



A REVIEW ON TREATMENT PROCESSES FOR MUNICIPAL WASTE WATER

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Abstract — Nowadays many water resources are polluted by anthropogenic sources including household and agricultural waste and industrial processes. Public concern over the environmental impact of wastewater pollution has increased. Several conventional wastewater treatment techniques, i.e. chemical coagulation, adsorption, activated sludge, have been applied to remove the pollution, however there are still some limitations, especially that of high operation costs. The use of aerobic waste water treatment as a reductive medium is receiving increased interest due to its low operation and maintenance costs. In addition, it is easy-to-obtain, with good effectiveness and ability for degrading contaminants. This paper reviews the use of waste water treatment technologies to remove contaminants from wastewater such as halogenated hydrocarbon compounds, heavy metals, dyes, pesticides, and herbicides, which represent the main pollutants in wastewater. The main purpose of wastewater treatment is to remove the various contaminants that presence in the wastewater such as suspended solids, organic carbon, nutrients, inorganic salts, heavy metals, pathogens and so on. The ultimate goal of the wastewater treatment is to provide the protection in terms of human health and environmental aspect.

Keywords-Sewage, Aerobic, Treatment, Wastewater

I. INTRODUCTION

Water is one the most important and valuable resources on the planet and effects almost all our daily activities. For this reason, municipal waste water is an issue of utmost important and has gained increasing popularity in recent years.

Wastewater is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by municipal wastewater that is rain water, domestic residence, commercial properties, industry, and agriculture and can encompass a wide range of potential contaminants and concentrations.

Water is vital to the existence of all living organisms, but this valuable resource is increasingly being threatened as human population grows and demand more water of high quality for domestic purpose and economic activities. Among various environmental challenges of that India is facing is this century, fresh water scarcity ranks very high. The key challenges of better management of the water quality in India are temporal spatial variation of rainfall ,improper management of surface runoff, uneven geographic distribution of surface water resource, persistent drought, overuse of ground water, and contamination, drainage, and stalinization and water quality problems due to treated, partially treated, and untreated waste water from urban settlements, industrial establishment, and runoff from the irrigation sector beside poor management of municipal solid waste and animal dung in rural areas.

India being an economy in transition from a developing to a developed nation, faces two problems on the one hand there is lack of infrastructure and on the other ever increasing urban population. The urban population in India has jumped from 25.8 million in 1901to about 387 million (estimated) in 2011. This has thrown up two self-perpetuating problems, viz. shortage of water and sewage overload. It is estimated that by 2050, more than country's population will live in cities and town and thus the demand for infrastructure facilities is expected to rise sharply, posing a challenge to urban planners and policy makers.

Public services have not been able to keep pace with rapid urbanization. Water supply, sanitization measures, and management of sewage and solid waste cover only a fraction of total urban population. There is clear inequity and disparity between the public services received by the inhabitant, depending on the economic strata. Slum dwellers have always received least attention from the civic authorities. The rapid growth of urban population has taken place due to huge migration of population (mostly from rural areas and small towns to bog towns) and inclusion of new rural areas in the nearest urban setting, apart from natural growth of urban population. The majority of towns and cities have no sewerage and sewage treatment services. Many cities have expanded beyond municipalities, but the new urban agglomerations remain under rural administrations, which do not have the capacity to handle the sewage. Management of sewage is worse in small towns. The sewage is either directly dumped into rivers or lakes or in open fields.

II. NATURE OF MUNICIPAL WASTE-WATER

An understanding of the nature of waste-water is fundamental for the design of appropriate wastewater treatment plants and the selection of effective treatment technologies. Waste-water originates predominantly from water usage by residences and commercial and industrial establishments, together with groundwater, surface water and storm water (see figure 1). Consequently, waste-water flow fluctuates with variations in water usage, which is affected by a multitude of factors including climate, community size, living standards, dependability and quality of water supply, water conservation requirements or practices, and the extent of meter services, in addition to the degree of industrialization, cost of water and supply pressure.

