Redesign of Wastewater Treatment Plant: Case Study on Karimbanathodu Drainage Issue

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***Abstract*—Wastewater is not just sewage. All the water used in the homes that goes down the drains or into the sewage collection system is wastewater. This includes water from baths, showers, toilets etc. Small business and industries often contribute large amounts of wastewater to sewage collection systems;others operate their own wastewater systems. The study envisages one of the most socially disputed issue in Vadakara Municipality of Calicut district. The difficulties faced by the people surrounding the area includes communicable diseases, stinking environment, stagnant wastewater, improper sludge disposal etc. The major reason for these was found out to be the improper treatment of wastewater primarily because of the insufficient capacity of the existing treatment plant. Thus the study put forward a proposal to redesign the plant of 1 lakh capacity to 5 lakh capacity incorporating improved facilities such as proper sludge removal ,more efficiency, alternative waste disposal system etc. The work includes redesigning with higher capacity considering rainfall data, layout and dimensions of the existing plant.**

Keywords—Wastewater,Sewage,Capacity, Treatment plant

I. INTRODUCTION

Vadakara is located at 11.60˚N 75.58˚E which is a municipality in Calicut district of Kerala state. Geographically Vadakara is situated about 48 Km to the north of Calicut city, approximately 44 Km to the south of Kannur Corporation and is proximate to Mahe.Today Vadakara is a commercial focal point in Calicut district with all the amenities for a modern township including hospitals,schools,colleges,hotels and recreational facilities.Vadakara comprises of natural drains (Thodu),major drains,roadside drains,shoulder drains all of which discharge into the Arabian sea. The growth of Vadakara, unaccompanied by necessary infrastructure has precipitated problems by a large magnitude.The drains here are overburdened during the rainy season and Vadakara has been facing tremendous water clogging issues as well as sewerage problems virtually every monsoon. The existing infrastructure and drainage system in the town has been insufficient in handling the excess water whenever there is a downpour. Moreover the tremendous increase in population also added to the scene. Now the scenario is that people staying nearby the drains, mainly Karimbanathodu,are facing serious difficulties such as water stagnation, unfavourable surroundings, communicable diseases and other socio economic issues.

On a primary investigation it was noticed that the wastewater being collected to the already existing treatment plant was not treated properly. It was also observed that the major reason for this was the insufficient capacity of the treatment plant to meet the requirement.

Thus the major objective of the study is to put forward a solution to the drainage problem by redesigning the existing treatment plant. The plant is having a capacity of 1 lakh litres which is insufficient. So it is decided to redesign the plant with a capacity of 5 lakh litres.

II. STUDY AREA

A. General

The study area manily concentrates to the region surrounding Karimbanathodu where the drainage problem is of prime concern. The major drains in the project area is Karimbanathodu itself. This was a natural water body-turned drain which begins at Narayana Nagar ground adjacent to the existing treatment plant and flows south to the co-operative hospital area and then flows across the railway lines and finally meets the river which leads to the Arabian sea.

B. Existing plant

The existing plant under the Vadakara municipality is of 1 lakh litres capacity which was found insufficient as per the requirement. The sewage coming to the plant is first passed

through a *Bar screen* which then flows to the *Equilisation tank* an then to the *Anerobic upflow filter* tank. It is then flown to an *Aeration tank* which then moves to a *Hopper bottom settling* tank. At this stage the treated sewage goes to a *Sludge tank* and is then moved again to the aeration tank and the process continues. From the settling tank it is being carried to a *Pressure sand filter* then to pressure carbon filter and finally to the *treated water storage tank*. It is then discharged out. This is how the existing plant works.

III. CHARACTERISTICS OF WATER

The following table shows the characteristics of wastewater.

Table I Water Characteristics

Sl no:	Characteristics	Sources
1	Physical i. colour ii. odour iii. solids iv. temperature	i. Domestic and industrial wastes ;natural decay of organic materials. ii.Decomposing wastewater;industrial wastes iii.Domestic water supply iv.Domestic and industrial waste
2	Chemical	Chemical contents present in the water,DO,BOD etc.
3	Biological	Includes micro organisms present in water.

