Wastewater Treatment by Effluent Treatment Plants

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Abstract

Most of the river basins are closing or closed to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Performance of state owned sewage treatment plants, for treating municipal waste water, and common effluent treatment plants, for treating effluent from small scale industries, is also not complying with prescribed standards. Thus, effluent from the treatment plants, often, not suitable for household purpose and reuse of the waste water is mostly restricted to agricultural and industrial purposes. The development of innovative technologies for treatment of wastewaters from various industries is a matter of alarming concern for us. Although many research papers have been reported on wastewater pollution control studies, but a very few research work is carried out for treatment of wastewater of steel industries, especially in reference to development of design of industrial effluent Treatment Plants (ETP) system. Another beneficial aspect of this research work will be recycling, reuse of water and sludge from steel industry The whole technologies for treating industrial wastewater can be divided into four categories: - Chemical, Physical, Biological and mathematical approaches.

Keywords- *Waste water, Effluent treatment plants (ETP), Environmental Impact assessment (EIA), and Physical treatment.*

INTRODUCTION

Avaibility of Water and Uses

Water is one of the most vital natural resources for all life on Earth. The availability and quality of water always have played an important part in determining not only where people can live, but also their quality of life.Total utilizable water resource in the country has been estimated to be about 1123 BCM (690 BCM from surface and 433 BCM from ground), which is just 28% of the water derived from precipitation. About 85% (688 BCM) of water usage is being diverted for irrigation (Figure 1), which may increase to 1072 BCM by 2050. Major source for irrigation is groundwater. Water use can mean the amount of water used by a household or a country,

Use of Water is Categorized by following-

Commercial water use includes fresh water for motels, hotels, restaurants, office buildings, other commercial facilities, and civilian and military institutions. Domestic water use is probably the most important daily use of water for most people.

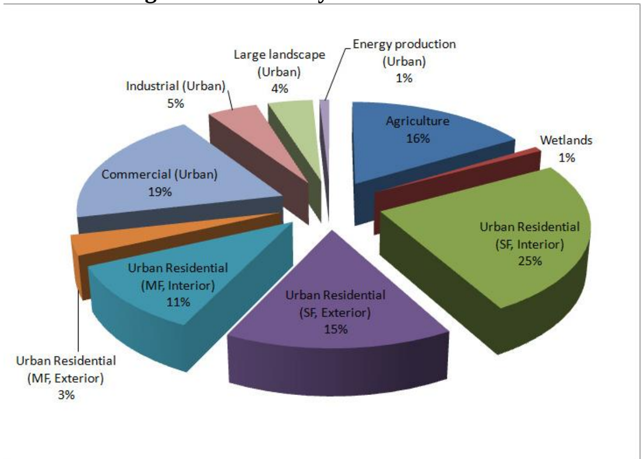
Domestic use includes water that is used in the home every day, including water for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens.

Industrial water use is a valuable resource to the nation's industries for such purposes as processing, cleaning, transportation, dilution, and cooling in manufacturing facilities. Major water-using industries include steel, chemical, paper, and petroleum refining. Industries often reuse the same water over and over for more than one purpose.

Irrigation water use is water artificially applied to farm, orchard, pasture, and horticultural crops, as well as water used to irrigate pastures, for frost and freeze protection, chemical application, crop cooling, harvesting, and for the leaching of salts from the crop root zone.
Mining water use includes water for the extraction of naturally occurring minerals; solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. The category includes quarrying, milling (such as crushing, screening, washing, and flotation), and other operations as part of mining activity. A significant portion of the water used for mining, about 32 percent, is saline.

Public Supply water use refers to water withdrawn by public and private water suppliers, such as county and municipal water works, and delivered to users for domestic, commercial, and industrial purposes. In 1995, the majority of the nation's population, about 225 million, or 84 percent, used water delivered from public water suppliers.

Fig 1 Water used by Different Sources



Wastewater can come from:

- Human excreta (feces and urine) often mixed with used toilet paper or wipes; this is known as blackwater if it is collected with flush toilets
- Washing water (personal, clothes, floors, dishes, cars, etc.), also known as greywater or sullage
- Surplus manufactured liquids from domestic sources (drinks, cooking oil, pesticides, lubricating oil, paint, cleaning liquids, etc.)
- Urban rainfall runoff from roads, carparks, roofs, sidewalks/pavements (contains oils, animal feces, litter, gasoline/petrol, diesel or rubberresidues from tires, soapscum, metals from vehicle exhausts, etc.)
- Highway drainage (oil, de-icing agents, rubber residues, particularly from tires)
- Storm drains (may include trash)
- Manmade liquids (illegal disposal of pesticides, used oils, etc.)
- Industrial waste
- Industrial site drainage (silt, sand, alkali, oil, chemical residues)

