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Review Article

A REVIEW ON WATER AND SEWAGE WATER TREATMENT PROCESS

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ABSTRACT
Rapid industrialization is going all over the world, especially in the developing countries. Because, the major source of country's income will comes through the industries. The increasing in the number of the industries, pollute the environment by releasing the toxic gases and toxic waste into the air and water thus contributing the air and water pollution respectively. As a result, the air and water quality of the surrounding villages will be put in danger. So, periodic survey has to be done by the industry/government/state or central pollution control boards, in order to investigate the concentration of various air and water pollutants in the industry surrounding villages.

Keywords: Water, Water Sampling, Composition of Wastewater, Treatment techniques.

1. INTRODUCTION

The purposes of pollution control endeavours should be (1) to protect the assimilative capacity of surface waters, (2) to protect shellfish, finfish and wildlife (3) to preserve or restore the aesthetic and recreational value of surface waters (4) to protect humans from adverse water quality conditions. The selection and design of treatment facilities is based on a study of the physical, chemical and biological characteristics of the waste water. The quality that must be maintained in the environment to which the waste water is to be discharged or for the reuse of the waste water the applicable environmental standards or discharge requirements that must be met[1].

2. Sources of water

a) Ground water

The water emerging from some deep ground water may have fallen as rain many tens, hundreds, or thousands of years ago. Soil and rock layers naturally filter the ground water to a high degree of clarity and often it does not require additional treatment other than adding chlorine or chloramines as secondary disinfectants. Such water may emerge as springs, artesian springs, or may be extracted from boreholes or wells. Deep ground water is generally of very high bacteriological quality (i.e., pathogenic bacteria or the pathogenic protozoa are typically absent), but the water may be rich in dissolved solids, especially carbonates and sulphates of calcium and magnesium. Depending on the strata through which the water has flowed, other ions may also be present including chloride, and bicarbonate. There may be a requirement to reduce the iron or manganese content of this water to make it acceptable for drinking, cooking, and laundry use. Primary disinfection may also be required. Where groundwater recharge is practised (a process in which river water is injected into an aquifer to store the water in times of plenty so that it is available in times of drought), the groundwater may require additional treatment depending on applicable state and federal regulations.

b) Upland lakes and reservoirs

Typically located in the headwaters of river systems, upland reservoirs are usually sited above any human habitation and may be surrounded by a protective zone to restrict the opportunities for contamination. Bacteria and pathogen levels are usually low, but some bacteria, protozoa or algae will be present. Where uplands are forested or peaty, humic acids can colour the water. Many upland sources have low pH which require adjustment.

c) Rivers, canals and low land reservoirs

Low land surface waters will have a significant bacterial load and may also contain algae, suspended solids and a variety of dissolved constituents.

d) Atmospheric water generation
It is a new technology that can provide high quality drinking water by extracting water from the air by cooling the air and thus condensing water vapour.

e) Rainwater harvesting or fog collection
which collects water from the atmosphere can be used especially in areas with significant dry seasons and in areas which experience fog even when there is little rain.

f) Surface Water
Freshwater bodies that are open to the atmosphere and are not designated as groundwater are classified in the USA for regulatory and water purification purposes as surface water and also another source is Desalination of seawater by distillation or reverse osmosis[2].

3. Water Sampling and Storage

The representative sample of water that is taken should be the one that truly reflects the composition of the water sample to be analysed. Due to varying period of time that may lapse between sample collection and analysis, storage conditions must be such as to avoid undesirable loses, contamination or other changes that could affect the results of the analysis. In some situations, a sampling plan or strategy may need to be devised so as to optimise the value of analytical information collected. For long term variation it may be beneficial to take samples at the same stage of each periodic cycle, whereas for short term variations such as seasonal, weekly or daily several samples have to be taken for each cycle[3]. Well known water sampling techniques are,

(a) Grab samples
Grab samples are single collected at a specific spot at a site over a short period of time (typically seconds or minutes). Thus, they represent a “snapshot” in both space and time of a sampling area. Discrete grab samples are taken at a selected location, depth, and time. Depth-integrated grab samples are collected over a predetermined part of the entire depth of a water column, at a selected location and time in a given body of water.

