International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Feasibility Analysis and Design of Natural Wastewater Treatment System for Madurai City

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Abstract - *Water is the one of the important compounds that which influence the human life. Wastewater is used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or stormwater, and any sewer inflow or sewer infiltration. Initially, mankind used water for domestic purpose such as drinking, cooking, washing. However, the present uses of water may be classified as domestic, public, commercial and industrial. The water may consist of pollutants and toxic metals which are injurious and damage human health. The condition of water and wastewater compound, generally examined according to its physical, chemical and biological agents. DEWATS samples, bore water samples and Kiruthumal samples are collected from different sources and required parameters that may be tested include pH, Electric Conductivity, TDS, Hardness and Chloride content, Total Nitrogen, Oil and Grease, BOD, TSS and COD. The tested samples will be checked against the standards laid by the Indian Standards for potable water as per BIS Specifications (IS 10500-1991) or WHO Standards for potable water condition. The design of DEWATS treatment system consists of Septic tank, Anaerobic Baffle reactor with four chambers, Anaerobic filter with two chambers and constructed the Planted gravel filter for recharge and storage with proper dimensions.*

Key Words: **DEWATS, Septic tank, Anaerobic Baffle reactor, Anaerobic filter, Planted gravel filter etc**

1. INTRODUCTION

Wastewater is "used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff or stormwater, and any sewer inflow or sewer infiltration". The terms "wastewater reuse" and "water reclamation "can be applied if the treated waste is used for another purpose. Wastewater that is discharged to the environment without suitable treatment can cause water pollution. In developing countries and in rural areas with low population densities, wastewater is often treated by various on-site sanitation systems and not conveyed in sewers. These systems include septic tanks connected to drain fields, on-site sewage systems (OSS), Verm filter systems and many more. Wastewater is simply that part of the water supply to the community or to the industry which has been used for different purposes and has been mixed with solids either suspended or dissolved. Wastewater is 99.9% water and 0.1% solids. The main task in treating the wastewater is simply to remove most or all of this 0.1% of solids. The main objective of the project is to study the feasibility analysis of the natural wastewater treatment units and to assess the untreated wastewater characteristics of the Kiruthumal River in Chokkanurani

2. NATURAL WASTEWATER TECHNOLOGY

Natural technologies of wastewater treatment use modified natural self-treatment processes that take place in the ground soil, water and wetland environment. These ways of treatment are classified according to the treatment technology and general arrangement.

2.1 DIFFERENT TYPES OF NWWT

Natural treatment methods are mainly used for wastewater treatment from decentralized houses, small settlements, dwelling, hotels, recreational facilities, restaurants and summer camps, smaller municipalities or their parts, usually up to 2000 p.e. According to the composition of wastewater, these methods are also applicable for treatment of industrial wastewater from the food processing industry, trade facilities (workshops) and selected small industrial plants, landfill leachate treatment, organically low-loaded agricultural runoff and wastewater agricultural facilities, polluted storm water runoff, erosion washes of polluted surface water. Wastewater with high load of fats, oils, oil derivatives, extremely acidic or alkaline mine water, extremely polluted water from roads and car parks and industrial wastewater containing toxic substances exceeding the limits of toxicity, wastewater with the excessive content of surfactants, pesticides, radioactive substances, wastewater from hospitals, veterinary facilities, rendering plants, etc. are without pre-treatment (treatment) inappropriate to unusable for natural technologies of treatment

3. DEWATS

"Decentralized Wastewater Treatment Systems" (DEWATS) were developed by an international network of organizations and experts. DEWATS provide treatment for wastewater flows with close COD/BOD ratios from 1m^3 to

1000m^3 per day and unit. DEWATS can treat wastewaters from domestic or industrial sources. They can provide primary, secondary and tertiary treatment for wastewaters from sanitation facilities, housing colonies, public entities like hospitals, or from businesses, especially those involved in food production and processing. DEWATS can be an integral part of comprehensive wastewater strategies. The systems should be perceived as being complementary to other centralized and decentralized wastewater-treatment options. DEWATS are based on a modular, technical configuration concept. Appropriate combinations of treatment modules can be selected, depending on the required treatment efficiency, costs, land availability, etc. DEWATS applications are based on the principle of low-maintenance since most important parts of the system work without technical energy inputs and cannot be switched off intentionally. DEWATS applications provide state-of-the art-technology at affordable prices because all of the materials used for construction are locally available.

