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Design of 3.5mld Sewage Treatment Plant for a Town Panchayat

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ABSTRACT: Since the inception of time, sweepers had manually collected, transported, and disposed of the waste items generated by society, including human excretion, at a safe site of disposal. This ancient method of gathering and discarding society's wastes has now been modernised and replaced with a system in which these wastes are combined with enough water and transported through closed containers while flowing gravitationally. Thus, after undergoing the necessary treatments, this mixture of water and waste—commonly referred to as wastewater—automatically flows up to a location where it is disposed of, alleviating the need for carrying garbage on people's heads or in carts. Our project's goal is to build a waste water treatment facility for the estimated population of 32.500 people and 3.5 MLD of sewage. A number of treatment sewage plant elements have been physically planned for this project. To collect domestic and household waste and remove the materials that affect the general public, a sewage treatment facility is absolutely necessary. Through this project, treated effluent or sludge that will be acceptable for disposal or reuse, which are in charge of the sewage treatment like inflow channel, have produced an environmentally safe environment. Activated sludge aeration tank, secondary clarifier, screen chamber, grit chamber design of the drying beds for sludge The entire sewage of the proposed area can be effectively and safely treated by the project's execution.

KEYWORDS:Design Approach, Sewage Treatment Plant, Sludge

I. INTRODUCTION

The process of sewage treatment involves removing impurities from waste water. To remove impurities from waste water, it makes use of physical, chemical, and biological processes.The sewage effluents after treatment can either be discharged in a body of flowing water, like a stream, or used to irrigate fields. In affluent nations like the United States, the traditional conservancy system of sanitation has been totally supplanted by this contemporary water-carried sewage system. India, a developing nation, continues to use the outdated conservancy system in a number of locations, particularly in its villages and smaller towns. Without a doubt, the metropolitan areas and a few bigger communities in our nation have already been provided with the amenities of this modern water conveyance sewerage system. As soon as funds are available, endeavours will be made to provide the remaining cities and towns with this system.However, depending on the characteristics of the source of disposal, sewage must normally be treated to make it safe before being dumped in river streams or on land. Only 20% of the wastewater generated worldwide receives adequate treatment. 1.8 million children die each year from water-borne illnesses, and 2 million tonnes of sewage, industrial, and agricultural waste are released into world rivers every day. Therefore, it is essential to treat sewage effluent in a way that improves water quality while protecting the environment.

II. STUDY AREA

The project will be located near a 3.5 MLD sewage treatment facility. In Tamil Nadu, India's Thanjavur district, Thiruvaiyaru Taluk office, The current population will be 20,000 in 2022. Three decades' worth of population were computed. In total, there are 42 panchayat villages. Thiruvaiyaru in Thanjavur district has been a developing place due to steady increase in population, there will be more generation of domestic and municipal sewage. So there is a basic need of construction of sewage treatment plant with a view of sufficient capacity to treat the sewage. A sewage treatment plant is quite necessary to receive the domestic and household waste and thus removing the materials which harms for public health. Its objective is to produce an environmental safe fluid waste and solid waste suitable for disposal or reuse.

III. METHODOLOGY

A.Population forecasting

The population will need to be calculated with consideration for all the variables influencing the project area's future growth and development in the commercial, educational, social, and administrative sectors.

Year	Population	Increase in population	Incremental increase; i.e, increment on the increase
1982	5425		
1992	8552	3127	
2002	12565	4013	(+)886
2012	16164	3599	(-)414
2022	20000	3836	(+)237
Total		14575	709
Average per decade		$\bar{x} = \frac{14575}{4} = 3643.75$	$\bar{y} = \frac{709}{3} = 236$

IV. DESIGN OF TREATMENT UNITS

Capacity of Sewage Treatment Plant

Population in the year 2052 is 32,500 approximately

Predicted population = 32,500

Water supply = 135 litres/day

Water used = 32,500× 135 = 4,387,500litres/day

Waste water generated 80% of the water consumption

= 4,387,500× 0.8 = 3,510,000litres/day

So, Sewage generated = 3.51 MLD

Design of Inlet Chamber

TWL. In inlet chamber=1863.50

Peak flow = 1.625m^3/day= 1624m^3/day = 0.2m^3/sec

Plan dimension of inlet chamber = 1.3× $1m$

Free board = 1.0m

Top of inlet chamber = RC= 1864.50m

Size of bye pass chamber by the size of inlet chamber

= 1.3× 1m(minimum size)

The outflow from the inlet chamber shall be taken to the screen chamber. A bye-pass channel 0.60 m ×1 m or 400 mm pipe shall be provided from the bye-pass chamber up to final effluent channel to meet with any exigencies of the S.T.P.

