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Cleanliness is the chief aim of sanitation. We have to keep our body, food, home and clothing as clean as possible. Our surrounding environment should also be maintained clean and neat. In many of our activities, we use water in residence, office, industries and public places. Cleaning of the lawns, floors, vehicles, and many materials are also done using water. During all these activities, a lot of waste substances are taken away in solution or in suspension by water. At the end, it becomes a liquid containing wastewater. This wastewater is a highly complex, unstable liquid which is dangerous to the health and well-being of all life.

The term sewage is used to denote any foul waste liquid. The sewage is a wastewater generated from domestic activities including kitchen, bathroom, toilet & floor washing. Due to rapid urbanization and increasing standards of living, the amount of sewage generated by the population will be increasing day by day. In India alone, it is estimated that about 23.0 billion litres of sewage is generated every day. If we look at the sources of waste, the first source is from domestic activities of human beings. They may be originated directly or indirectly from one way or the other. The faeces and urine from domestic lavatories, washing machines, food from dishwashers or vessel cleaning operations, soaps, detergents and food residues from domestic sinks.

The second source may be from Agricultural practices wherein animal faeces and urine from livestock, silage and other food effluents, chemical fertilisers (nitrate) from arable farms and pesticides.

The third major source is from the Industrial practices releasing chemical residues including (organic) solvents, oil, fuel, hydraulic fluid, acids, alkalies, heavy metals and scrap metal.

Based on these sources, sewage is classified into (a) Sanitary sewage, b) Manufacturing sewage and c) Storm sewage.

Sanitary sewage is the foul wastes of human or animal origin from residences, hotels, public lavatories, Malls, Community halls, stores, public buildings, and other places of human or animal abode. Manufacturing sewage is the foul wastes from factories. In different factories, it is of extremely different in nature. It is often exceedingly strong, and very offensive and difficult to dispose of, as compared to sanitary sewage. Storm sewage is the urban storm water flowing from city surfaces during and after the rainstorms. Though polluted especially at the beginning of a storm, from droppings of animals and other surface filths of cities, it is not so foul, nor so liable to swarm with disease germs, as obtained from the sanitary sewage. The term sewer is a drain used for the removal of foul waste liquids. These are pipelines. Usually, sewers are closed, underground conduits. An open sewer is an open channel which conveys foul waste liquids. The term sewerage refers to the entire system of sewers including pipes, pumps and tanks and other purification works. Collection, treatment and disposal are the three essential stages in a sewerage system of a city or municipality.

Due to several reasons, the sewage may not be properly collected & treated in some urban centers. Nearly 2/3rd of the pollution problem occurs due to the discharge of untreated or partially treated sewage in a country. Due to inadequate collection system, the sewage is accumulated within urban areas forming cess pools. These promote breeding of mosquitoes, percolating in the ground & polluting the groundwater. Groundwater may be the only source of drinking in many urban areas, which once polluted may pose serious health hazards to all the people. In many areas, sewage also includes liquid waste from industry and commerce. There are two terms used in wastewater usage.

The domestic human waste including human excreta, urine and the associated sludge is known as black water. The wastewater generated through bathing and kitchen is collectively known as grey water. The separation and draining of household waste into greywater and

blackwater is becoming more common in the developed countries. The greywater is being permitted to be used for watering plants or recycled for flushing toilets, in some cities. The blackwater cannot be used like that. Sewage may include stormwater runoff. If a sewerage system is capable of handling both municipal sewage and stormwater sewage then it is called as Combined Sewer Systems. Sanitary sewers are typically much smaller than combined sewers, and they are not designed to transport stormwater.

Any domestic sewage may have five major characteristics as: 1) Presence of organic matter 3 2) Presence of nitrogen and phosphorous 3) Presence of suspended solids 4) Control of dissolved oxygen 5) Presence of faecal coliform bacteria.

In details:

1. The first one is the presence of organic Matte: Organic matter is the most important polluting constituent of sewage in respect of its effects on receiving water bodies. It is mainly composed of proteins, carbohydrates and fats. If untreated sewage is discharged into natural water bodies, biological stabilization of organic matter leads to depletion of oxygen in water bodies.

