Wastewater Treatment Technologies

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Abstract: Waste-water treatment is becoming ever more critical due to diminishing water resources, increasing wastewater disposal costs and stricter discharge regulations that have lowered permissible contaminant levels in waste streams. The treatment of waste-water for reuse and disposal is particularly important for countries, since they occupy one of the most arid regions in the world. Physical, chemical and biological methods are used to remove contaminants from waste-water. In order to achieve different levels of contaminant removal, individual waste-water treatment procedures are combined into a variety of systems, classified as primary, secondary and tertiary waste-water treatment. More rigorous treatment of waste-water includes the removal of specific contaminants as well as the removal and control of nutrients. Natural systems are also used for the treatment of waste-water in land-based applications. Sludge resulting from waste-water treatment operations is treated by various methods in order to reduce its water and organic content and make it suitable for final disposal and reuse. This chapter describes the various conventional and advanced technologies in current use and explains how they are applied for the effective treatment of municipal waste-water.

Key words: Waste water • Reuse • Purification • Contaminant • Advanced technologies

INTRODUCTION

Untreated waste-water generally contains high levels of organic material, numerous pathogenic microorganisms, as well as nutrients and toxic compounds. It thus entails environmental and health hazards and consequently, must immediately be conveyed away from its generation sources and treated appropriately before final disposal. The ultimate goal of waste-water management is the protection of the environment in a manner commensurate with public health and socio-economic concerns [1].

Wastewater treatment is becoming evermore critical due to diminishing water resources, increasing wastewater disposal costs and stricter discharge regulations that have lowered permissible contaminant levels in waste streams. The ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socio-economic concerns. Wastewater is a combination of water and water-carried wastes originating from homes, commercial and industrial facilities and institutions. Untreated wastewater generally contains high levels of organic material, numerous pathogenic microorganisms, nutrients and toxic compounds leading to environmental pollution and health hazards. So, the wastewater must be treated appropriately before final disposal, which leads to protection of the environment with public health and socioeconomic concerns. Understanding the nature of wastewater is fundamental to design appropriate wastewater treatment plant and technologies [2,3].

The Following Points Are to Be Considered for Choosing a Suitable Treatment process.

- How clean the final water effluent from our plant must be
- The quantities and nature of the influent water we need to treat
- The physical and chemical properties of the pollutants we need to remove or render neutral in the effluent water
- The physical, chemical and thermodynamic properties of the solid wastes generated from treating water
The cost of treating water, including the cost of treating process and finding a home for the solid wastes.

**Treatment of Wastewater:** Treatment of wastewater in pharmaceutical industry is carried out in four stages. They are

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary treatment

Based on the nature of wastewater, primary, secondary and tertiary treatment will be carried out before final disposal. For some wastes, primary treatment only is sufficient. Most of the wastes require secondary treatment also. But some other effluents require tertiary treatment.

**Preliminary Treatment:** Preliminary treatment process is attempted to render the effluent suitable for further treatment. Preliminary treatment processes consist of physical unit operations like screening and comminution for the removal of debris and rags, grit removal for the elimination of coarse suspended matter, and flotation for the removal of oil and grease. Other preliminary treatment operations include equalization, flow equalization and neutralization. Preliminary treatment reduces or eliminates the non-favourable wastewater characteristics like large solids and rags, abrasive grit, odours and, in certain cases, unacceptably high peak hydraulic or organic loadings.

**Primary Treatment:** Primary treatment involves the partial removal of suspended solids and organic matter from the wastewater by means of physical operations such as screening and sedimentation. Pre-aeration or mechanical flocculation with chemical additions can be used to enhance primary treatment. Primary treatment acts as a precursor for secondary treatment. It is aimed mainly at producing a liquid effluent suitable for downstream biological treatment and separating out solids as a sludge that can be conveniently and economically treated before ultimate disposal.

**Secondary Treatment:** Secondary treatment processes are used to convert the finely divided and dissolved organic matter in wastewater into floculent settle able organic and inorganic solids. The purpose of secondary treatment is the removal of soluble and colloidal organics and suspended solids that have escaped the primary treatment and reduce BOD and COD through biological process. In these processes, micro-organisms, particularly bacteria, convert the colloidal and dissolved carbonaceous organic matter into various gases and into cell tissue leading to reduction of BOD and COD. This is typically done through processes, namely treatment by trickling filtration, activated sludge process, oxidation ditch and oxidation ponds are some of the common secondary treatment procedures.