Water quality analysis is done to determine the various impurities in it. On the basis of these impurities, the treatment plant will be designed. Therfore the analysis of water is very necessarybefore designing any water supply scheme. Similarly after treatment of water , its analysis is again done to ascertain that water has been purified or not. The treated water should be free from turbidity and the pH of the water should be between 6.6 to 8.60 and free from bacteria. It must also be free from disease spreading germs. Thus inorder to discharge out the treated water , water quality tests must be carried out inorder for the justification of the proper working of the plant.This is done to compare the water quality before and after treatment. Tests for Biological Oxygen Demand(BOD), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS) etc were conducted.

Table II Test Results

TEST(RANGE)	**INFLUENT**	**EFFLUENT**
DO (>=4mg/l)	2.57	3
BOD(<30 mg/l)	279	179.5
COD (<250 mg/l)	736	640
pH (6.5-8.5)	5.71	5.64
TSS (<100mg/l)	60.45	58.35
TDS (<500 ppm)	417	404
Oil and grease (<10mg/l)	4.65	4.05
Coliform (nil MPN/100 ml)	900	500
E-coli	absent	absent

From the above table,it is clear that even after the treatment from the existing plant there is no much improvement to the treated waste water. So it is certain that the plant is inefficiently working and the study for redesigning is worth it.

A. Wastewater treatment methods

At treatment plants, this flow is treated before it is allowed to be returned to the environment, lakes or streams. Wastewater treatment plants operate at a critical point of the water cycle, helping nature defend water from excessive pollution. Most treatment plants have ***primary treatment*** (physical removal of floatable and settleable solids) and ***secondary treatment*** (the biological removal of dissolved solids). ***Tertiary treatment*** may include processes to remove nutrients such as nitrogen and phosphorous ,and carbon adsorption to remove chemicals.

B. Stages of treatment

The different stages of the wastewater treatment are briefly described below.

- **Screening:** The first operation in treatment plant wherein adevice called screen is incorporated to remove large objects coming in.
- **Plain sedimentation:** The process of removing suspended matters from the water by keeping it quiescent in tanks, so that suspended matter may settle down in the bottom due to force of gravity.
- **Coagulation:** To remove smaller particles, it must be made larger by adding coagulants such as alum inorder to remove them.
- **Flocculation:** It is the agglomeration of destabilized particles and colloids towards settlesble particles or flocs.
- **Aeration:** It involves bringing air or other gases in contact with water to strip volatile substances from the liquid to the gaseous phase and to dissolve benefecial gases into the water.
- **Filtration:** Filters are used for removing bacteria,colour,taste etc and the process of passing water through beds of sand or other granular materials is known as filtration.
- **Disinfection:** The process of killing the infective bacteria from the water and making it safe to the user is called disinfection.

IV. PROPOSED TREATMENT PLANT

The proposed treatment plant incorporates all the required aspects for the redesigning of the existing treatment plant.

The major sources of wastewater are

- Shops and hotels
- Hospitals
- Storm water

From the calculations, the quantity of wastewater generated by all the above is approximated to be 5 lakhs litres per day which is to be taken as the capacity of the proposed treatment plant. The operation time is taken to be 20 hours. The amount of water to be treated in 1 hour is calculated as 25,000 litres.

The characteristics of influent water is taken as:

Table III Design Characteristics

Sl no:	Characteristics	Range
1	Inlet BOD	300-350 mg/l
2	Temperature	28-30˚C
3	Viscosity	Normal
4	Total solids	45-50 mg/l
5	Oil and grease	3.5-5 mg/l
6	COD	650-750 mg/l
7	TDS	400 mg/l
8	TSS	60-75 mg/l
9	Coliforms	500-1000
10	E-coli	Absent

A. Layout

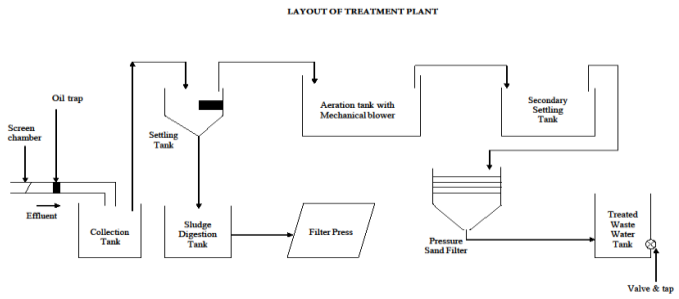

Fig. 1 Layout Of Proposed Treatment Plant

The figure given above depicts the layout of the proposed treatment plant. The different units for the treatment plant with improved design features are as follows:

i. *Screens*

A single screen is used made out of mildsteel or stainless steel. It is having a size 2.5X 2.5X 2.5m

ii. Oil trap

Only one oil trap is used made os mild steel with size 2.5 X 2.5 X 2.5 m.