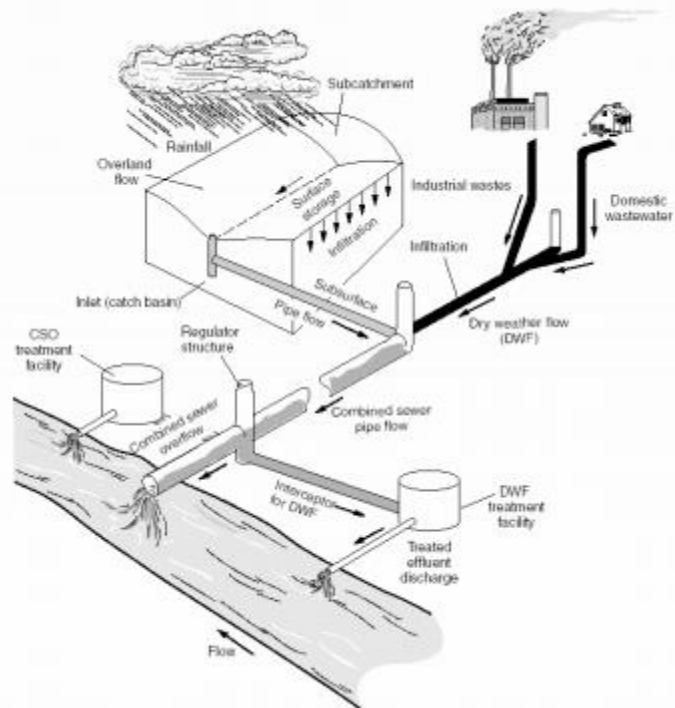


Figure 1: Sources of waste-water

III. WASTE-WATER TREATMENT TECHNOLOGIES

There are numerous processes that can be used to clean up wastewaters depending on the type and extent of contamination. Wastewater can be treated in wastewater treatment plants which include physical, chemical and biological treatment processes. Municipal wastewater is treated in sewage treatment plants (which may also be referred to as wastewater treatment plants). Agricultural wastewater may be treated in agricultural wastewater treatment processes, whereas industrial wastewater is treated in industrial wastewater treatment processes.

For municipal wastewater the use of septic tanks and other On-Site Sewage Facilities (OSSF) is widespread in some rural areas, for example serving up to 20 percent of the homes in the India.

One type of aerobic treatment system is the activated sludge process, based on the maintenance and recirculation of a complex biomass composed of micro-organisms able to absorb and adsorb the organic matter carried in the wastewater. Anaerobic wastewater treatment processes (UASB, EGSB) are also widely applied in the treatment of industrial wastewaters and biological sludge. Some wastewater may be highly treated and reused as reclaimed water. Constructed wetlands are also being used. In figure 2.2 typical municipal wastewater treatment system is showing and in figure 2.3 typical municipal wastewater applications is showing.

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.