3.1 DEWATS - DIFFERENT TREATMENT DEVICES

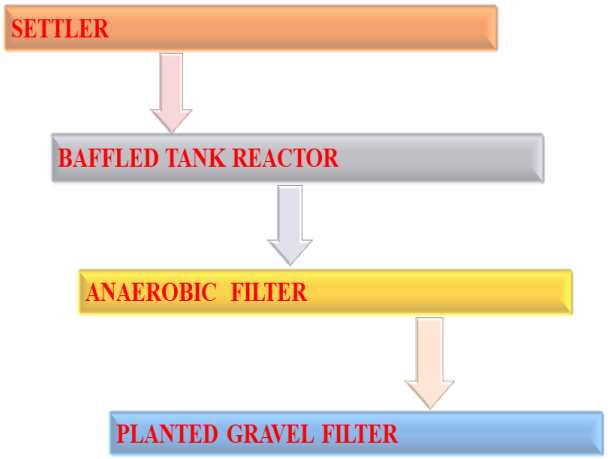


Chart -1: Dewats – Treatment Process

3.1.1 SETTLER

It is an underground constructed tank with one partition wall. A gas vent is provided between chambers and to the outside, two main treatment process are takes place, First a separation of larger solids from liquids by flotation and sedimentation. Second a stabilization and digestion of the settled sludge through naturally occurring biological treatment. Around 30% pollution removal is achieved through the settler. The settlers equipped with a sump and transfer of the pre-treated waste water flow towards the main STP's components for further processing.

3.1.2 BAFFLED TANK REACTOR

Anaerobic baffled tank reactor functions based on optimized hydraulic flow and by biological and naturally occurring chemical processes used to digest and remove most of the organic matter. It is constructed below ground level. Several chambers are constructed in series to digest degradable substances and gas vent is provided between the chambers. Baffle walls direct the wastewater stream between the chambers from top to bottom which ensure flow reparation and contact with sludge. The treatment process is carried out through the mix of fresh sewage with the active blanket of sludge, highly rich in microorganisms, growing and accumulating naturally at the bottom of each chamber. About 70% of pollution removal is achieved at the outlet of baffle reactor.

3.1.3 ANAEROBIC FILTER

Anaerobic filter functions based on optimized hydraulic flow and by enhanced biological and naturally occurring chemical processes. It is constructed below ground level. Several chambers are constructed in series and filter with a filtering media to help digesting left over substances and gas vent is provided between the chambers. Baffle walls direct the wastewater stream between the chambers from top to bottom which ensure flow reparation and contact with sludge. A filtering media, allowing widespread contact with the sewage is used to efficiently retain and digest the left-over pollutants and it works on fixed bed bacteria principle. A perforated slab is provided at the bottom of each chamber, holding the filter material. It shows around 132% pollution removal from the STP's inlet load.

3.1.4 PLANTED GRAVEL FILTER

Treatment occurs in the presence of oxygen (aerobic). Treatment Concentrates more on removal of smell and color. Planted gravel filter consists of plants (reeds) and filter materials (graded gravels, river pebbles) Filter is permanently soaked (up to 50 cm from bottom) in water.

4. STUDY AREA

Kiruthumal river is a separate river originating in the hills of Nagamalai in Thuvariman to the west of the city. The Kiruthumal river that found its way through Erkudi, Achampathu, SBOA Colony, Subramaniapuram, Makalipatti, Keeraithurai, Melavasal, Heera Nagar, Ellis Nagar, Thideer Nagar, and Samanatham met its death when the flow from Nagamalai springs was blocked and a channel was constructed to take water to the southern outskirts of the city. Till the 1960s, river Kiruthumal had a bed width of 40 feet and 11 months of water-flow. Kiruthumal river banks were adorned with plantations and the river catered to the

