing of any waste in these sewers was forbidden, but by the 19th century it was recognized that community health could be improved by discharging human waste into the storm sewers for rapid removal. Development of municipal water-supply systems and household plumbing brought about flush toilets and the beginning of modern sewer systems. Despite reservations that sanitary sewer systems wasted resources, posed health hazards, and were expensive, many cities built them. By 1910 there were about 25,000 miles of sewer lines in the United States.

At the beginning of the 20th century, a few cities and industries began to recognize that the discharge of sewage directly into the streams caused health problems, and this led to the construction of sewage-treatment facilities. At about the same time, the septic tank was introduced as a means of treating domestic sewage from individual households both in suburban and rural areas.

As a result of the abundance of diluting water and the presence of sizeable social and economic problems during the first half of the 20th century, few municipalities and industries provided wastewater treatment. When waste matter enters water, the resulting product is called sewage or wastewater. Disposal points distribute the used water either to aquatic bodies such as oceans, rivers, lakes, ponds, or lagoons or to land by absorption systems, groundwater recharge, and irrigation. Wastewaters must be mixed, diluted, and absorbed so that receiving environments retain their beneficial use, be it for drinking, bathing, recreation, aquaculture, silviculture, irrigation, groundwater recharge, or industry.

Wastewater is treated to remove contaminants or pollutants that affect water quality and use. Discharge to the environment must be accomplished without transmitting diseases, endangering aquatic organisms, impairing the soil, or causing unsightly or malodorous conditions. The type and degree of treatment are dependent upon the absorption capability or dilution capacity at the point of ultimate disposal. Discharges into any aquatic system cannot contravene the standards set for the most beneficial use of that water body. Water quality standards are used to measure an aquatic ecosystem after the discharge has entered and mixed with it. Water quality standards relate to the esthetics and use of the receiving environment for public water supply, recreation, maintenance of aquatic life and wildlife, or agriculture. The parameters of water quality, which define the physical, chemical, and biological limits, include floating and settleable solids, turbidity, color, temperature, pH, dissolved oxygen, biochemical oxygen demand (BOD), numbers of coliform organisms, toxic materials, heavy metals, and nutrients.

Effluent standards define what is allowed within the wastewaters discharged into the aquatic environment. Effluent standards specify the allowed biochemical oxygen demand, suspended solids, temperature, pH, heavy metals, certain organic chemicals, pesticides, and nutrients in the discharge. Point-source wastewater effluent discharge standards, established for ease of sampling, simplicity of repetitive testing, and clarity for enforcement, are more likely to be used by regulatory agencies.

Waste disposal

The more waste we generate, the more we have to dispose of. Some methods of waste disposal release air pollutants and greenhouse gases into the atmosphere. Waste recycling offers one means of reducing the impacts of waste disposal on the atmosphere, but there are other methods of waste disposal which are more environmentally friendly. The most common disposal methods, particularly in the UK, are landfill and to a lesser extent incineration. Each year, approximately 111 million tones of controlled waste (household, commercial and industrial waste) are disposed of in landfill sites in the UK. Some waste from sewage sludge is also placed in landfill sites, along with waste from mining and quarrying. There are over 4000 landfill sites in the UK. As landfill waste decomposes, methane is released in considerable quantities. Currently, it is estimated that over 1.5 million tones of methane are released by landfill sites in the UK each year. Methane is a strong greenhouse gas and contributes to global warming. Furthermore, the leachates fluids formed from decomposing waste can permeate through the underlying and surrounding geological strata, polluting groundwater which may be used for drinking water supplies. Containment landfills, however, can limit the spread of this waste leachates.

Incineration is the second largest waste disposal method in most countries. In the UK, approximately 5% of household waste, 7.5% of commercial waste, and 2% of industrial waste is disposed of by incineration. When burning waste, a large amount of energy, carbon dioxide and other potentially hazardous air pollutants are given off. Modern incinerators, however, can use this waste energy to generate electricity and hence prevent the energy from being wasted. Incineration plants range from large scale, mass-burn, and municipal waste incinerators to smaller clinical waste incinerators used in hospitals.

A less common but more sustainable method of waste disposal is anaerobic digestion. In this process, waste decomposes in an enclosed chamber, unlike in a landfill site. Digestion takes place in an oxygen-free environment. Bacteria thrive in this environment by using the oxygen that is chemically combined within the waste. They decompose waste by breaking down the molecules to form gaseous by-products (methane) and small quantities of solid residue. Anaerobic sewage plants produce significant quantities of methane, which can be burnt to generate electricity. Liquid and solid organic fertilizers are also formed, and can be sold to cover operating costs. For several years, sewage sludge and agricultural waste have been treated by anaerobic digestion, and the process is now being used for municipal solid waste. It requires the biodegradable section of the waste to be separated from other material and put into digestion chambers.