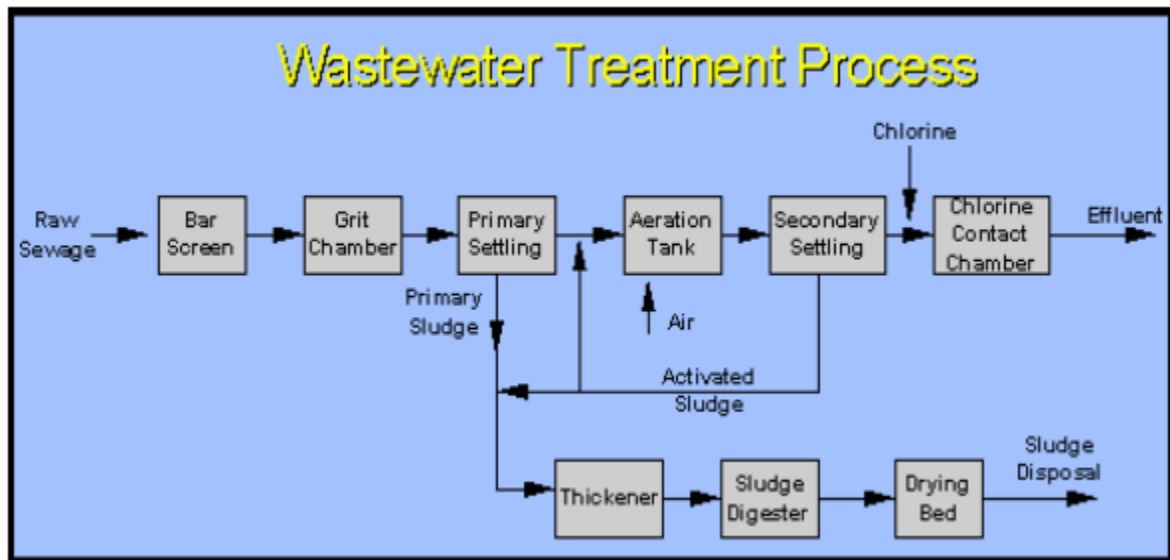


Figure 2: Typical Municipal Wastewater System

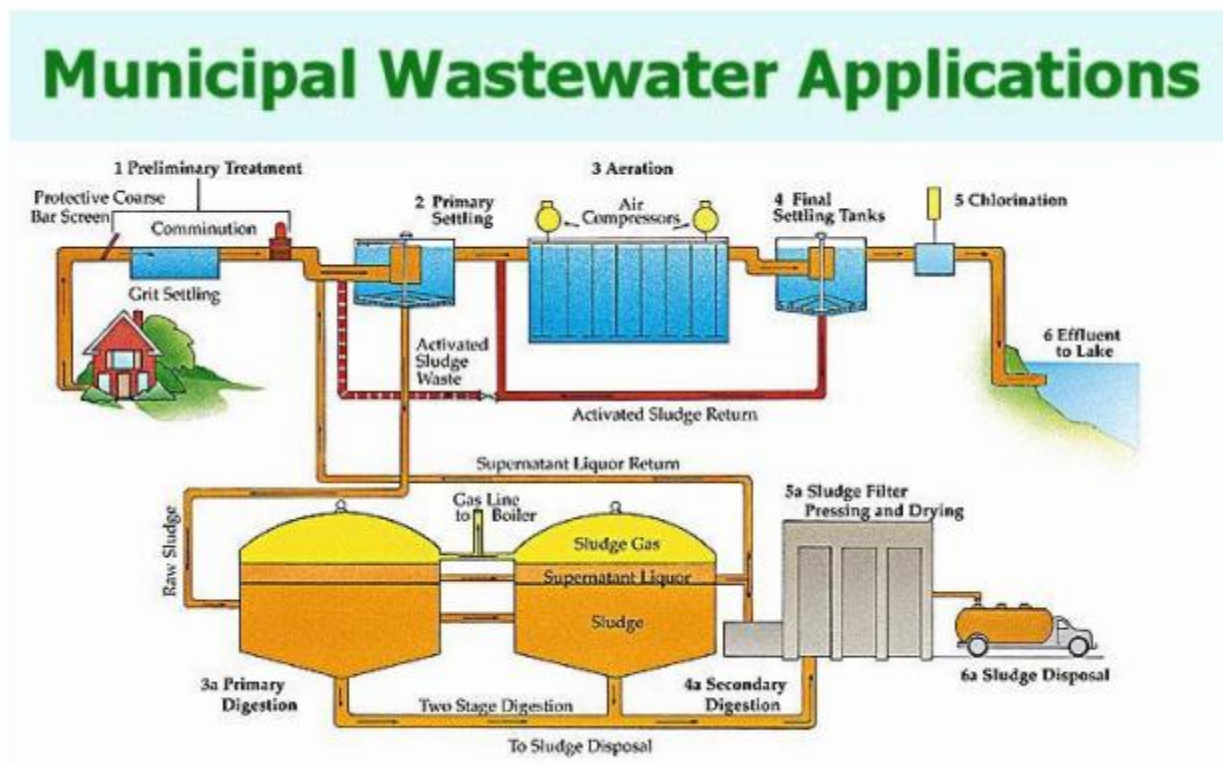


Figure 3: Typical Municipal Wastewater Applications

IV. WASTE-WATER TREATMENT METHODS

As mentioned earlier, waste-water treatment methods are broadly classifiable into physical, chemical and biological processes. Figure 2 lists the unit operations included within each category.