2. The second one is the presence of Nitrogen &: Nitrogen and phosphorus are also very important polluting constituents of sewage because of their role in algal growth and eutrophication of water bodies. Nitrogen is present in fresh domestic sewage in the form of proteinaceous matter urea (i.e. organic nitrogen). Phosphorus is usually present in orthophosphate, polyphosphate and organic phosphate forms. Organically bound phosphorus is of little importance in domestic sewage whereas polyphosphate forms undergo hydrolysis to revert into the orthophosphate forms, although this conversion is quite slow.

3. The third one is the presence of Suspended Solids: Suspended solids represent that fraction of total solids in any wastewater that can be settled gravitationally. Suspended solids can further be classified into organic and inorganic fractions. Organic are volatile fractions and inorganic are fixed fractions. Organic matter is present in the form of either settleable form or non-settleable form. These refer to the dissolved or colloidal states. If the organic fraction of suspended solids present in sewage is discharged untreated into the local streams, it leads to sludge deposits and subsequently to anaerobic conditions.

4. The fourth one is the control of Dissolved Oxygen: Dissolved oxygen, as such, does not have any significance as a sewage characteristics. However, it is the most important pollution monitoring parameter of the receiving water bodies. Stabilization of organic matter, when

discharged as untreated or partially treated substance into any receiving waters, that may leads to depletion of their dissolved oxygen. Nutrients like nitrogen and phosphorus are mainly added in this process. This nutrient load due to discharge of untreated or treated sewage may lead to the growth of algae in streams, lakes and ponds.

5. The fifth one is the oresence of Faecal Coliform Bacteria: These are organic and excreted matter, occurring in dissolved as well as suspended form in sewage waters. The most important parameter of sewage is the amount of faecal coliform (FC). This serve as an indicator of faecal pollution in waterbodies, drinking water sources or any water before consumption. This is a very important factor to be monitored when human health is concerned. Faecal Coliform bacteria should be fully controlled.

Sewage from large and small towns is discharged either into a water body or on a land surface. This water may be used for various purposes such as source of domestic water supply and bathing or discharged on land for irrigation, where human beings come in contact with it. The population consuming that particular water or the persons involved in agricultural activities where such sewage is applied, all become vulnerable to infection from pathogenic organisms (mainly bacteria and viruses). They may be infected with water-borne diseases. Hence, it is necessary to treat the sewage before disposal in any place. Sewage treatment is a major task in the sanitation works of a city.

Main Processes involved in sewage treatment works: Sewage can be treated close to the place where it is created, in a decentralised system. Typical examples are septic tanks, biofilters or aerobic treatment systems. Septic tank is an old method of decentralized sewage treatment system. In centralized system, the sanitary sewer-line of every house is connected to the street-wise sewer lines. These are interconnected to the main large-diameter sewer conduits. Finally, they reach the nearest sewage treatment plants of the city or town. Sewage can be collected and transported via a network of pipes and pump stations to a municipal treatment plant and treated under a centralised system.

Sewage treatment generally involves four major stages as: **1) Pre-treatment, 2) Primary treatment, 3) Secondary treatment and 4) Tertiary treatment.**

The first stage is the Pre-treatment. Any municipal sewage may invariably contain trash, tree limbs, leaves and hard raw substances. They may be large in sizes and shapes and also denser to move. In this stage itself, these are to be removed first, other-wise, they may affect the other subsequent processes.

The second stage is the Primary treatment stage. This stage consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle first at the bottom of the basin and at the same time, oil, grease and lighter solids may float to the surface of the basin. These settled and floating materials are removed in this stage. The remaining liquid may be discharged or subjected to the next stage of treatment.

The third stage is the Secondary treatment. In this stage steps are taken to remove the dissolved and suspended biological matter. The processes are 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 the discharge for subsequent treatments.

The fourth stage is the Tertiary treatment. In this stage, the treated effluent is allowed into a highly sensitive or fragile ecosystem like an estuary, low-flow rivers, coral reefs, lakes and ponds. The treated water is also disinfected chemically or physically prior to the discharge into a stream, river, bay, lagoon or wetlands. This water can be used for the irrigation of a grass-land, meadows, golf course, green ways or parks. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes. 5 Each stage has its own sequence of processes to be completed in sewage treatment. It is also necessary to know the essential steps involved for a better understanding.