**Tertiary Treatment:** Tertiary treatment goes beyond the level of conventional secondary treatment for purification of wastewater i.e. removal of significant amounts of nitrogen, phosphorus, heavy metals, biodegradable organics, bacteria and viruses. In addition to biological nutrient removal processes, other unit operations like chemical coagulation, flocculation and sedimentation, followed by filtration and activated carbon are frequently used. Less frequently ion exchange and reverse osmosis for specific ion removal or for dissolved solids reduction are used.

**Treatment Procedures**

**Preliminary Treatment**

**Screening:** The screening of wastewater, one of the oldest treatment methods, removes gross pollutants from the waste stream to protect downstream equipment from damage, avoid interference with plant operations and prevent objectionable floating material from entering the primary settling tanks. It is the process by which the larger suspended and floating materials such as fibers, paper, rags, string substances and other materials are removed. The openings may be of any shape, but are generally circular or rectangular. The material retained from the manual or mechanical cleaning of bar racks and screens is referred to as "screenings", and is either disposed of by burial or incineration, or returned into the waste flow after grinding. The conventional screening system is comprised of two units. The first one known as coarse screen consists of metal bars or heavy wires spaced 25 to 50mm apart. They are set in the flow channel either at an angle of about 60° to the horizontal axis of the flow or curved to the radius of a circle. The second unit fine screens, as the name implies are used to remove the finer particles. The size opening ranges from 0.8 to 6.0 mm depending upon the type of effluent treated. The accumulated materials at screens must be removed at frequent intervals.
**Comminution:** Comminutors are installed when there is a difficulty in handling the screening. They are used to pulverize large floating material. Comminutors are installed between the gritchamber and the primary settling tanks and reduce odours, flies and unsightliness. Two types of comminutors are available.

- Rotating cutter comminutor
- Oscillating cutter comminutor

**Removal of Greases and Oils:** Greases and oils tend to form an insoluble layer on water surface. Grease can be removed using grease traps. Gravity or simple skimming methods are also used to remove the grease and oil [10-15].

**Flow Equalization:** Flow equalization processes; by leveling out operation parameters such as flow, pollutant levels and temperature over a period of time until a near constant flow rate is achieved; improve the effectiveness of secondary and advanced wastewater treatment process. There are four types off low equalization processes available.

- Alternating flow diversion
- Intermittent flow diversion
- Completely mixed, combined flow
- Completely mixed, mixed flow

**Neutralization of Acid Wastes and Alkaline Wastes:** Mixing of acid wastes with alkaline wastes generated within the same plant. Commonly Lime-slurry treatment procedure is done for the neutralization of acid wastes and sulphuric acid treatment for the neutralisation of alkaline wastes [16-19].

**Effluent Guidelines and Standards:** Environmental standards are developed to ensure that the treated wastewater discharges into ambient waters which is of acceptable quality in physical and chemical aspects. Regulations and procedures vary from one country to another and are continuously reviewed and updated to reflect growing concern for the protection of ambient waters. Standards play a fundamental role in the determination of the level of wastewater treatment required and in the selection of the discharge location and outfall structures [20,21].

**CONCLUSIONS**

The ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socio-economic concerns. Based on the nature of wastewater it is decided whether primary, secondary and tertiary treatment will be carried out before final disposal. New technologies have made growing numbers of water treatment alternatives available. Cost may be a major determining factor, especially in developing countries. Cost estimation is a difficult and even costly undertaking in itself, because of the large number of parameters involved and the fact that those parameters are usually unclear until the design process is well under way. Historical data are very useful in generating preliminary cost estimates. When these data are sufficiently detailed, they are also useful for the purpose of deriving cost equations that reflect system cost variations according to basic system parameters, including capacity. These equations form the basis of several computer software tools for water treatment cost estimation that are now available. As the cost of membrane modules declines, membrane techniques become progressively more viable, especially for large-capacity systems. In fact, all membrane systems yield economies of scale up to five mgd capacity. However, system designers must bear in mind that downmarket membrane systems will generally entail higher maintenance costs and will be difficult to expand and upgrade. A balance must be struck, depending on system requirements and projected lifetime.

**REFERENCES**