Use of Waste water and its Disposal

1. Cereals: Along 10 km stretch of the Musi River (Hyderabad, Andhra Pradesh) where wastewater from Hyderabad is disposed-off, 2100 ha land is irrigated with waste water to cultivate paddy. Wheat is irrigated with waste water in Ahmedabad and Kanpur.
2. Vegetables: In New Delhi, various vegetables are cultivated on 1700 ha land irrigated with wastewater in area around Keshopur and Okhla STPs. Vegetables like Cucurbits, eggplant, okra, and coriander in the summers; Spinach, mustard, cauliflower, and cabbage in the winters are grown at these place. In Hyderabad, vegetables are grown in Musi river basin all year round which includes spinach, amaranths, mint, coriander, etc.
3. Flowers: Farmers in Kanpur grow roses and marigold with wastewater. In Hyderabad, the farmers cultivating Jasmine through wastewater. Avenue trees and parks: In Hyderabad, secondary treated wastewater is used to irrigate public parks and avenue trees. etc

Environmental Impact Assessment (EIA)-

Environmental assessment (EA) An environmental Impact Assessment (EIA) is a way by which we can assess different factors such as impact of environmental health of human, ecological health and associated risk with it and existence of changes in services of nature in particular projects. [1]. It is the term used for the assessment of the environmental consequences (positive and negative) of a plan, policy, program, or concrete projects prior to the decision to move forward with the proposed action. In this context, the term "environmental impact assessment" (EIA) is usually used when applied to concrete projects by individuals or companies and the term "strategic environmental assessment" (SEA) applies to policies, plans and programmes most often proposed by organs of state (Fischer, 2016). Environmental assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review.

Purpose of EIA-

1. The purpose of Environmental Impact Assessment (EIA) is to identify and evaluate the potential impacts(beneficial and adverse)of development and projects on the environmental system.It is an useful aid for decision making based on understanding of the environment implications including social, cultural and aesthetic concerns which could be integrated with the analysis of the project costs and

benifits.This exercise should be undertaken early enough in the planning stage of projects for selection of environmentally compatible sites, process technologies and such other environmental safeguards.

2. While all industrial projects may have some environmental impacts all of them may not be significant enough to warrant elaborate assessment procedures. The need for such exercises will have to be decided after initial evaluation of the possible implications of a particular project and its location. The projects which could be the candidates for detailed Environment Impact Assessment include the following:-

   Industrial wastewater treatment covers the mechanisms and processes used to treat wastewater that is produced as a by-product of industrial or commercial activities. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Most industries produce some wastewater although recent trends in the developed world have been to minimise such production or recycle such wastewater within the production process. However, many industries remain dependent on processes that produce wastewaters.

Types of Wastewater Treatment Process: ETP, STP and CETP

Some of the major important types of wastewater treatment process are as follows:

1. Effluent Treatment Plants (ETP)
2. Sewage Treatment Plants (STP)
3. Common and Combined Effluent Treatment Plants (CETP).

It is estimated that every year 1.8 million people die due to suffering from waterborne diseases. A large part of these deaths can be indirectly attributed to improper sanitation.

Wastewater treatment is an important initiative which has to be taken more seriously for the betterment of the society and our future. Wastewater treatment is a process, wherein the contaminants are removed from wastewater as well as household sewage, to produce waste stream or solid waste suitable for discharge or reuse.

1. Effluent Treatment Plants (ETP):

Effluent Treatment Plants or (ETPs) are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non toxic materials or chemicals from it. These plants are used by all companies for environment protection.

An ETP is a plant where the treatment of industrial effluents and waste waters is done. The ETP plants are used widely in industrial sector, for example, pharmaceutical industry, to remove the effluents from the bulk drugs.

Need of ETP –

- To clean industry effluent and recycle it for further use.
- To reduce the usage of fresh/potable water in Industries.
- To cut expenditure on water procurement.
- To meet the Standards for emission or discharge of environmental pollutants from various Industries set by the Government and avoid hefty penalties.
- To safeguard environment against pollution and contribute in sustainable development.