Pre-treatment: Pre-treatment removes materials that can be easily collected from the raw waste water before they damage or clog the pumps and skimmers of primary treatment clarifiers (trash, tree limbs, leaves, etc.). The steps involved in this stage are: 1) Screening 2) Grit removal 3) Fat and Grease removal

Screening is done to remove all the large objects carried in the sewage stream. It is attempted using an automated mechanically raked bar screens in bigger systems. In smaller or less modern plants, a manually cleaned screen may be used. The solids are collected and later disposed off as landfill or incinerated. Bar screens or mesh screens of varying sizes may be used to optimize solids removal.

Grit removal is another step. It may include a sand or grit channel or chamber where the velocity of the incoming wastewater is adjusted to allow the settlement of Coarse sand, grit, stones, and broken glass pieces. These particles are removed first, because they may damage the pumps and other equipment of the treatment plants at a later stage.

Fat and grease removal is yet another step. In some larger plants, fat and grease is removed by passing the sewage through a small tank where skimmers may collect the fat floating on the surface. Air blowers in the base of the tank may also be used to help recover these fat as a froth. In most plants, fat and grease removal takes place in the primary settlement tank itself using mechanical surface skimmers.

Primary treatment stage. It involves sedimentation process. In the primary sedimentation stage, sewage flows through large tanks, commonly called as "primary clarifiers" or "primary sedimentation tanks." The tanks are used to settle the sludge while grease and oils rise to the surface and are skimmed off. The Primary settling tanks are usually equipped with mechanically driven scrapers. These scrappers continually drive the collected sludge towards a hopper in the base of the tank where it is pumped into the sludge treatment facilities. Grease and oil from the floating material can sometimes be recovered for saponification.

Secondary treatment stage. Secondary treatment is designed to substantially degrade the biological content of the sewage which are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. To be effective, the biota require both oxygen and food to live. The bacteria and protozoa consume biodegradable soluble organic contaminants like, sugars, fats, organic short-chain carbon molecules, etc. and bind much of the less soluble fractions into floc.

The Secondary treatment systems are classified into a) fixed-film or b) suspended-growth systems.

The Fixed-film or attached growth systems include trickling filters and rotating biological contactors, where the biomass grows on the media and the sewage passes over its surface. The Suspended-growth systems include activated sludge, where the biomass is mixed with the sewage. This can be operated in a smaller space than fixed-film systems that treat the same amount of water. However, the fixed-film systems are more able to cope with the 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. They are designed to allow high hydraulic loading and a high level of aeration. On larger installations, air is forced through the media using blowers. A filter removes a small percentage of the suspended organic matter, while the majority of the organic matter undergoes a change of character, only due to the biological oxidation and nitrification taking place in the filter. With this aerobic oxidation and

nitrification, the organic solids are converted into coagulated suspended mass, which is heavier and bulkier. These can settle at the bottom of a tank. The effluent of the filter is therefore passed through a sedimentation tank, called a secondary clarifier, secondary settling tank or humus tank.

Activated sludge stage.

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 the organic material. The process traps particulate material and can, under ideal conditions, a) convert ammonia to nitrite and nitrate and b) ultimately to nitrogen gas. Surface-aerated basins called Lagoons are used for these processes. Many small municipal sewage systems use aerated lagoons for this purpose. Most biological oxidation processes for treating industrial wastewaters have in common the use of oxygen (or air) and microbial action. The basins may range in depth from 1.5 to 5.0 metres and use motor-driven aerators floating on the surface of the wastewater. 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). The last part of the treated water is passed through constructed wetlands. Constructed wetlands include engineered reed beds and belong to the family of phytorestoration and ecotechnologies. Filter beds or oxidizing beds are used subsequently. In older plants trickling filter beds are used where the settled sewage liquor is spread onto the surface of a bed made up of coke (carbonized coal), limestone chips or specially fabricated plastic media. The liquor is typically distributed through perforated spray arms. The distributed liquor trickles through the 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 bacteria, protozoa and fungi form on the media's surfaces and eat or otherwise reduce the organic content. This biofilm is often grazed by insect larvae, snails, and worms which help maintain an optimal thickness.

References:

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