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REGULAR ARTICLE

WASTE WATER REUSE: EXTENSION APPROACH TO DEPLETING WATER RESOURCES

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SUMMARY

Vellore is a district in Tamil Nadu, India consisting of mainly villages having agriculture as the chief occupation. Dug wells are the major irrigation source. Numerous tanneries also throng the area which again necessitates large quantity of water to fulfill its requirements. Long-term water level fluctuations indicate lowering of water table in Vellore. Development of ground water in the district seeks immediate attention. Establishment of a wastewater reuse program and usage of reclaimed wastewater is a significant and reliable alternative solution. This practice has found implementation in developed nations but developing countries lack in community based application. In Vellore, the industrial wastewater from tanneries is collected in CETP's (Common Effluent Treatment Plants). In Vellore Institute of Technology (VIT, Vellore) a smaller scale wastewater treatment process is carried out using biological means. Kitchen and Bathroom wastewater is treated. (BOD: 30mg/L; COD: 250mg/L) and used mainly for watering the lawns. Such wastewater reuse to be taken up in a wider scale in the various regions to combat water shortage. Effective extension of this technique needs to be taken up for community based applications. Lowering water tables can be managed, and water for irrigation can be made available round the year through such implementations.

Key words: Water shortage, Tanneries, Wastewater recycle, Reuse, CETP, Small treatment plant

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1. Introduction

Water is one of the major depleting resources. Groundwater comprises about 20% of the freshwater. Most of the freshwater (approx 85%) is used for irrigation purposes. The population explosion, industrial pollution & overexploitation of existing aquifers combined with the uncertain availability & variability of water resources in time and region; demands sustainable development of water resources. India is a large country facing fluctuating monsoon patterns in different parts of the country and explosive population growth. This leads to water scarcity & droughts in areas across the nation in varying time periods. Added to this, the continuing opinion that water is an infinite resource further augments water shortage.

Vellore is a district in Tamil Nadu which comes under South Eastern Coastal Region of India. With the geographical area of 5920 sq. km, Vellore consists of 20 blocks under 8 talukas. Palar River provides the major drainage. The district consists of 843 villages where agriculture is the chief occupation, &, paddy and groundnut are principally cultivated. Dug wells are the major irrigation source. The long-term water level fluctuations indicate lowering of water table in Vellore. The ground water is suitable for drinking and domestic uses in respect to all the constituents, except total hardness (due to the composition of litho units constituting the aquifers), Chloride and Nitrate (high levels due to the use of fertilizers and improper waste disposal).Tannery waste has polluted water resources in many areas. Out of the 20 blocks, an estimated 16 are over exploited and 1 block is under critical category with respect to water resources. Integrated management policies may benefit the populace residing in the area.

2. Wastewater Treatment

Conventional treatment process encompasses three means: primary, secondary and tertiary.

Primary Treatment refers to treatment through physical means. It involves processes like filtration, flocculation, adsorption and sedimentation. The wastewater is passed through sedimentation tanks so that the fine solids settle by gravity; and the settleable solids form sludge in the base of the tank to be removed as primary sludge. Primary sedimentation tanks clarify sewage by floatation as well as settlement. Suspended matter which is less dense than water (such as oil, grease, fat) rises to surface and form scum. Primary treatment reduces the BOD by 30-40%, the SS concentration by 40-70% and the fecal coliforms by almost 50%.

Secondary Treatment, also called as biological treatment, involves the use of micro-organisms (mainly bacteria). After primary treatment the settled wastewater is transferred to a specially designed reactor and is exposed to dense microbial population under aerobic conditions. Microbes convert soluble and colloidal organic matter into new cells. Secondary settlement tanks separate the dense microbial biomass from the purified wastewater. The sludge from secondary settlement is different from primary sludge; and its main constituents are biological cells rather than fecal solids. Other biological unit processes are fixed film reactors, activated sludge systems and stabilization ponds.

Tertiary Treatment involves methods such as prolonged settlement in lagoons, irrigation onto grassland or via percolation areas (land treatment), or straining through a fine mash or filtration through sand or gravel. Disinfectants such as chlorine are used to inhibit pathogen outburst. Chlorine oxidizes any organic matter remaining in wastewater before it acts as a disinfectant. Non-chemical disinfection using membrane filters can also be used.

A number of advanced processes and modern technologies are available now but rarely find usage due to financial constraints. Different technologies are suited to different wastewater types. Industrial wastewater may contain large amounts of chemicals, heavy metals, dyes etc, which if released untreated; would have severe implications. Although wastewater treatment is not a prevalent technology; Vellore holds wastewater treatment plants, CETP being the pioneers.