iii. *Collection tank*

A single collection tank with material of construction as Reinforced Cement Concrete (RCC) with a capacity of 2 lakh litres is designed. The diameter and height of the tank is fixed to be 9m and 3.5m.

iv. *Primary settling tank*

Primary settling tank constructed out of RCC where 25,000 litres of water to be treated in 1 hour is being designed. The diameter and height of the tank is same as that of collection tank. Additional features such as alum is used as a coagulant in addition to a clarifier with a rake mechanism to avoid gas formation. Also parallel separators are provided on the top for more floc formation.

v. *Aeration tank*

BOD reduction in settling tank is expected to be 40% i.e 150 reduction. Thus BOD content in this unit is 200 mg/l. So aeration unit of capacity 2,50,000 litres made of RCC with dimensions ,diameter 9m and height 4m is designed.

vi. *Secondary settling tank*

This is also constructed with RCC having diameter of 7m and height 3.5m. Here, again a rake mechanism is provided. Bioslurry formed from this tank is recirculated to aeration tank.

vii. *Recirculation tank*

Recirculation of slurry from secondary settling tank to aeration tank is mechanised with a recirculation pump. This is also constructed in RCC with a capacity of 40,000 litres of diameter 4 m and height 3.5m.

viii. *Filtration unit*

The tank is to have a capacity of 75,000 litres made of RCC having size 5 X 5 X 3.5m which works once in 3 hours. A pressure sand filter is provided in this unit.

ix. *Treated water tank*

The treated water tank has to have a capacity of 75,000 litres made of RCC with diameter 5m and height 4m.

x. *Treatment of chemical sludge*

The capacity of this tank is also 75,000 litres. Chemical sludge formed from the primary settling tank is treated in a filter press with 30 plates with size of each plate as 32 inches.

The mechanical equipments used are given below:

i. *Effluent transfer pumps*

In total there are 5 number of pumps being used with capacity 15,000 litres per hour.

ii. *Parallel plate separator*

A single parallel plate separator made of mild steel with FRP lining inside and epoxy painting outside is to be used. A mixing box, lime tank with stirrer, reagent tank with stirrer, ladder and support structure etc are also provided.

iii. *Filter press*

The number of plates and frames used are 30 and 29 respectively, the size of each plate being 32 inches. The material of construction is filter cloth.

iv. *Filter press feed pumps*

There are two pumps of which one is standby with a capacity of 5 HorsePower (HP).

v. *Mechanical blower*

Here pumps with a capacity of 5 HP are to be used. Twin lobe blowers and fine bubble tubular diffusers are used in aeration unit.

V. ECONOMIC ASPECTS

The various economic aspects within the study are portrated below. The estimation of these gives a clear picture about the approximated cost for the treatment plant.

- Cost of concrete
- Cost of reinforcement
- Pressure sand filter
- Cost of mechanical equipments includes cost of screens, oil trap, effluent transfer pump, parallel plate separator, filter press with accessories, blower for aeration tank, filter press feed pumps, electrical works, pipes, valves, fittings, erection and commissioning.

The cost of the above features is calculated to be Rs 39,83,228.

- Cost of operation includes functioning of alum, lime, sodium hypochlorite , electric power etc. Annual operation cost of plant in 350 days (on an average) is found out to be Rs 6,38,750.

Thus after redesigning the proposed treatment plant, the overall cost by taking into account all the above aspects is estimated to be Rs 50 lakh.

VI. CONCLUSION

The proposed treatment plant for the Vadakara municipality is sufficient enough to meet the required demand where the total capacity of the new plant is 5 lakh litres. The expected cost of the new plant after redesigning is about Rs 50 lakhs.

Peak flow rate has been incorporated while designing the plant. The values of BOD, COD, Coliform, E-coli etc have been brought down to its limiting values as required. The expected life of the new plant is about 30 years. The overall cost or expense of the plant is supposed to be economical. Also it is hoped that the study will prove to be permanent solution to the Karimbanathodu drainage issue in the most efficient and systematic way.

The provision for future development of the treatment plant has been left for the upcoming years. Thus further studies and suggestions can be put forward in such areas for the full-fledged working of the plant as well as for the betterment of the area.

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