Design of Screen Chamber

Q_{max} =0.66m^3

Assumptions

Shape of bar =M.S flats

Size = 10mm × 50mm

Clear space between the bars = 20mm

Inclination of bars =80 deg

Assume,

Average velocity to screen = 0.8m/sec

At peak flow net area (inclined) required = $\frac{0.066}{0.8}$ = 0.825 sq.m

Gross inclined area = 0.082 × sin 80 = 0.080 sq.m

Provide submergence depth = 0.3m

Width of the channel = $\frac{0.080}{0.3}$ = 0.26m

Provide,

20 bars of 10mm × 50mm at 20mm clear spacing

Screen chamber will be 60cm wide

Design of Grit Chamber

Flow from screen chamber taken into grit chamber, provide in duplicate 2no. C.I. gates, one each at inlet and outlet, are provided for each Grit chamber.

Design flow = ($\frac{2.5 \times 3.510}{2}$) = 4.387MLD (or) = 4387 m^3/day

Surface loading = 1100m^3/sq.m/day

Area required = $\frac{4387}{800}$ = 5.48 sq.m

Provide 1.70m diameter (circular chamber).

Detention time = 60sec

Volume =$\frac{4387 \times 60}{24 \times 3600}$ = 3.04m^3

Liquid depth = volume/area= $\frac{3.04}{5.48B}$ = 0.554m

Size of the Grit chamber = 1.70×(0.554+0.6) = $\frac{1.7}{dia} \times \frac{1.15}{depth}$

Check for horizontal velocity

Cross sectional area of Grit chamber = 1.7×0.554 = 0.941sq.m

Velocity = $\frac{4387}{(1.7 \times 0.554 \times 24 \times 3600)}$

= 0.549m/sec

= 5.4cm/sec <18cm/sec

Assume,

Grit chamber = 0.05m^3 per 1000m^3 of sewage flow

Storage volume required = ($\frac{3510 \times 8}{24}\frac{0.5}{1000}$)=0.585$m^3$

Grit storage area = $(\pi/4) \times 1.7^2 = 2.27m^2$

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Grit storage 1 depth = 0.554+0.2577 = 0.811 = 0.8m
Provide Grit chamber of size
$=1.7\times(0.8+0.6)=1.7m\times1.4m.$
Outer flow from Grit chamber shall be carried to the aeration tanks through a 600mm wide R.C.C. channel provided with fine bars screen.
The clear space between the bar shall be 10mm.

Design of Aeration Tank
No. of tank = 2
Average flow of each tank = $\frac{3.510}{2}$ = 1.755MLD
Q=1755m^3/day
Total BOD entering S.T.P= 295mg/L
y_o=295mg/L
BOD left in effluent = y_e= 20mg/L
BOD removed in activated plant
= 295-20 = 275 mg/L
Minimum efficiency required in activated plant
= $\frac{275}{295}$ = 0.93 = 93%
Let us assume MLSS
= 3000mg/L (between 0.18 to 0.10)
$\frac{F}{M}=\frac{Q}{V}=y_o$/xt
Q = 1755m^3/day
There fore,
V=?
y_o =295mg/L
X(T) = 3000mg/L
F/M= 0.12
0.15=(1755×295)/V× 3500
V = (1755×295)/(3000×6.12)
V= 1438.121m^3
Aeration tank dimensional :
Adopt as liquid depth 3.5m and 9m width then.
Length of the tank
V/B.D= $\frac{1438.12}{9\times3.5}$ = 45.65 = 46m
Volume provided = $\frac{V}{B.D}=\frac{1438.12}{9\times3.5}$ = 1449m^3
1.Check for Aeration period:
t= $\frac{V}{Q}$=24n = $\frac{1449}{1755}\times24$ = 19.81n
2.Check for Volumetric Loading:
= $\frac{Q.y_o}{V}$ gm of BOD/m^3 Vol.of tank
=$\frac{1755\times295}{1449}$ gm/m^3= 359 gm/m^3 =337.29gm/m^3
=0.35kg/m^3
3.Check for return sludge ratio = $\frac{QR}{Q}=\frac{X_T}{(\frac{10^6}{SVI}-X_T)}$
Using SVI = 100ml/g; X_T = 3000 mg/l
RD/Q =$\frac{3000}{(\frac{10^6}{1000}-3000)}$ = 0.43
4.Check for S.R.T.
V.X_T=$\frac{\alpha.Q(y_{0-}x_g).\theta c}{1+Ke.\theta c}$
$\alpha=1.0(constant)$
$K_c=0.06\ d^{-1}$
y_o = 295mg/l
$y_g=\frac{20mg}{l}$
V= 1438.2m^3
X_T = 3000 mg/l
Q =1755$m^3\ /day$
1438×3000 = $\frac{1.0\times1755\,(295-20)}{1+1.06\theta c}\theta c$
1438× 3000 = $\frac{1.0\times1755\,(295-20)}{1+0.06\theta c}\theta c$
1+0.06θc = $\frac{1.0\times1755\,(275)}{1438\times3000}\theta c$
1+0.06θc=0.11187θc
1=0.11187-0.06θc = 1= 0.0518 θc = θc 19.3 days
Assume,
BODs applied to each tank = 295mg/l
Average flow in each tank = 1755 m^3/day
BODs to be removed in each tank = 1755× 0.295 = 517.72kg/day
=8 kg/hr
Oxygen requirements = 1.2 kg/kg BOD applied
Peak oxygen demand = 125%
Oxygen transfer capacity of aeration in standard conditions
= 1.9kg/k wn =1.41kh/HP/hr
At field condition :
=0.7× 1.41 = 0.98kg/hr
H.P of required = $\frac{12}{0.98}Hp=12.34\ says\ 14Hp.$