2.1. Wastewater treatment in tannery industry – CETP Vanitech

Tannery industry in India is well developed. India annually produces around 180 million sq. m of leather, which accounts for about 10% of global production. Tamil Nadu is the chief tanning center in India and accounts for 50% of 2500 tanneries in India. Major tanneries are developed along Ambur, Chennai, Erode, Dindigul, Trichy, Ranipet and Vaniyambadi. Of the 51 CETP's evolved in the state, one is CETP-Vanitech located in Vaniyambadi. Waste effluent from 144 tanneries is treated in the CETP-Vanitech plant currently using a series of steps as depicted in Fig.1

Fig. 1: Schematic diagram representing treatment steps in CETP, Vanitech

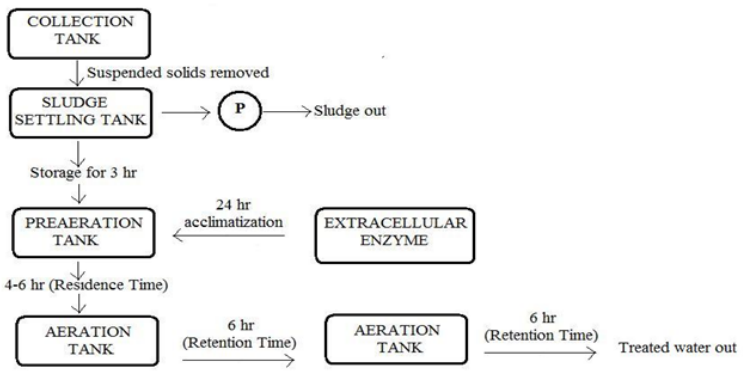


Fig 1. Schematic Diagram representing Treatment Steps in CETP, Vanitech

Around 40lakhs liters of water is treated in the plant per day. Treatment of this water up to potable water standards has been recently initiated.

2.2. Waste water treatment on small scale basis: VIT sewage plants

An example of smaller scale treatment process is in Vellore Institute of Technology (**VIT, Vellore**), where the domestic wastewater is treated by using biological means. The sewage treatment aims to stabilize decomposable organic matter present into treated wastewater and sludge without causing health hazards and nuisance. The treatment process is carried out so as to comply with the norms set by the regulatory agencies. VIT adheres to the Tamil Nadu Pollution Control Board norms. Various plants are established to treat the water emanating from different structures within the college campus. There are plants using either the Conventional Process or the ones using Specialized Reactor System.

2.2.1. Wastewater characteristics

The quality of water can be estimated by assessing the wastewater characteristics.

Comparison of the wastewater characteristics of the influent to that of effluent water in the process indicates process efficacy.

- Color: Generally, within the collection tank it is brown in color. Upon addition of the activated sludge (sent back from settling tank), it gets a thicker texture & acquires dark brown color.
- Odor: Foul-smelling. Upon prolonged stay, the odor gets stronger.
- Temperature: varies with influent water and local conditions.
- pH: Hydrogen ion concentration is an important parameter for estimating biological activity & determining wastewater quality and constituents.
- Solids: These may be classified as either suspended or dissolved; & volatile or non-volatile. Amount of suspended solid present is important for determining the load on the treatment units as well as comprehending the sedimentation process & grit removal. Sewage is abundant in organic suspended solids.
- Nitrogen: Proteins, amines, amino acids and urea are the principle nitrogenous compounds. Nitrogen determination is important in assessing the adequacy of waste with regard to biological treatment and land irrigation.
- BOD: Biodegradable matter can be estimated through it. In the test microbes are allowed to degrade the organic matter in aerobic conditions. The oxygen consumed is directly related to the amount of decomposable organic matter. The standard BOD test is carried out for a period of 5 days at 20 degree Celsius.
- COD: In the COD test, the organic matter is related to the oxygen required for its chemical oxidation. It requires lesser time than the BOD test. Also, it does not differentiate between biologically oxidizable and non-oxidizable matter.
- Chloride: Strength of waste is known by assessing the concentration of chloride above normal levels.

Influent wastewater characteristics.

S.No.	Parameter	Value
1	pH	7-8
2	Suspended Solid	100-150mg/L
3	Total Dissolved Solid	varies
4	BOD	300-400mg/L
5	COD	700mg/L
6	Oil & grease	50-100mg/L
7	Chloride	varies
8	Sulphate	varies

2.2.2. Design

The Sewage Treatment Plant design is based upon the daily average flow and the average characteristics as determined from a weighted 24 hr composite sample. The hydraulic design load varies for the various components in the plant. Grit channel, screen and the various channels, conduits etc are designed to accommodate maximum flow.