(b) Composite samples
Composite samples should provide a more representative sampling of heterogeneous matrices in which the concentration of the analytes of interest may vary over short periods of time and/or space. Composite samples can be obtained by combining portions of multiple grab samples or by using specially designed automatic sampling devices. Sequential (time) composite samples are collected by using continuous, constant sample pumping or by mixing equal water volumes collected at regular time intervals. Flow-proportional composites are collected by continuous pumping at a rate proportional to the flow, by mixing equal volumes of water collected at time intervals that are inversely proportional to the volume of flow, or by mixing volumes of water proportional to the flow collected during or at regular time intervals.

(c) Integrated (discharge-weighted) samples: For certain purposes, the information needed is best provided by analysing mixtures of grab samples collected from different points simultaneously, or as nearly so as possible, using discharge-weighted methods such as equal-width increment (EWI) or equal discharge-increment (EDI) procedures and equipment. An example of the need for integrated sampling occurs in a river or stream that varies in composition across its width and depth. To evaluate average composition or total loading, use a mixture of samples representing various points in the cross-section, in proportion to their relative flows. The need for integrated samples also may exist if combined treatment is proposed for several separate wastewater streams, the interaction of which may have a significant effect on treatability or even on composition. Mathematical prediction of the interactions among chemical components may be inaccurate or impossible and testing a suitable integrated sample may provide useful information[4].

4. Major Pollutant Sources

(a) Dumping and Marine Transport Pollution-Many industrial plants dump their toxic wastes into rivers and streams. Some industrial plants dispose of their radioactive wastes from ships and other man-made structures by throwing these into the seas. Toxic wastes are burned in the seas and some ships illegally wash their empty tanks here. Millions of tons of oil are spilled into the oceans every year.

(b) Air-Based Pollution-One example of air-based water pollution is the acid rainphenomenon. During the rainy season, rainwater washes away the chemicals in the air and brings them to the ground and into bodies of water. This is harmful to the schools of fish and other animals living in the seas and oceans.

(c) Land-Based Pollution-Urban development contributes to water pollution. When large groups of people migrate to urban areas to seek better employment opportunities, these areas become overpopulated. Because of overpopulation and the establishment of industrial plants and factories in these areas, the sources of drinking water become filthy and contaminated.

(d) Thermal pollution is another type of water pollution. It takes place when electric plants throw away clean hot water into different bodies of water. This endangers the life forms in these bodies of water because hot water reduces oxygen. Apart from this we have another sources of surface waters,itmay have the following types of pollutions. They are,

(e) Suspended solids-The inorganic suspended solids blanket the stream bed effecting benthos (flora and fauna at bottom of water) organisms, while the organic solids create sludge banks and decompose causing odours and pathogens.

(f) Floating solids including oils, greases-Floating materials obstruct passage of light and aeration which are vital for flora and fauna and self-purification of water.

(g) Organic matter-Biological decomposition of waste organic matter in stream depletes dissolved oxygen content of water which may stifle the fish and aquatic life due to lack of oxygen. Unpleasant odour, flavour and taste, result due to lack of dissolved oxygen. Untreated sewage is the biggest pollutant and a cause of pathogens in water.

(h) Inorganic dissolved salts-High total dissolved solids (TDS) may interfere with the use of water in industries, municipal supplies and for irrigation purposes. Phosphorusand Nitrogen are plant nutrients which induce algae growth and sometimes create ‘Eutrophic’ condition when excessive plant and algal growth may kill fishes and water animals.

(i) Acid, alkalis, toxic chemicals and heavy metals-Adverse effect on human and animal life and plants

(j) Radioactive materials-Adverse effects on all biological beings.

(k) Foam and colour are indicators of contaminations.

(l) Microorganisms-Pathogenic bacteria, viruses, etc. are health hazards[5-7].