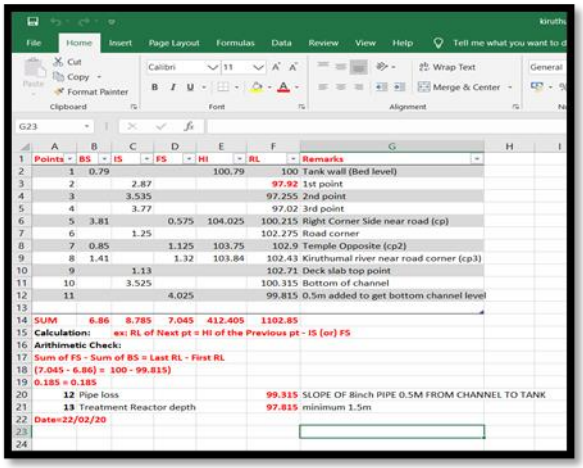
purposes of bathing, washing and agriculture in addition to its role of draining out flood water and recharging the ground water. The river got encroached and its width reduced drastically. Agricultural lands were converted for residential use. The land use changes at the original catchment, the redirection of water and the changed geomorphology of Vaigai contributed to the drying up of the Kiruthumal river, which also faced onslaught from untreated effluents and household garbage.

Fig -1: Kiruthumal River

Fig -2: Satellite Images of Kiruthumal River

4.1 FIELD SURVEYING

To measure the Level difference between the Kiruthumal River to the Chokkanurani tank by using Dumpy level and measure the depth of the tank by using Laser distance meter. From the level difference to identity the Level diagram of the tank



Points	BS	IS	FS	HI	RL	Remarks
1	0.79			100.79	100	Tank wall (Bed level)
2		2.87			97.92	1st point
3		3.535			97.255	2nd point
4		3.77			97.02	3rd point
5	3.81		0.575	104.025	100.215	Right Corner Side near road (cp)
6		1.25			102.275	Road corner
7	0.85		1.125	103.75	102.9	Temple Opposite (cp2)
8	1.41		1.32	103.84	102.43	Kiruthumal river near road corner (cp3)
9		1.13			102.71	Deck slab top point
10		3.525			100.315	Bottom of channel
11			4.025		99.815	0.5m added to get bottom channel level
SUM	6.86	8.785	7.045	412.405	1102.85	

Calculation: ex: RL of Next pt = HI of the Previous pt - IS (or) FS
Arithimetic Check:
Sum of FS - Sum of BS = Last RL - First RL
(7.045 - 6.86) = 100 - 99.815)
0.185 = 0.185
12 Pipe loss — 99.315 SLOPE OF 8inch PIPE 0.5M FROM CHANNEL TO TANK
13 Treatment Reactor depth — 97.815 minimum 1.5m
Date=22/02/20

Fig -3: Level Diagram of the River

4.2 SAMPLE COLLECTION

The Samples can be collected from the Bore water, Kiruthumal river in Chokkanurani and DEWATS in Thiagarajar college of Engineering at early morning (6 am to 8am).

Fig -4: Bore water samples

Fig -5: Kiruthumal River samples

5. RESULTS AND DISCUSSION

The Physical, Chemical and biological characteristics of the sample were determined based on APHA standards compared with Indian standards are given below.

Table -1: Physical Characteristics of Samples

SL. No	Samples	pH	TDS (mg/L)	EC (µs/cm)
1	Dewats Untreated	8.40	1280	2560
2	Dewats Treated	7.50	949	1898
3	Kiruthumal	8.78	1340	2680

Table -2: Chemical Characteristics of Samples

SL. No	Samples	TN (mg/L)	TSS (mg/L)	Oil &grease (mg/L)
1	Dewats Untreated	123	72	88
2	Dewats Treated	78.45	19	32
3	Kiruthumal	134.5	50	121.5

Table -3: Biological Characteristics of Samples

SL. No	Samples	BOD (mg/L)	COD (mg/L)
1	Dewats Untreated	34	156
2	Dewats Treated	2.5	20
3	Kiruthumal	14	240

Table 4-: Bore water Characteristics

SL. No	Samples	pH	TDS (mg/L)	TH (mg/L)	Chloride (mg/L)
1	BWS -1	9.08	2140	2540	724
2	BWS -2	9.23	1200	1680	454.4
3	BWS -3	9.15	1260	1640	411.8
4	BWS -4	8.93	1450	1500	482.8
5	BWS -5	9.23	1160	1220	326.6

6. DEWATS – DESIGN

DEWATS design is mainly depends upon the capacity of the tank. The volume of the flow in the system is **922.59** m^3 and the discharge of tank is **38.12KLD** for all treatment unit. The design of the DEWATS system consists of,

