Feasibility of Sewage Treatment Plant Establishment in Poornima Group of Foundation

Vedprakash Saini
Assistant professor, Department of Civil Engineering
Poornima Group of Institutions (PGI)
Jaipur, Rajasthan (India)

Brijesh Kumar Saini
Assistant professor, Department of Civil Engineering
Swami Keshvanand Institute of Technology,
Jaipur, Rajasthan (India)

***Abstract*– The Poornima group of foundation is one of the most important educational institutes in the state of Rajasthan with a large number of students residing in its campus consisting of a number of laboratories of various departments, residential units, academic blocks and number of hostels. A study on commercial waste water characterization has been performed followed by the design of sewage treatment plant. The present study involves the analysis of pH value, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, BOD, DO and heavy metals such as Iron, Copper, Zinc, Magnesium, Nickel, Chromium, Lead, Calcium, Aluminum, Silicon, Potassium. A sewage treatment plant is quite necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. 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).**

Keywords- Screening, detritus tank, trickling filter, pollutant of sewage, design steps of sewage treatment plant.

I. INTRODUCTION

Pollution in its broadest sense includes all changes that curtail natural utility and exert deleterious effect on life. The crisis triggered by the rapidly growing population and industrialization with the resultant degradation of the environment causes a grave threat to the quality of life. Degradation of water quality is the unfavorable alteration of the physical, chemical and biological properties of water that prevents domestic, commercial industrial, agricultural, recreational and other beneficial uses of water. 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.

Environmental pollution the growing 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.

II. POLLUTANTS IN WASTEWATER

The three chief categories of pollutants in wastewater are the dissolved and suspended solids and the water-borne organisms. These are tabulated hereunder-

TABLE I. POLLUTANTS IN WASTEWATER

DISSOLVED SOLIDS	SUSPENDED SOLIDS	
Inorganic Biodegradable, Water	Biodegradable, Water	Biodegradable,
Compounds Solubl Organic	Insoluble Organic	Water Insoluble
Compounds (BOD)	Compounds (COD)	Organic
Such as Starches,	Such as Tannin,	Compounds
Fats, Carbohydrates,	Lignin, Cellulose,	Resistant
Proteins, Alcohols,	Phenols, Detergents,	to Bacterial
Fatty and Amino	Petroleum Products,	Decomposition
Acids	Pesticides,	
Esters	Insecticides, Industrial	
	Chemicals and	
	Hydrocarbons	

The present study comprises the study on quality of domestic waste water that is discharged from the Poornima group of foundation of the Jaipur city, through the hostel kitchen outlets and bathroom effluents. The study includes characterization tests for pH value, acidity, alkalinity, chloride, turbidity

III. DESIGN OF SEWAGE TREATMENT PLANT

Quantity

1) Population =10000
2) Assumed rate of water supply =180 l/c/d
3) Total water supplied =1800000 l/d
4) avg. quantity of sewage generated=1440000l/d
=1440cum/day
5) Peak factor =3
6) Max. Design flow =4320cum/day

A. Collection Pit

There are many types of waste water collection system. In general, a collection system is located at or near the point of waste water generation and is designed to receive one or more waste water streams and then to direct this streams to treatment and or storage systems.

Calculations

1) Retention/detention time = 4hr

2) Capacity of collection sump = Retention time*Avg quantity of sewage

= 4*1440*24/1000=138

3) Assumed depth = 4m

4) Area of collection pit = Capacity/ depth

= 34.5sq m

5) Radius of circular tank = π /4*d2

= 4m

6) Volume of pit = π /4*d*r

= 600m3

B. Screens

IS-6280-1971 code is used for sewage screens

1) Assumed velocity of flow - 0.8m/s

2) Assumed bar's inclination with vertical 45°

3) Sin45° - 0.707

4) Assumed bar thickness – 9mm

5) Assumed bar length - 50mm

6) Assumed bar spacing - 36mm

7) Channel width - w

8) Water depth in channel - d

9) Assumed d/w = 1.5

10) Channel cross-section area = Quantity/velocity of flow

=0.15625sq m

11) w = (Area/1.5)0.5

= 0.322749m

12) d = Assumed (d/w)*w = 0.484133 m

13) Bar screen cross-section = area/sin45°

= 0.221004 sq m

14) Flow area of bar screen = bar screen cross-section (spacing/(spacing + thickness))

= 0.176803 sq m

15) Number of bars in screen = (n*t)+(n-1)s =w

= 8.0

C. Grit Chamber

Grit is the heavy mineral material found in raw sewage and it may contain sand, gravel, silt, cinders, broken glass, small fragments of metal and other small inorganic solids in waste water. Grit has a specific gravity ranging from 2.4 to 2.65.

IS-1597(Calculations Part 1 & 2)-19675 is used for grit removal

1) Assumed hoz. Velocity of flow - 0.3 m/s

2) Assumed depth of chamber - 1 m/s

3) Assumed settling velocity of particles - 0.02 m/s

4) Area of tank = Quantity/velocity of flow

= 0.416667 sq m

5) Width of tank = Area/depth

= 0.416667 m

6) Detention time = depth/settling velocity of particles

= 50sec

7) Length of tank = hoz. Velocity of flow*detention time

= 15m

D. Detritus tank

A detritus tank is a grit removal unit which also removes silt as well as some organic matter along with grit. This is because the flow through velocity is less and detention time is more in a detritus tank. The main idea of installing a detritus tank is therefore remove finer particle than those removed by a grit chamber.