Treatment Levels & Mechanisms of ETP –

- Treatment levels: Preliminary
- Primary
- Secondary
- Tertiary (or advanced)

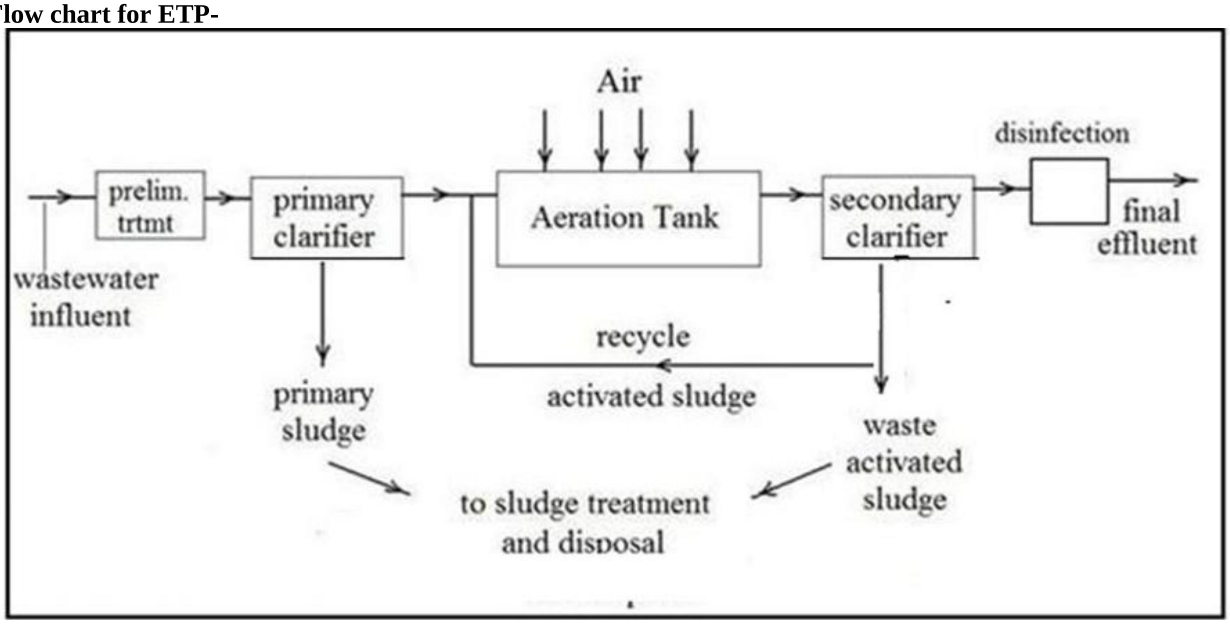
Preliminary Treatment level Purpose: Physical separation of big sized impurities like cloth, plastics, wood logs, paper, etc. Common physical unit operations at Preliminary level are: Screening: A screen with openings of uniform size is used to remove¬ large solids such as plastics, cloth etc. Generally maximum 10mm is used. Sedimentation: Physical water treatment process using gravity to¬ remove suspended solids from water. Clarification: Used for separation of solids from fluids.

Primary Treatment Level Purpose: Removal of floating and settleable materials such as suspended solids and organic matter. • Methods: Both physical and chemical methods are used in this treatment level. • Chemical unit processes: Chemical unit processes are always used with physical operations and¬ may also be used with biological treatment processes. Chemical processes use the addition of chemicals to the wastewater to¬ bring about changes in its quality. Example: pH control, coagulation, chemical precipitation and oxidation. pH Control: To adjust the pH in the treatment process to make wastewater pH neutral.¬ For acidic wastes (low pH): NaOH, Na_2CO_3¬ , $CaCO_3$or $Ca(OH)_2$. For alkali wastes (high pH): H_2SO_4¬ , HCl. Chemical coagulation and Flocculation: • Coagulation refers to collecting the minute solid particles dispersed in a liquid into a larger mass. • Chemical coagulants like $Al_2(SO_4)_3$ {also called alum} or $Fe_2(SO_4)_3$ are added to wastewater to improve the attraction among fine particles so that they come together and form larger particles called flocs. • A chemical flocculent (usually a polyelectrolyte) enhances the flocculation process by bringing together particles to form larger flocs , which settle out more quickly. • Flocculation is aided by gentle mixing which causes the particles to collide.

Secondary Treatment Level Methods: Biological and chemical processes are involved in this level. Biological unit process To remove, or reduce the concentration of organic and inorganic compounds. Biological treatment process can take many forms but all are based around microorganisms, mainly bacteria. Aerobic Processes Aerobic treatment processes take place in the presence of air (oxygen). Utilizes those microorganisms (aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass. Anaerobic Processes the anaerobic treatment processes take place in the absence of air (oxygen). Utilizes microorganisms (anaerobes) which do not require air (molecular/free¬ oxygen) to assimilate organic impurities. The final products are methane and biomass.

