Design of Sewage Treatment Plant for Peri Education

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Abstract— One of the most important and valuable land resources for humans and all other living things on the planet is water. Regretfully, pollution and contamination are spreading quickly. This was primarily caused by industries disposing of waste untreated into adjacent bodies of water, such as lakes, ponds, and rivers. Every educational institution needs a suitable treatment facility to handle the sewage that is produced there. Thus, a sewage treatment plant with enough capacity to process the sewage must be built for the PERI EDUCATION. Prior to designing the sewage treatment plant, a study on the characteristics of the wastewater will be conducted. The pH value, total solids, total suspended particles, hardness, alkalinity, fluoride, iron, ammonia, nitrate, and phosphate are all analyzed as part of this research study. A sewage treatment plant is quite necessary to receive the hostels, college and canteen waste water and removes the materials which pose harm for general public environment. 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 (usually as farm fertilizer). The main purpose of Sewage treatment process is to remove the various constituents of the polluting load: solids, organic carbon, nutrients, inorganic salts, metals, pathogens etc. Effective wastewater collection and treatment are of great importance from the standpoint of both; environmental and public health. Sewage/Wastewater treatment operations are done by various methods in order to reduce its water and organic content, and the ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socioeconomic concerns. This project deals with the proper design of a complete treatment of sewage and its major components such as storage tank, screen chamber, primary sedimentation tank, ASP (activated sludge process), secondary sedimentation tank.

Index Terms- sewage, BOD, Solids, ASP, public health. Sewage

I. INTRODUCTION

Sewage and sewage effluents are the major sources of water pollution. Sewage is mainly composed of human fecal material, domestic wastes including wash-water and industrial wastes. The growing environmental pollution needs for decontaminating waste water result in the study of characterization of waste water, especially domestic sewage. In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants.

Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. It includes physical, chemical, and biological processes to remove various contaminants depending on its constituents. Using advanced technology it is now possible to re-use sewage effluent for drinking water.

1.1 DEFINITIONS

Sewerage: the system by which waste matter is carried away in sewers and made harmless.

1. Sewage: waste matter such as faeces or dirty water from homes and factories, which flows away through sewers.
2. Storm water: water that comes from precipitation and ice/snow melt – it either soaks into exposed soil or remains on top of impervious surfaces, like pavement or rooftops.
3. Activated sludge: the type of wastewater treatment process for treating sewage or industrial wastewaters using aeration and a biological floc composed of bacteria and protozoa.

4. MLSS: the amount of suspended solids in the mix of raw water and activated sludge.
5. Sludge age: the average residence time of biological solids in the system. It can be defined as the average life span of bacteria in the system.
6. Over flow rate: the discharge per unit of plan area
7. Food to Micro-organisms ratio: the ratio between daily BOD loads applied to aerator system and total microbial mass in the system.

1.2 OBJECTIVES OF THE STUDY

1. To design the sewage treatment plant in PERI EDUCATION.
2. To characteristics the sewage wastewater coming from hostel, college and canteen for physico-chemical parameters and then comparison with the prescribed standard

II. LITERATUTE REVIEW

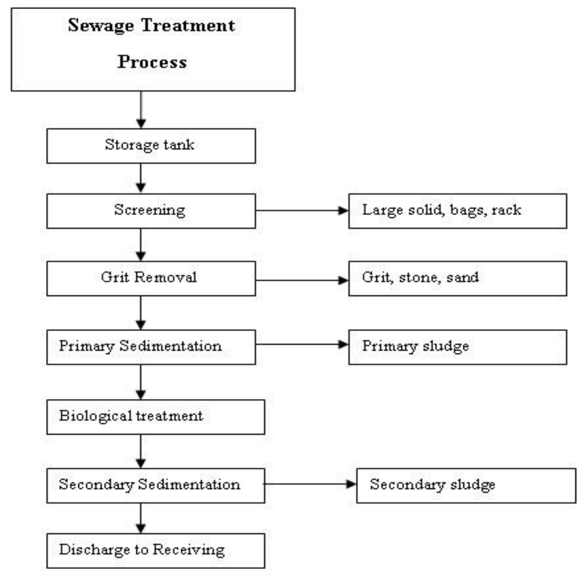
2.1 Puspalatha et.al (2016) reviewed on design approach for sewage treatment plant. A case study of srikakulam greater municipality. The present study involves the analysis of parameters like BOD, raw sewage, effluent. The construction of sewage treatment plant will prevent the direct disposal of sewage in nagavali river and the use of treated water will reduce the surface water and contaminated ground water.