As well as recycling waste, individuals can adopt more sustainable ways of disposing it. One way is to compost any organic waste such as food and garden waste. Organic waste breaks down over a few weeks into a mulch which can be used as a soil fertilizer. Individual households have practiced small-scale composting for many years, and the UK Government is now encouraging this on a wider scale. Large-scale composting schemes are also being developed, with the collection of organic waste from parks and civic amenity sites. Garden and food wastes are collected directly from households in separate kerbside collections. Large central facilities can then compost the collected organic waste. These schemes are to help the UK meet its target of recycling and composting 33% of household waste by 2015.These are various processes involved in the collection, treatment, and sanitary disposal of liquid and water-carried wastes from households and industrial plants.

Transportation of Water

Wastewater is carried from its source to treatment facility pipe systems that are generally classified according to the type of wastewater flowing through them. If the system carries both domestic and storm-water sewage, it is called a combined system, and these usually serve the older sections of urban areas. As the cities expanded and began to provide treatment of sewage, sanitary sewage was separated from storm sewage by a separate pipe network. This arrangement is more efficient because it excludes the voluminous storm sewage from the plant. It permits flexibility in the operation of the plant and prevents pollution caused by combined sewer overflow, which occurs when the sewer is not big enough to transport both household sewage and storm water. Another solution to the overflow problem has been adopted by Chicago, Milwaukee, and other U.S. cities to reduce costs: instead of building a separate household sewer network, large reservoirs, mostly underground, are built to store the combined sewer overflow, which is pumped back into the system when it is no longer overloaded.

Households are usually connected to the sewer mains by clay, cast-iron, or polyvinyl chloride (PVC) pipes 8 to 10 cm (3 to 4 in) in diameter. Larger-diameter sewer mains can be located along the centerline of a street or alley about 1.8 m (about 6 ft) or more below the surface. The smaller pipes are usually made of clay, concrete, or asbestos cement, and the large pipes are generally of unlined or lined reinforced-concrete construction. Unlike the water-supply system, wastewater flows through sewer pipes by gravity rather than by pressure. The pipe must be sloped to permit the wastewater to flow at a velocity of at least 0.46 m per sec (1.5 ft per sec), because at lower velocities the solid material tends to settle in the pipe.

Storm-water mains are similar to sanitary sewers except that they have a much larger diameter. Certain types of sewers, such as inverted siphons and pipes from pumping stations, flow under pressure, and are thus called force mains. Urban sewer mains generally discharge into interceptor sewers, which can then join to form a trunk line that discharges into the wastewater-treatment plant. Interceptors and trunk lines, generally made of brick or reinforced concrete, are sometimes large enough for a truck to pass through them. Sewage and waste water is also disposed of to rivers, streams and the sea in many parts of the world. Doing so can lead to serious pollution of the receiving water. This is common in third world countries and may still occur in some developed countries, where septic tank systems are too expensive.

Economic importance of sewage

Energy from waste

A lot of waste we produce is disposed of in landfill sites. When this waste decomposes over time, a lot of methane is given off. If left to accumulate in the atmosphere, this methane can contribute to global warming. However, it can be utilized to generate electricity by burning it. Although this releases carbon dioxide into the air, it is not as strong a greenhouse gas as methane. It has been estimated that 6 to 8 tons per cubic metre of methane gas are produced from landfill gas extraction each year. This method was first utilized to power boilers and furnaces in close proximity to the landfill sites. However, present schemes use the gas to power engines and generate electricity. Landfill gas currently provides approximately 250 megawatts (MW or million watts) of electricity in the UK, about 21% of all electricity produced by renewable sources. This figure set to increase further in the coming years. Energy can be derived from waste besides the burning of methane. Firstly, when waste is incinerated in large amounts, heat energy can be recovered and used for heating schemes in factories, hospitals and other large-scale complexes. Secondly, waste-derived fuel can be burnt in many conventional boilers and larger combustion units. Unfortunately the fuel is not as energy-rich as coal, and is not always economically viable for companies to utilize. Incentives are often required to encourage firms to use this type of fuel.

Electricity

Power can also be obtained from sewage water. The technique uses Microbial fuel cells.

Conversion to fertilizer

Sewage sludge can be collected through a sludge processing plant that automatically heats the matter and conveys it into fertilizer pellets (this removes possible contamination by chemical detergents).This approach eliminates seawater pollution by conveying the water directly to the sea without treatment (a possible contamination by chemical detergents).This approach eliminates seawater pollution by conveying the water directly to the sea without treatment (a practice which is still common in developing countries, despite environmental regulation). Sludge plants are useful in areas that have already set-up a sewage-system, but not in areas without such a system, as composting toilets are more efficient and do not require sewage pipes (which break over time).

Waste recycling

The definition of recycling is to pass a substance through a system that enables that substance to be reused. Waste recycling involves the collection of waste materials and the separation and clean-up of those materials. Recycling waste means that fewer new products and consumables need to be produced, saving raw materials and reducing energy consumption.

CONCLUSION

Sewage disposal is regarded as a thorn in the flesh of man due to the inherent problems, but they have also been proved to be useful if properly recycled . It is imperative for Governments of the day to seek very lasting and less cost effective means of recycling sewage for a better environmental cleanup and other benefits to man.

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