Tertiary / Advanced Treatment Purpose: Final cleaning process that improves wastewater quality before it is reused, recycled or discharged to the environment. Mechanism: Removes remaining inorganic compounds, and substances, such as the nitrogen and phosphorus. Bacteria, viruses and parasites, which are harmful to public health, are also removed at this stage. Methods: Alum: Used to help remove additional phosphorus particles and group¬ the remaining solids together for easy removal in the filters. Chlorine contact tank disinfects the tertiary treated wastewater by¬ removing microorganisms in treated wastewater including bacteria, viruses and parasites. Remaining chlorine is removed by adding sodium bisulphate just before¬ it's discharged.

Flow chart for ETP-



ETP Plant Operation-

1. Screen chamber: Remove relatively large solids to avoid abrasion of mechanical equipments and clogging of hydraulic system.

2. Collection tank: The collection tank collects the effluent water from the screening chamber, stores and then pumps it to the equalization tank.

3. Equalization tank: The effluents do not have similar concentrations at all the time; the pH will vary time to time. Effluents are stored from 8 to 12 hours in the equalization tank resulting in a homogenous mixing of effluents and helping in neutralization. It eliminates shock loading on the subsequent treatment system. Continuous mixing also eliminates settling of solids within the equalization tank. Reduces SS, TSS.

4. Flash mixer: Coagulants were added to the effluents:
1. Lime: (800-1000 ppm) To correct the pH upto 8-9
2. Alum: (200-300 ppm) To remove colour
3. Poly electrolyte: (0.2 ppm) To settle the suspended matters & reduce SS, TSS. The addition of the above chemicals by efficient rapid mixing facilitates homogeneous combination of flocculates to produce microflocs.

5. Clarriflocculator: In the clarriflocculator the water is circulated continuously by the stirrer. Overflowed water is taken out to the aeration tank. The solid particles are settled down, and collected separately and dried; this reduces SS, TSS. Flocculation provides slow mixing that leads to the formation of macro flocs, which then settles out in the clarifier zone. The settled solids i.e. primary sludge is pumped into sludge drying beds. ETP Plant Operation

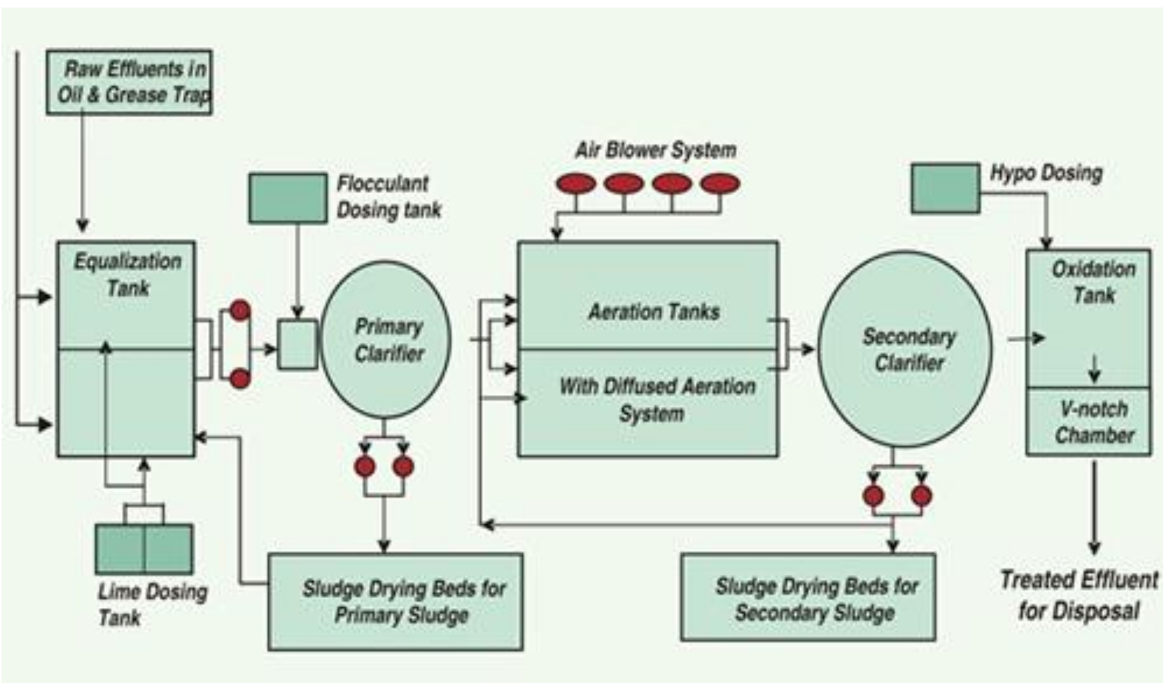
6. Aeration tank: The water is passed like a thin film over the different arrangements like staircase shape. Dosing of Urea and DAP is done. Water gets direct contact with the air to dissolve the oxygen into water. BOD & COD values of water is reduced up to 90%.