2.2 Chakar bhushan et al. (2017) reviewed about design of sewage treatment plant for lohegaon village, Pune. This project studied that social and environmental pollution issue due to sewage is disposed in some part of village and directly sewage drain in open land. It is used for recharging sub surface water level at lohegaon and used for irrigation purpose.

2.3 M. Aswathy et al.(2017) studied on analysis and design of sewage treatment plant of apartment in Chennai. This project is studied that domestic and commercial waste and removes the material with possess harm from generated public. To produce an environmental sewage fluid waste stream and solid waste suitable from disposal of use.

2.4 S. Ramya et al.(2015) reviewed on design of sewage treatment plant and characteristics of sewage. The growing environmental pollution need for decontaminating water results in the study of characterization of waste water especially domestic sewage. The waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants.

III. METHODOLOGY



IV. CHARACTERSITICS OF WASTEWATER

4.1. INITIAL CHARACTERISTICS OF WASTEWATER

Table 4.1 Initial characteristics of wastewater

COLLEGE POPULATION	NUMBER OF THE POPULATION
Total students	1671
Total staff workers (teaching & Non teaching)	142
Total Workers	103
Total Population	1916- 450 [1466]
Per captia demand	45 per head
Water demand	65970 l/ day + 60750 l/day = [126720l/day]
Sewage demand	= 101376 l/day =0.0012 m^3/s
Peak factor, Q max	=0.0012 * 3 = 0.0036 m^3/s

4.2 Quantity of sewage generation from hostel and college

Table 4.2 Quantity of sewage generation from hostel and college

S.NO	PARAMETERS	UNITS	RESULTS	PERMISSIBLE LIMIT
1	pH	-	6.8	6.5-8.5
2	Total dissolved solid	mg/L	1458	500
3	Total solid	mg/L	3108	1000
4	Total alkalinity	mg/L	439	200
5	Total hardness	mg/L	940	300
6	Fluoride	mg/L	0.34	1
7	Iron	mg/L	8.6	1
8	Ammonia	mg/L	104	1.5
9	Nitrate	mg/L	0.18	45
10	Phosphate	mg/L	9.2	1
11	Free residual chlorine	mg/L	0.1(lower)	0.2
12	BOD	mg/L	480	30
13	COD	mg/L	1460	250

V. DESIGNING

5.1 DESIGN OF STORAGE TANK

Maximum Quantity of sewage produced/ day = 0.0036X (24X 60 X 60) = 31m^3

Volume / day = 311m^3

Since volume of tank is large. Tanks are divided into two tanks.

Volume = 311/2

= 156 m^3

Hence provide two as a volume from IS 3370 Part 4

Depth of the inlet tank (2 to 4m)

In Rectangular tank, the water is only stored for 12 hr

Volume of tank = 156 / 12

= 13 m^3

Area of the tank = volume/ depth

= 13/2

=6.5 m^2

Assume L:B=1.5 :1

Area of tank = 6.5

LX B =6.5

1.5 B^2 =6.5

Breadth = 2m

Length =3m

Hence provide 2 tank of rectangulat storage tank with length and breadth 3 X 2 (m)

Velocity of flow in the storage tank= Vol/Surafce area

= 13/6

=2 m/s

Assume inlet and outlet pipe dia =0.15 m

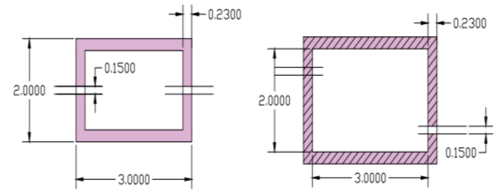


Figure 1.1 Plan and section of storage tank

5.2 SCREENING

The first unit operation generally encountered in wastewater treatment plants is screening. A screen is a device with openings, generally of uniform size, that is used to retain solids found in the influent wastewater to the treatment plant.

The principal role of screening is to remove course materials from the flow stream that could: 1. Damage subsequent process equipment. 2. Reduce overall treatment process reliability & effectiveness, 3. Contaminate waste way.

There are two types of screening processes 1. Manually Operated 2. Automatically

1. Coarse screens (Bar Racks)
2. Fine screens
3. Micro screens.

5.2.1 DESIGN CRITERIA:

- Screen chamber is designed for peak flow.
- Area of screen opening=2 to 2.5 times the area of incoming pipe
- Depth of submergence over the crown of the pipe=75 to 100cm.
- Detention time=2 to 5 minutes
- Width of chamber=2 times width of the screen.
- Size of bars
  - Width = 25 to 50mm
  - Thickness = 10 to 20mm
  - Width of bars is placed parallel to the flow
- Clear opening = 25 to 50mm
- Width of end clearance = same as opening
- Angle of screen = 45° to 60°.
- Shape and material of the bar = M.S. Flats
- Inclination of bars with horizontal = 800 (cleaning manually)
- 2 numbers of screen chambers/ channels shall be provided as per sound engineering practice. The

flow from the inlet chamber to screen channels shall be controlled by C.I. penstock gates.