The overall depth of detritus tank varies from 2.5 m to 3.5 m. They have detention time of 3-4 minutes and velocity of flow 0.2 to 0.3 m/s.

CALCULATIONS

1) Assumed detention time = 3min
2) Assumed flow velocity = 0.2m/s
3) Assumed water depth = 1.2m
4) Cross-sectional area of tank = Quantity/velocity of flow
=0.625 sq m
5) Width of tank = Area of tank/depth

=0.520833m

6) Length of tank = velocity of flow*detention time*60
= 36m

E. Sedimentation tank

Sedimentation is the separation from water, by gravitational settling of suspended particles that are heavier than water. These suspended solids will be organic if the waste water has been subjected to preliminary treatment prior to primary treatment. In general, sedimentation is used for grit removal in grit chamber, particulate matter removal in the primary settling basin, biological removal in the activated sludge settling basin and chemical removal when the chemical coagulation process is used. Sedimentation is also used for solids concentration in sludge thickness.

CALCULATIONS

IS-10267-1982 for waste water

IS-10313-1982 for water treatment plant

1) Assumed detention time = 2hr
2) Assumed surface loading rate = 30 cu-m/d/sq m
3) Assumed l/b = 4
4) Capacity of tank = Quantity*detention time
   = 30 cu-m
5) Surface area = Quantity/surface loading rate
   =1440/30=48m2
6) Depth = Capacity/area
   = 2.5m
7) Width = (Area/assumed l/b)0.5
   = 6m
8) Length = assumed (l/b)*width
   = 24m

F. Trickling filter

Trickling filters, also known as percolating filters or sprinkling filters are similar to contact bed in construction, but their operation in continuous and they allow constant aeration. In this system, sewage is allowed to sprinkle or trickle over a bed of course, rough, hard filter media, and it is then collected through the under drainage system. Spray nozzles or rotary distributers are used for this purpose.

IS-8413(PART 1)-1977 is used for trickling filters

1) Assumed hydraulic loading = 4 cu-m/d/sq m
2) Assumed organic loading = 320g/d/cu-m
3) Calculated 5 day BOD = 100mg/l
4) Total 5 day BOD = Quantity*5 Day BOD/1000
   = 144000g/d
5) Volume of filter media= Total 5 day BOD/ Organic loading
   = 144000/320cu-m
6) Surface area = Quantity/ hydraulic loading
   = 360 sq m
7) Depth of bed = Volume/area
   = 1.25m

G. Aeration tank

Aeration is the most important operation in activated sludge process, so as to provide oxygenation and mixing. The aeration facilities are designed to meet the calculated oxygen demand of the process while maintaining in aeration tank a minimum DO of about 1-2 mg/ l which is necessary for proper development of biological sludge. In addition to supplying dissolved oxygen, the aeration devices have also to provide adequate mixing and agitation so that the mixed liquor suspended solids do not settle down.

CALCULATIONS

IS-8413 (PART 2)-1982 is used for the aeration tank

1) Assumed number of aeration tank = 1
2) Assumed MLSS = 2500mg/l
3) Assumed F/M = 0.15
4) Calculated 5 day BOD = 100mg/l
5) Avg flow of tank =1440
6) Volume of tank=(avg flow*cal. BOD)/(assumed(F/M) *assumed MLSS)
   = 384cum
7) Assumed depth = 3m
8) Area of tank = Volume/ Depth
   = 128sq m
9) Assumed(b/d) = 1.5
10) Breadth = 1.5*depth
    = 4.5m
11) Length = Area/Breadth
    = 28.44m
12) Aeration period(HRT) = Volume/Avg. flow
    = 0.27 days
    = 6.4 hr

H. Secondary settling tank

Secondary settling assume considerable importance in the activated sludge process as the effluent separation of the biological sludge is necessary not only for insuring final effluent quality but also for return of adequate sludge to maintain the MLSS level in the aeration tank. The secondary settling tank of the activated sludge process is particularly sensitive fluctuations in flow rate and on this account it.

IS-10261-1982 Its for waste water

IS-10313-1982 Its for water treatment plant

1) Assumed no. of tanks = 2
2) Assumed surface loading rate w.r.t. depth = 20 cu-m/d/sq m
3) Surface area = Quantity/(2*surface loading rate)
   = 36sq m
4) Diameter of circular tank = ((surface area*4)/3.14)0.5
   = 6.7m
5) Assumed depth = 3

IV. CONCLUSION

Waste water treatment involves a variety of processes perform at different levels of treatment. The basic form of treatment id the breaking down of organic waste by bacteria either aerobically or an aerobically or a combination of both which occurs in secondary treatment. Primary treatment offers the settlement of solids tertiary treatment involves the removal of phosphorus, nitrogen and toxic substances. Pathogen removal occurs throughout treatment but becomes more effective mostly at tertiary levels through the use of

UV rays and chlorination. The higher the treatment efficiency the better the quality of effluent produced.

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[9] IS-10313-1982 for water treatment plant in sedimentation tank and also use for secondary settling tank.
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