5. Composition of Waste water

Wastewaters consist of water in which solids exist as settle able particles, dispersed as colloids, which are materials that do not settle readily, or solids in a dissolved state. The wastewater mixture will contain large numbers of microscopic organisms, mostly bacteria that are capable of consuming the organic component (fats, proteins and carbohydrates) of the mixture and bringing about rapid changes in the wastewater. Since the sources of wastewater as well as the inputs are highly variable and since there is also an active microbial component, the composition of all wastewaters is constantly changing. Prior to entering a wastewater treatment plant, a wastewater is sometimes called raw wastewater or raw sewage. The solid components of waste waters actually represents a very small part of most discharges, usually less than 0.1 percent by weight. However, it is this small component of the wastewater that presents the major challenges in wastewater treatment, operation and disposal. Essentially, the water component, the other 99.9 percent can be viewed as providing the volume and the vehicle for transporting the solid and microbial component of the wastewater. Although the solid component of wastewaters was noted above as consisting of less than 0.1 percent by weight of the wastewater, the common method used to express the components of water is not percentage. The amount of materials commonly found in or added to wastewater are more easily expressed as a concentration in milligrams per litre. This is sometimes still called parts per million. For practical purposes, these terms may be considered equal. For purposes of conversion, one milligram per litre is equivalent to 8.34 pounds per million gallons. Considered chemically, wastewater is a very complex mixture of components that would be difficult to completely define. In broad terms, it consists of an organic and an inorganic component.

Although a variety of chemical tests are used to characterize wastewaters, not all of the chemical components will be discussed, only the most important. Probably the most often measured characteristics of wastewater are suspended solids and BOD. Because solids are an important category in wastewaters, their composition is explained in some detail[8]. The typical composition of municipal wastewater is given in Table 8. From this table it can be seen that typical municipal wastewater contains about 220 mg L^{-1} of both suspended solids and BOD. The organic composition of this wastewater is approximately 50 percent proteins, 40 percent carbohydrates, 10 percent fats and oils, and trace amounts of priority pollutants and surfactants. Of the trace components, surfactants may be the largest constituent. These are present in detergent, soap, shampoo, and similar consumer products. In a recent study at Iowa State University, the measured concentrations of linear alkyl benzenesulfonate (LAS), a common surfactant in daily used consumer products, was 2.9 mg L^{-1} in the influent to a municipal wastewater treatment plant and 1.1 mg L^{-1} in the influent to a municipal/industrial plant that received approximately 50 percent industrial flow. Reported LAS concentrations in the influent to domestic wastewater treatment plants typically range from 1 to 5 mg L^{-1}[9].

6. Water treatment history

In ancient Greek and Sanskrit (India) writings dating back to 2000 BC, water treatment methods were recommended. People back than knew that heating water might purify it, and they were also educated in sand and gravel filtration, boiling, and straining. After 1500 BC, the Egyptians first discovered the principle of coagulation. They applied the chemical alum for suspended particle settlement.After 500 BC, Hippocrates discovered the healing powers of water. He invented the practice of sieving water, and obtained the first bag filter. In 300-200 BC, Rome built its first aqueducts. Archimedes invented his water screw.During the Middle Ages (500-1500 AD). In 1627 the water treatment history continued as Sir Francis Bacon started experimenting with seawater desalination. He attempted to remove salt particles by means of an unsophisticated form of sand filtration. In the 1700s the first water filters for domestic application were applied. These were made of wool, sponge and charcoal. In 1804 the first actual municipal water treatment plant designed by Robert Thom, was built in Scotland. In 1854 it was discovered that a cholera epidemic spread through water. The outbreak seemed less severe in areas where sand filters were installed. British scientist John Snow found that the direct cause of the outbreak was water pump contamination by sewage water. He applied chlorine to purify the water, and this paved the way for water disinfection. In the 1890s America started building large sand filters to protect public health. These turned out to be a success. Instead of slow sand filtration, rapid sand filtration was now applied. In 1902calcium hypo chlorite and ferric chloride were mixed in a drinking water supply in Belgium, resulting in both coagulation and disinfection. In 1906ozone was first applied as a disinfectant in France. Additionally, people started installing home water filters and shower filters to prevent negative effects of chlorine in water. In 1903 water softening was invented as a technique for water desalination. Cations were removed from water by exchanging them by sodium or other cations, in ion exchangers. Eventually, starting 1914drinking water standards were implemented for drinking water supplies in public traffic, based on coliform growth. It would take until the 1940s before drinking water standards applied to municipal drinking water. In 1972, the Clean Water Act was passed in the United States. In 1974 the Safe Drinking Water Act (SDWA) was formulated. The general principle in the developed world now was that every person had the right to safe drinking water. Starting in 1970, public health concerns shifted from waterborne illnesses caused by disease-causing microorganisms, to anthropogenic water pollution such as pesticide residues and industrial sludge and organic chemicals. Techniques such as aeration, flocculation, and active carbon adsorption were applied. In the 1980s, membrane development for reverse osmosis was added to the list. Risk assessments were enabled after 1990. Water treatment experimentation today mainly focuses on disinfection by-products[10].