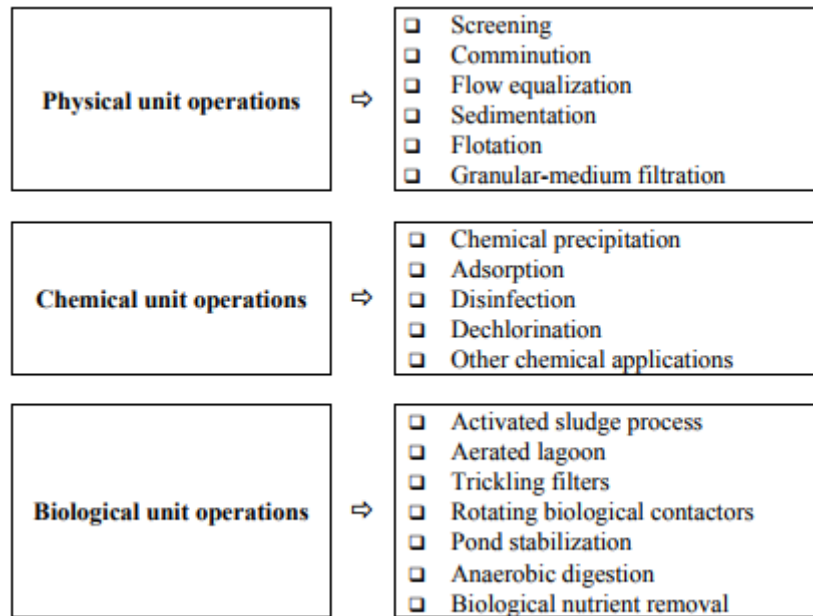


Figure 4: Waste-water treatment unit operations and processes

4.1. Physical Unit Operations

Among the first treatment methods used were physical unit operations, in which physical forces are applied to remove contaminants. Today, they still form the basis of most process flow systems for wastewater treatment. This section briefly discusses the most commonly used physical unit operations.

Screening

The screening of waste-water, 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. Screening devices may consist of parallel bars, rods or wires, grating, wire mesh, or perforated plates, to intercept large floating or suspended material. The openings may be of any shape, but are generally circular or rectangular.² 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.

Comminution

Comminutors are used to pulverize large floating material in the waste flow. They are installed where the handling of screenings would be impractical, generally between the grit chamber and the primary settling tanks. Their use reduces odours, flies and unsightliness. A comminutor may have either rotating or oscillating cutters. Rotating-cutter comminutors either engage a separate stationary screen alongside the cutters, or a combined screen and cutter rotating together. A different type of comminutor, known as a barminutor, involves a combination of a bar screen and rotating cutters.

Flow equalization

Flow equalization is a technique used to improve the effectiveness of secondary and advanced wastewater treatment processes by levelling out operation parameters such as flow, pollutant levels and temperature over a period of time. Variations are damped until a near-constant flow rate is achieved, minimizing the downstream effects of these parameters.

Sedimentation

Sedimentation, a fundamental and widely used unit operation in waste-water treatment, involves the gravitational settling of heavy particles suspended in a mixture. This process is used for the removal of grit, particulate matter in the primary settling basin, biological floc in the activated sludge settling basin, and chemical floc when the chemical coagulation process is used.

Flotation

Flotation is a unit operation used to remove solid or liquid particles from a liquid phase by introducing a fine gas, usually air bubbles. The gas bubbles either adhere to the liquid or are trapped in the particle structure of the suspended solids, raising the buoyant force of the combined particle and gas bubbles. Particles that have a higher density than the liquid can

thus be made to rise. In waste-water treatment, flotation is used mainly to remove suspended matter and to concentrate biological sludge. The chief advantage of flotation over sedimentation is that very small or light particles can be removed more completely and in a shorter time. Once the particles have been floated to the surface, they can be skimmed out. Flotation, as currently practised in municipal waste-water treatment, uses air exclusively as the floating agent.

Granular medium filtration

The filtration of effluents from waste-water treatment processes is a relatively recent practice, but has come to be widely used for the supplemental removal of suspended solids from waste-water effluents of biological and chemical treatment processes, in addition to the removal of chemically precipitated phosphorus. The complete filtration operation comprises two phases: filtration and cleaning or backwashing. The waste-water to be filtered is passed through a filter bed consisting of granular material (sand, anthracite and/or garnet), with or without added chemicals. Within the filter bed, suspended solids contained in the waste-water are removed by means of a complex process involving one or more removal mechanisms such as straining, interception, impaction, sedimentation, flocculation and adsorption. The phenomena that occur during the filtration phase are basically the same for all types of filters used for waste-water filtration. The cleaning/backwashing phase differs, depending on whether the filter operation is continuous or semicontinuous. In semi-continuous filtration, the filtering and cleaning operations occur sequentially, whereas in continuous filtration the filtering and cleaning operations occur simultaneously.

4.2. Chemical unit processes

Chemical processes used in waste-water treatment are designed to bring about some form of change by means of chemical reactions. They are always used in conjunction with physical unit operations and biological processes. In general, chemical unit processes have an inherent disadvantage compared to physical operations in that they are additive processes. That is to say, there is usually a net increase in the dissolved constituents of the waste-water. This can be a significant factor if the waste-water is to be reused. This section discusses the main chemical unit processes, including chemical precipitation, adsorption, disinfection, dechlorination and other applications.