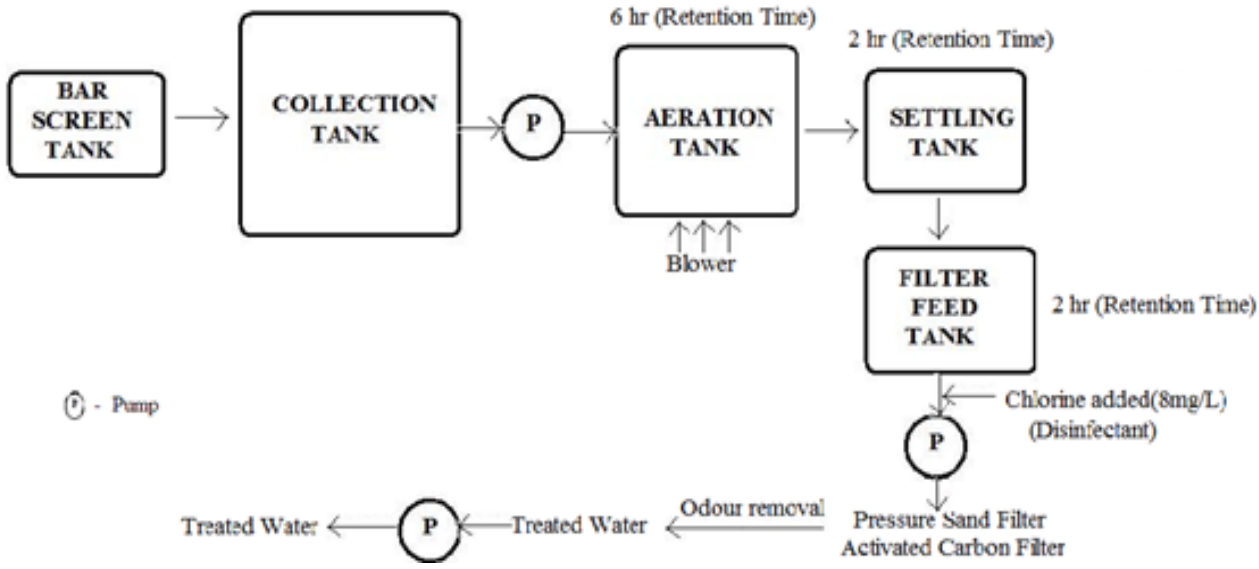
Total wastewater per day	200,000-500,000
Collection Tank (Volume)	90kLD
Aeration Tank (Volume)	25kLD
Settling Tank (Volume)	15kLD
Filter Feed Tank (Volume)	20kLD

Effluent Transfer Pump, Sludge Re-Circulation Pump, Filter Feed Pump, Blower, Pressure Sand Filter and Activated Carbon Filter are used for various purposes.

2.2.3. Operation

The main units of the plant are designed for maximum efficacy within a set flow range and effluent quality. Proper maintenance is done to keep equipment and processes functioning properly without interruption. Close control and coordination of operation of different units is maintained within the plant. Thus, flow measuring devices and meters are employed to regulate the raw sewage, settled sewage, air, sludge and effluent.

Fig. 2: Schematic diagram representing treatment steps in VIT sewage treatment plant



2.2.4. Discharge standards

S.No.	Parameter	Discharge Standard[7]
1	pH	8.5
2	Suspended Solid	30mg/L
3	Total Dissolved Solid	2100mg
4	BOD	30mg/L
5	COD	250mg/L
6	Oil & grease	10mg/L
7	Chloride	1000mg/L
8	Sulphate	600mg/L

2.2.5 Effluent wastewater characteristics

S. No.	Parameter	Value
1	Suspended solid	less than 30mg/L
2	Total Dissolved Solid	-
3	BOD	less than 30mg/L
4	COD	less than 250mg/L
5	Oil & grease	less than 10mg/L
6	Chloride	-
7	Sulphate	-

3. Analysis

In CETP Vanitech, estimated Percentage Reduction (SS 75%, BOD 92%, COD 64%) is observed. Equalization, Settling followed by Enzymatic degradation & Aeration forms the key operations. This is discharged into river streams. Reverse osmosis, Ozonisation/UV treatment further purify the water. Purification of water up to potable water standards will be taking place soon.

In VIT Sewage Treatment Plant, efficient reduction in various parameters up to the permissible limits is maintained. 91.4% of BOD and 64.4% COD reduction is done. Also, suspended solids got reduced by 76%. The treated water characteristics are regulated as per Tamil Nadu Pollution Control Board norms. Close Monitoring, routine checks and data recording are essential for accurate assessment of efficiency of operation. The various parameters including MLVSS, MLSS, F/M ratio, DO level and concentration of nutrients are closely monitored and maintained to achieve the maximum degradation of organics. ***Jar Test*** is carried out on a daily basis for monitoring purposes.

4. Effluent disposal and utilization

The kind of effluent produced by a plant is determined mainly by the treatment process employed. In Industrial Treatment processes, the treated water is reused as a substituent for clean potable water for various industrial purposes, cleaning up or maybe discharged into the streams. In a Domestic Sewage Treatment plant (as in VIT); the treated water obtained is used for the following purposes:

- Flushing and foam control
- Chlorination-injector water
- Lawn sprinkling/ gardening
- Dead Sludge as fertilizer
- General usage in plant operations

5. Conclusion

Grey water recycling, along with wastewater recycle & reuse is especially important for developing countries, to resolve the uncertain availability & variability of water resources in time and region. Vellore sets an example to other smaller cities in India & other developing nations; to manage their water resources by applying better conservation practices and management schemes. Recently, incompetent handling of the toxic wastes in CETP's has been reported by people residing in the vicinity. Many tanneries still dump their effluents into the Palar river. The various tannery associations in the district have agreed to install reverse osmosis plants in all the CETPs to meet the TNPCB standards. Better effluent disposal and monitoring practices are important to restrain such contamination. Conservation, recycling & reuse; & optimum use of water are the most obvious devices to respond to the situation. Community based common effluent treatment plants are necessary to combat the existing water crisis and irregularities. Effective policies in terms of water distribution system should be employed.

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