5.3 DESIGN OF SCREENING

Peak discharge of storage = 0.0036 m3/s

The velocity at average flow is not allowed to exceed 0.9 m/s

Vertical projected area of screen, A

= (0.0036 / 0.9)

= 0.004 m^2

Vertical projected gross area of screen

Thickness = 10 mm

Width = 25 mm

Clear spacing = 30 mm

Total area =0.004(25+10/30)

=0.0065 m^2

The screen is inclined @ 45 degree

Horizontal gross sectional area of screen

= area / sin 45

= 0.0065/sin45

=0.01m^2

If 20 no of bars are provided, then no of openings = 21

Width of screen = (no of bars * thickness)+ (no of opening * spacing)

= (20 *0.01) +(21 * 0.03)

=0.83 m

Assuming depth as 0.9 m including free board. Coarse screen channel is designed for the size of 0.83 m X 0.9 m

Provide 20 bars of 10mm X 25 mm at 30mm clear spacing Screen chamber shall be 83 cm wide.

Assumption:

U/S of screens, 2 Nos. C.I. penstock gates shall be provided (one for each channel).

Min. drop of 150 mm shall be provided in the bed of screen channel.

The size of the penstock gates: 2Nos. of 350X450 mm size be provided.

Table 1.3. Results of screen chamber

S.No	Design parameters	value
1	Peak flow through coarse screen	0.0036 m^3/s
2	Velocity through the screen	0.9 m/s
3	Clear opening area	0.01 m^2
4	Clear opening between bars	0.03 m
5	No of clear opening in coarse screen	21
6	Width of channel for coarse screen	0.83
7	Depth of channel for coarse screen	0.9

5.4 DESIGN OF GRIT CHAMBER

Grit chamber are basin to remove the inorganic particles to prevent damage to the pump and to prevent their accumulation in sludge digestors.

Grit chamber are nothing but like to sedimentation tank, designed to separate the intended heavier inorganic materials and to pass forward the lighter organic materials. Hence flow velocity to neither be too low as to cause the settlement of the slit and grit presence in the sewage. This velocity is called differential sedimentation and differential scouring velocity. The scouring velocity determines the optimum flow through velocity.

5.4.1 DESIGN CERTERIA

- Velocity of flow through grit chamber: 0.15 to 0.3m/s
- Minimum width of chamber = 0.45m
- Detention period = 30 to 90 seconds
- Surface loading rate =1.5 to 2.56 $m^2/100m^3/hr$ oh peak flow
- Free board = 0.3 to 0.6m
- Quantity of grit accumulation $0.06m^3/MLD$ of sewage cleaning interval=3 days

5.5 DESIGN OF GRIT CHAMBER

Flow from screen chamber shall be taken into grit chamber, provided in duplicate. 2 Nos. C.I. gates, one each at inlet and outlet, are provided for each grit chambers. One more C.I. The gate shall be provided at the inlet to bye-pass channel in between two grit chambers.

Design flow = 311 m^3/day

Assume Surface loading = 500-1100 $m^3 /m^2 /day$

To account for turbulence and short circuiting, reduce the surface loading to about $500m^3 /m^2 /day$

Area required = 311/ 500 = 0.622 m^2

Provide 1 m dia. chamber (if circular), or 1X 1 m square chamber (if square).

Detention time = 60sec

Volume = (311X 60) / (24 X 3600) = $0.35m^3$

Depth = .35m^3 / 0.622m^2 = 0.6 m
Size of the Grit chamber = 1.0m X 1.0m (dia. or side) X 0.6 m (i.e. 0.6 + 0.5 F.B. =1.1 m)
Check for Horizontal Velocity Velocity = 311 / (1 X 0.6 X 24 X 3600) = 0.006 = 0.6 cm / sec < 18cm / sec. Hence Ok
Grit generation = 0.05 m3 per 1000m3 of sewage flow (Assume)
Even though Grit is continuously raked, still 8 hours of grit storage is provided for average flow.
Storage Volume required = (311 X 8 / 24) X (0.05 / 1000) =0.005184 m^3
Grit Storage area = (π/4) X 1 = 0.785 m^2
Grit Storage depth = 0.028 /0.785 = 0.035 m^2
Total liquid depth = 0.6 + 0.035 = 0.64

- = 0.65m

Provide grit chamber of size = 1.0 X 1.0 X 1.15 (depth). Assume inlet and outlet pipe diameter as 0.15 m and wall thickness 230mm
Note: Parshall Flume and measuring arrangement has not been proposed for two reasons viz:
a) The measuring instruments are rarely working satisfactorily at any plant.
b) The plant is very small, to seconomize the cost