Chemical precipitation

Chemical coagulation of raw waste-water before sedimentation promotes the flocculation of finely divided solids into more readily settleable flocs, thereby enhancing the efficiency of suspended solid, BOD₅ and phosphorus removal as compared to plain sedimentation without coagulation (see table 7). The degree of clarification obtained depends on the quantity of chemicals used and the care with which the process is controlled.

Adsorption with activated carbon

Adsorption is the process of collecting soluble substances within a solution on a suitable interface. In waste-water treatment, adsorption with activated carbon—a solid interface—usually follows normal biological treatment, and is aimed at removing a portion of the remaining dissolved organic matter. Particulate matter present in the water may also be removed. Activated carbon is produced by heating char to a high temperature and then activating it by exposure to an oxidizing gas at high temperature. The gas develops a porous structure in the char and thus creates a large internal surface area. The activated char can then be separated into various sizes with different adsorption capacities.

Disinfection

Disinfection refers to the selective destruction of disease-causing micro-organisms. This process is of importance in waste-water treatment owing to the nature of waste-water, which harbours a number of human enteric organisms that are associated with various waterborne diseases.

Dechlorination

Dechlorination is the removal of free and total combined chlorine residue from chlorinated wastewater effluent before its reuse or discharge to receiving waters. Chlorine compounds react with many organic compounds in the effluent to produce undesired toxic compounds that cause long-term adverse impacts on the water environment and potentially toxic effects on aquatic micro-organisms. Dechlorination may be brought about by the use of activated carbon, or by the addition of a reducing agent such as sulfur dioxide (SO₂), sodium sulfite (Na₂SO₃) or sodium metabisulfite (Na₂S₂O₅).

4.3. Biological unit processes

Biological unit processes are used to convert the finely divided and dissolved organic matter in wastewater into flocculent settleable organic and inorganic solids. In these processes, micro-organisms, particularly bacteria, convert the colloidal and dissolved carbonaceous organic matter into various gases and into cell tissue which is then removed in sedimentation tanks. Biological processes are usually used in conjunction with physical and chemical processes, with the main objective of reducing the organic content (measured as BOD, TOC or COD) and nutrient content (notably nitrogen and phosphorus) of waste-water. Biological processes used for waste-water treatment may be classified under five major headings:

- (a) Aerobic processes
- (b) Anoxic processes
- (c) Anaerobic processes
- (d) Combined processes
- (e) Pond processes.

4.4. Application Of Treatment Methods

In waste-water treatment plants, the unit operations and processes described in the previous section are grouped together in a variety of configurations to produce different levels of treatment, commonly referred to as preliminary, primary, secondary and tertiary or advanced treatment

Preliminary treatment

Preliminary treatment prepares waste-water influent for further treatment by reducing or eliminating non-favourable waste-water characteristics that might otherwise impede operation or excessively increase maintenance of downstream processes and equipment. These characteristics include large solids and rags, abrasive grit, odours, and, in certain cases, unacceptably high peak hydraulic or organic loadings. Preliminary treatment processes consist of physical unit operations, namely 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 flow equalization, septage handling, and odour control methods.

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. Preaeration or mechanical flocculation with chemical additions can be used to enhance primary treatment. Primary treatment acts as a precursor for secondary treatment. Its 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. The effluent from primary treatment contains a good deal of organic matter and is characterized by a relatively high BOD.

Secondary treatment

The purpose of secondary treatment is the removal of soluble and colloidal organics and suspended solids that have escaped the primary treatment. This is typically done through biological processes, namely treatment by activated sludge, fixed-film reactors, or lagoon systems and sedimentation.

Tertiary/advanced waste-water treatment

Tertiary treatment goes beyond the level of conventional secondary treatment to remove significant amounts of nitrogen, phosphorus, heavy metals, biodegradable organics, bacteria and viruses. In addition to biological nutrient removal processes, unit operations frequently used for this purpose include chemical coagulation, flocculation and sedimentation, followed by filtration and activated carbon. Less frequently used processes include ion exchange and reverse osmosis for specific ion removal or for dissolved solids reduction.

V. CONCLUSIONS

This paper is a review of the application of biofilm technology, aerobic granulation and microbial fuel cell for the treatment of wastewater. The treatment performances in terms of their advantages, applications and limitations have been discussed thoroughly. The ultimate goal of the wastewater treatment is the protection of the environment in a manner commensurate with public health and socio-economic concerns. Understanding the nature of wastewater is fundamental to design an appropriate treatment technology in order to ensure the safety, efficacy and the quality of the treated wastewater. Further, improved public education to ensure awareness of the technology and its benefits, both environmental and economic, is recommended.

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