1. Settler
2. Baffle Reactor Tank
3. Anaerobic Filter
4. Planted Gravel Tank

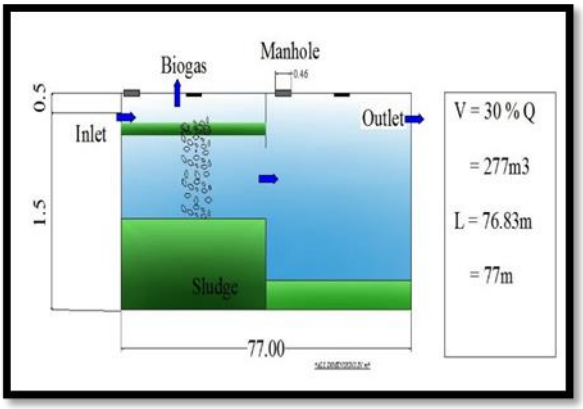


Fig -6: Septic tank design

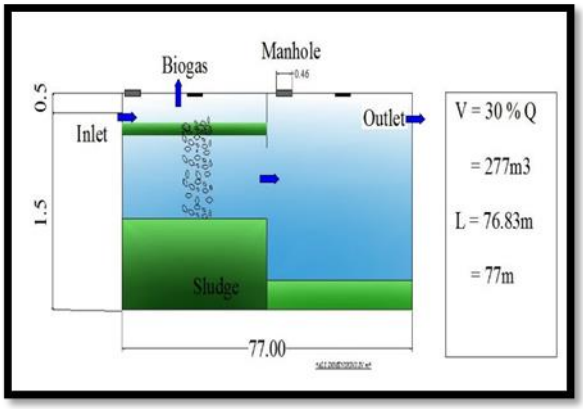


Fig -7: Anaerobic Baffle reactor design

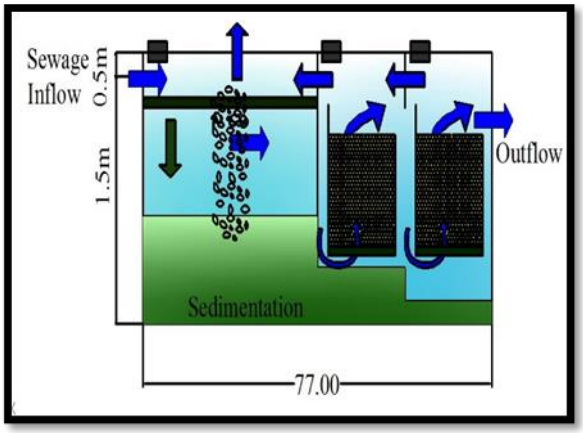


Fig -8: Anaerobic Filter design

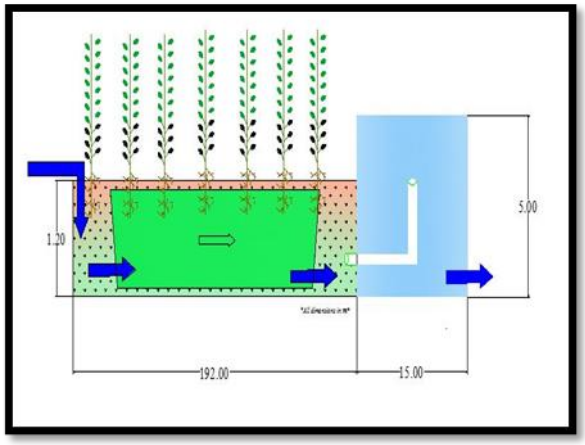


Fig -9: Planted Gravel filter design

7. CONCLUSIONS

In this study, the Physical, chemical and biological characteristics of the bore water samples and Kiruthumal river samples can be determined based on APHA standards. The bore water and wastewater samples can be collected from the Kiruthumal river near the Chinthamani Main road and also collected the samples from the DEWATS treatment units in Thiagarajar College of Engineering. The tested samples will be checked against the standards laid by the Indian standards for potable water as per BIS specifications (IS 10500-1991) or WHO standards for potable water condition. The design of DEWATS treatment system consists of Septic tank, Anaerobic Baffle Reactor with four chambers, Anaerobic Filter Reactor with two chambers and constructed the Planted Gravel filter for recharge and storage with Proper dimensions.

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