7. Sewage & its treatment

Sewage treatment is the process of removing contaminants from wastewater and household sewage, both runoff (effluents), domestic, commercial and institutional. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer). Sewage is generated by residential, institutional, commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that 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 greywater and blackwater is becoming more common in the developed world, with greywater being permitted to be used for watering plants or recycled for flushing toilets.

(a) Process overview

Sewage can be treated close to where the sewage is created, a decentralised system (in septic tanks, bio filters or aerobic treatment systems), or be collected and transported by a network of pipes and pump stations to a municipal treatment plant, a centralised system (see sewerage and pipes and infrastructure). Sewage collection and treatment is typically subject to local, state and federal regulations and standards. Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

- Pre-treatment removes materials that can be easily collected from the raw sewage before they damage or clog the pumps and sewage lines of primary treatment clarifiers. Objects that are commonly removed during pre-treatment include trash, tree limbs, leaves, branches, and other large objects.
- 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 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 in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow Rivers, coral reefs,). Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigationof a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.Process flow diagram for a typical large-scale treatment plant is shown in Figure 1.[11]

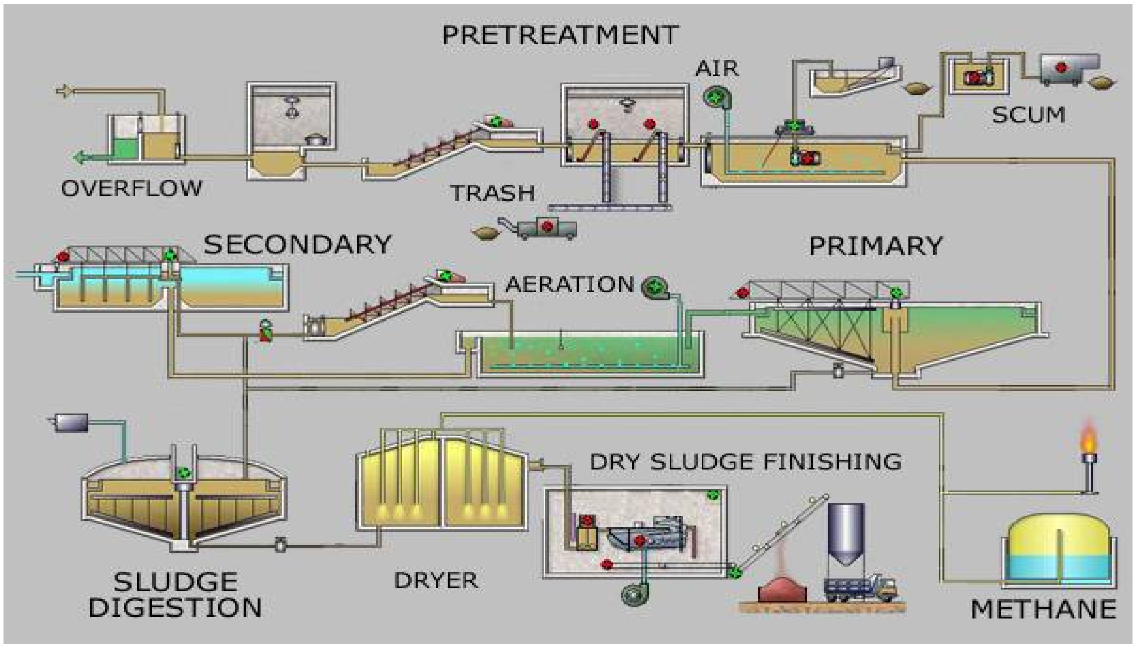

Fig. 1: Process flow diagram for a typical large-scale treatment plan

8. Pollution load and concentration

In most industries, wastewater effluents result from the water uses like, sanitary wastewater, cooling, process wastewater, cleaning etc. shown in Table 1. The use of water by industry can significantly affect the water quality of receiving waters. The level of wastewater loading from industrial sources varies markedly with the water quality objectives enforced by the regulatory agencies. There are many possible in-plant changes, process modifications and water-saving measures through which industrial wastewater loads can be significantly reduced. Up to 90 % of recent wastewater reductions have been achieved by industries employing such methods as recirculation, operation modifications, effluent reuse or more efficient operation. As a rule, treatment of an industrial effluent is much more expensive without water-saving measures than the total cost of in-plant modifications and residual effluent treatment.