7. Clarifier: The clarifier collects the biological sludge. The overflowed water is called as treated effluent and disposed out. The outlet water quality is checked to be within the accepted limit as delineated in the norms of the Bureau of Indian standards. Through pipelines, the treated water is disposed into the environment river water, barren land, etc.

8. Sludge thickener: The inlet water consists of 60% water + 40% solids. The effluent is passed through the centrifuge. Due to centrifugal action, the solids and liquids are separated. The sludge thickener reduces the water content in the¬ effluent to 40% water + 60% solids. The effluent is then reprocessed and the sludge collected¬ at the bottom.

9. Drying beds: Primary and secondary sludge is dried on the drying beds. FLOW CHART OF ETP Influent Screening Equalization (Lime + Alum) pH = 8.5 SS, TSS removal Disperse unit RECYCLE TANK Sedimentation tank {pH = 7.5} Sludge thickening unit Biological Treatment & Aeration {Dosing = (Urea + DAP) for O2} BOD removal ~ 90% COD removal ~ 90% Sludge Sludge discharge Fish pond Effluent Effluent discharge 60% water + 40% solids 40% water + 60% solids SCREENING Screening is the filtration process for the separation.

FLOW CHART OF ETP



SCREENING Screening is the filtration process for the separation of coarse particles from influent. Stainless steel net with varying pore size can be utilized. Screens are cleaned regularly to avoid clogging.

EQUALIZATION TANK

Equalization makes the waste water homogenous.

Retention time depends upon the capacity of treatment plant. (Generally 8-16 hours)

MATERIALS AND METHODS –

Methodology: In this research paper the treatment technologies adopted for treating sewage are as follows :

A. Activated Sludge Process
B. Chlorination
C. Filtration

Sewage treatment is the process of removing contaminants from wastewater and house hold sewage, both runoffs (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 .The treatment of waste water is not only important for our own health but also to keep our environment clean and healthy.

In a sewage treatment plant, the activated sludge process is a biological process that can be used for one or several of the purposes like oxidizing carbonaceous biological matter, oxidizing nitrogenous matter: mainly ammonium & nitrogen in biological matter, removing phosphate, driving off entrained gases such as carbon dioxide, ammonia, nitrogen generating a biological floc that is easy to settle, generating a liquor that is low in dissolved or suspended material. The process involves air or oxygen being introduced into a mixture of screened and primary treated sewage or industrial wastewater combined with organisms to develop a biological floc which reduces the organic matter content of the sewage. The combination of wastewater and biological mass is commonly known as mixed liquor. In all activated sludge plants, once the sewage or wastewater has received sufficient treatment, excess mixed liquor is discharged into settling tanks and the treated supernatant is run off to undergo further treatment before discharge. Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new sewage entering the tank. This fraction of the floc is called return activated sludge. Excess sludge is called surplus activated sludge is removed from the treatment process to keep the ratio of biomass to food supplied in the wastewater in balance, and is further treated by digestion, either under anaerobic or aerobic conditions prior to disposal. Activated sludge refers to biological treatment processes that use a suspended growth of organisms to remove BOD and suspended solids. The process requires an aeration tank and a settling tank. Clarifiers are settling tanks built with mechanical means for continuous removal of solids being deposited by sedimentation. Disinfection of sewage is necessary for healthy rivers and streams .Microorganisms are present in large numbers in sewage and waterborne disease outbreaks have been associated with sewage-contaminated water supplies

CONCLUSIONS

The problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources. The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to the conventional treatment systems, constructed wetlands need lesser material and energy, are easily operated, have no sludge disposal problems and can be maintained by untrained personnel. Further these systems have lower construction, maintenance and operation costs as these are driven by natural energies of sun, wind, soil, microorganisms, plants and animals. Hence, for planned, strategic, safe and sustainable use of wastewaters there seems to be a need for policy decisions and coherent programs encompassing low-cost decentralized waste water treatment technologies, bio-filters, efficient microbial strains, and organic / inorganic amendments, appropriate crops/ cropping systems, cultivation

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