Design of Secondary Clarifier
No. of clarified :1 no
Avg.flow = 3510 m^3/day
Provide hydraulic detention time = dhrs
Volume of tank = 5265× $\frac{2}{24}$ = 438.75m^3
Assume liquid depth = 3.5m
Area = $\frac{438.75}{3.5}$ = 123.35m^3
Surface area to be provided = 3510/15 = 234 m^2
Diameter of circular tank(d)
d= $\sqrt{234\times\frac{4}{\pi}}$ = 17.265m
Actual area provided = 85 sq.m
Check for weir loading
Arrange flow = 3510 m^3/day
Weir loading =3510/$\pi\times17$ = 65.75m^3/day/m
Provide peripheral lander
Check for solid loading
Recirculated Flow = 1755m^3/day
Average flow = 3510 m^3/day
MLSS in the tank = 3000mg/l
Total solids in flow = (3510+1755)× 3 =15795kg/day
Solid loading = 15795/234=67.5 kg/day/m^2

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Provide a clarified of 11mm diameter having liquid depth 3.5m
Topper slope area be 1 in 12. F.6-0.3M
Return sludge pump house
Total Return flow = 1755 m^3/day = 1.21875 m^3/day
Detention time = 15 min
Volume of wet well = 1.218×15=18.27 m^3
Provide 2 nos Pumps each of 1.75 MLD
Capacity in dry for returning the sludge to aeration tank
The returning sludge pipe line could be 150mm Ø

Design of Sludge Drying Beds
Sludge applied to drying beds @ 100kg/MLD
Sludge applied = 125 kg/day
Specific gravity = 1-015
Solid contents = 1-5%
Volume of sludge = $\frac{125}{1.5\%} \times \frac{1}{1000 \times 1.015}$ = 8.2 m^3/day
Total no. of cycle in one year = 33
Period of each 365/33=11 days
Volume of Sludge cycle = 8.2× $11 = 90.2m^3$
Spreading layer of 0.3 /cycle Area of beds
Provide 4 beds of 90.2/0.3=300.67
1.2m× $7m$
Providing $336m^2$
Filtrate pump house and bars,
Actual BODs removed 20 deg. Per day
= 3510×(295-20)/100= 965.25 kgm
Excess water sludge
θ_c = v.$\frac{X^t}{Qw \times R}$
$Qw \times R$= $\frac{1449 \times 3000}{19.3}$ = 22523g/d
QW× R = 22.5 kg/d
Thus excess Sludge provided = 22.5kg/l
Assuming the exam Sludge to contain 1% solids and specific gravity
=1.015
Volume of excess sludge =$\frac{22.5}{1.7 \times (1000 \times 1.015)} \cdot \frac{m^3}{d}$
= 2.216m^3/d
=22.5× $100/(1000 \times 1.015)$= 2.216 m^3/d = 0.092m^3/hr
Taking Detention time at 8 hrs.
Volume of wet well = 8× $0.092 = 0.736m^3$ for 1 % concentration
Provide liquid depth = 1m
Area required for 1% concentration of solids 0.736/1=0.736m^2
Dia of wet well = $\sqrt{0.736 \times \frac{4}{\pi}} = 0.968$
Assume 1m dia .

III. CONCLUSION

By this project we designed the various treatment units of a sewage treatment plant.Our project focused on the analysis and design of a sewage treatment facility for the people who live in the Thiruvaiyaru in the Thanjavur district. The sewage treatment plant's intended characteristics and considerations are provided. 30 years should pass during the design phase. 32,500 people are anticipated to live there in 2052.

It has been determined that installing a sewage water treatment unit on the property will allow the community to save water in a wise way. This project demonstrated that, with the proper treatment, sewage water may be used Regular sample analysis will reveal the effectiveness and essential actions for the treatment units through ongoing, maintenance of the treatment units. A single person may conserve a staggering quantity of potable water throughout the course of his lifetime. Reusing sewage water not only reduces the need for potable water but also paves the way for smart water management, which is currently crucial.

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