Table 1: Pollution load of different industries

Industry - company sector	Type of water to be treated	Contamination to be treated
• Food and beverage • Petrochemical industry • Pharmaceutical sector • Agriculture • Micro-electronics (UP-water) • Electro-Galvanic industry • Vegetable/fruit processing companies • Printing • Car wash installations • Sewer/sewage • Paper & Cellulose • Textile industry • Painting & Electroplating	• Process water • Drinking water • Wastewater • Water recycling • Boiler feed water • Swimming pool water • Whirlpool disinfection • Demineralised water (demi-water) • Cooling tower water • Shower water (Legionella) • Surface (lake) water • Groundwater - well-water • Water quality monitoring • Humidification • Bottled water	• Suspended solids • Dissolved particles • Micro-organisms (disinfection) • Oil and fat • (Heavy) metals • Salts - minerals - ions; cation/anion • Colour/Color • Odour/Odor • Legionella control • Biologically non-degradable • Hardness; scaling • Corrosion treatment

9. Water Quality Index (WQI) Estimation

WQI is computed to reduce the large amount of water quality data to a single numerical value. WQI reflects the composite influence of different water quality parameters on the overall quality of water. Water quality index was computed to determine the suitability of the groundwater for drinking purposes as follows,[12-13]

$$WQI = \text{Antilog}\left[\sum_{i=1}^{n} w_i \log_{10} q_i\right]$$

Where,
wi = weightage factor of i th parameter
qi = quality rating of i th parameter
wi is calculated from the following equation, wi = k/sn

$$\text{Where } k = \text{constant} = \frac{1}{1/vs_1 + 1/vs_2 + \ldots\ldots 1/vs_n}$$

sn = standard value of i th parameter
qi is calculated from the following equation,

$$q_i = \left(\frac{v_a - v_i}{v_s - v_i}\right) \times 100$$

Where
va = actual value obtained from laboratory analysis of i th parameter
vs = standard value of i th parameter
vi = ideal value (P^H=7 and 0 for all parameters)

CONCLUSIONS

The improper management of solid wastes represents a source of air, land and water pollution, and poses risks to human health and the environment. Despite considerable expenses, the situation tends to further deteriorate due to the rapid growth of cities likely to occur over the next few decades. Globalization is likely to boost economic growth in the developing world, which would increase the amount of wastes that need to be treated, further straining Third World cities. Ground water and surface water are presently one of the most important natural resources and are in much demand because of the advantage that their quality is usually less uniform in a particular region and they can be exploited without the added cost of laying down pipelines for carrying the water.

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