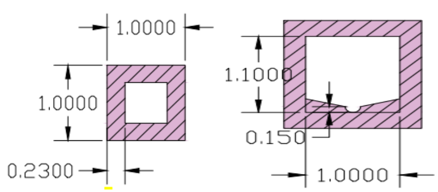


Figure 1.2 Plan and section of Grit chamber

5.6 SKIMMING TANK

It is generally the standard parameters of skimming tank are length should be in between 0.6m to 1m, width should be in between 0.5m to 1m, depth should be in between 1m to 1.5m. After designing the skimming tank obtained values are length is 0.83m, width is 0.8m, and depth is 1m.

4.8 DESIGN OF SKIMMING TANK

Surface area of tank
A= 0.00622 X q / Vr
q= rate of flow sewage (m^3/day)
Vr = min rising velocity of the oily material to be removed in m/min
q= 0.0036 * 60*60*24
= 311 m^3/day
Vr= 0.25 m/min
= 0.25 *60*24
= 360 m/day
Area (A) =0.00622 * 311/360
= 0.0054 m^2
Provide the depth of the skimming tank (1 to 3 m) = 2m
The length breadth ratio is 1.5 :1
Area = L *B
0.0054= 1.5 B2
B= 0.06 m
L =0.12 m
Skimming tank is designed for the size of 0.12 m*0.06 m*2m

4.10 DESIGN OF PRIMARY SEDIMENTAION TANK

Total amount of water to be treated =0.0036 m^3/s
Quantity of sewage to be treated for 3 hr (2 to 3hr)
Volume = discharge * detention time
= 0.0036 * 3 * 3600
=40 m^3
Provide depth = 2 to 4 (3m)
Surface area = volume/ depth
= 40 / 3
= 15 m^2
Diameter of tank = 4.5 m
Free board =0.5 m
Hence actual depth = 3+0.5 = 3.5 m
Primary sedimentation tank is designed for the dimension of 3.5 m * 4.5 m

4.11 DESIGN OF ACTIVATED SLUDGE PROCESS

Quantity of sewage = 0.0036m3/s
=311 m3/day
We know that ASP unit
Initial BOD = 480 mg/L
Final BOD = 30 mg/L
Efficiency (η) = [initial BOD- final BOD/ initial BOD] *100 = (480-30)480 *100
= 93.75%
Therefore for η between 82-92
We have,
F/M = 0.3
MLSS = 2000 mg/L
Now, F/M = (Q * Y0)/V * Xt 0.3= (311*480)/V * 2000
V= 250 m3

- Check for HRT

t = v/Q
= 250*24/311
= 19 hr

Check for volumetric loading rate

VLR = .311 * .480/.250
= 0.6 Kg/day/m^3 (within the limit less than 0.8 Kg/day/m^3)

Tank dimensions

Depth = 3m

Breadth = 3 m

Total length of aeration tank = V/bd = 40 /(3*3.5)
= 3.8 m

Provide 2 baffles gives 3 sections

- Length of each tank = 3.8/3= 1.3 m

Providing, Thickness of baffle = 0.2 m

Total width = (3*1.3) + (3*0.2) =4.5 m

Over all dimensions= 1.3 m* 4.5m * 3.5m

Air requirement

Assuming air= 100 m3/day/Kg of BOD removal

Air required = .311 *(480-30) *100= 5.76 m^3/min

4.12 DESIGN OF SECONDRAY SEDIEMNATION TANK

Average flow, Q	= 0.0036 m^3/s
	= 311m^3/day
Recirculated flow	= 53 % of Q
Re-circulated flow	= 163 m^3/day
Detention period	= 2 hours
Total in flow	= 311+ 163
	= 480 m^3/day
Volume of tank	= 480*(2/24)
	= 40 m^3

Providing liquid depth = 3.5 m

Surface loading rate= 30m^3/day/m^2

Area of tank = 311/3.5= 88 m^2

Diameter = 10m

Secondary sedimentation tank = 10 m* 3.5m

VII. CONCLUSION

1. The project deals with design parameters of sewage treatment plant.
2. The design has been done for predicted population of 15 years (2020-2035).
3. Although the project and the data helps in DESIGN OF SEWAGE TREATMENT PLANT in future.
4. The plant is designed perfectly to meet the needs and demands of appropriate 7500 population with a very large time period.
5. The treated sewage water is further used for the irrigation, fire protection, and toilet flushing in public, commercial and industrial buildings and if it is sufficiently clean, it can be used for ground water recharge.

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