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Design OF SEWAGE TREATMENT PLANT FOR INDUSTRIAL AREA ROOMA, KANPUR, UTTAR PRADESH, INDIA

[1]Vineet Kumar Verma, [2]Prateek Dubey [3]Vinay Kumar, [4]Divyanshu Kumar and [5]Rubia Khan

[1]Student, [2] Student, [3] Student, [4]Student and [5]Associate Professor
[1]Civil Engineering Department,
[1]Axis Institute of Technology & Management, Kanpur, Uttar Pradesh, India.

Abstract: Present study aimed to design a sewage treatment plant for industrial arae Rooma , Kanpur, Uttar Pradesh, India. Rooma, Kanpur has been a developing place due to the steady increase in industilization, which in turn resulted in the increase of sewage generated, but still there is no sewage treatment plant. So it is required to construct a sewage treatment plant with sufficient capacity to treat the generated sewage. Sewage water treatment has challenges to treat the excess sludge and disposal of sludge Water pollution has become one of the most serious environmental problems in recent years then work on the project sewage treatment plant for industrial area Rooma, Kanpur. The use of aerobic waste water treatment as a reductive medium is receiving increased interest due to its low operation and maintenance costs. In addition, it is easy-to-obtain, with good effectiveness and ability for degrading contaminants. This paper reviews the use of waste water treatment technologies to remove contaminants from waste water such as halogenated hydrocarbon compounds, heavy metals, dyes, pesticides, and herbicides, which represent the main pollutants in wastewater.

***Index Terms* - Sewage, Aerobic, Treatment, Technologies , Population Forecasting.**

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. The growing environmental pollution needs for decontaminating sewage water result in the study of characterization of sewage water, especially domestic sewage. In the past, domestic sewage water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the sewage 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.

1.1 Study Area

Rooma is a satellite town situated about 20 kilometers east of Kanpur, India and a major industrial and institutional centre on Kanpur-Allahabad Highway of NH-2.Its one of the major towns enlisted in Kanpur metropolitan area. Achievement of a safe and healthful workplace is the responsibility of an organization, the people residing in the place and the workers who are given the charge to protect the environment. Waste disposal and minimization and pollution prevention should be the preferred approach. Stringent penalties for the improper disposal of wastes should be adopted. Rooma is one of the most significant industrial hubs in the city of Kanpur. It has got an integrated leather industries, textile industries and educational institutes.
The following is the list of workplace which is the main sources pollution generating unit in the study area:
a) Leather industries and textile industries
b) Educational institutes and domestic.

1.2 Objectives of Study

The principal objective of sewage water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. An environmentally-safe fluid waste stream is produced. No danger to human health or unacceptable damage to the natural environment is expected. Sewage includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage also includes liquid waste from industry and commerce. The objectives of the study are:

1. To study physical, chemical and biological characterization of the domestic waste water and industrial waste water from Industrial Area Rooma, Kanpur.
2. Population forecasting
3. Design of the sewage treatment plant.

II Materials and Methods

2.1 Methods of Population Forecasting

2.1.1 Incremental increase method

The advantages of both arithmetic increase method and geometrical increase method are included in this method. Average increase per decade is found out first of all and average percentage increase per decade is worked out as in arithmetic increase method and geometric increase method respectively. Future population is worked out from the equation given below.

$$Pn = Po + nx + x(x+1)/2 \times y \ldots\ldots\ldots\ldots\ldots(1)$$

Where,
Pn = future population after n decades
Po = present population
n = number of decades
y = average incremental increase per decade
x = average increase per decade

2.2 Treatment of Sewage Water

Treatment of sewage consists of many complex functions. The degree of treatment depends upon the characteristics of row inlet sewage as well as required influent characteristics.
Treatment processes are often classified as :

i. Preliminary treatment
ii. Primary treatment
iii. Secondary treatment
iv. Tertiary treatment

2.3 Preliminary Treatment

Preliminary treatment consists slowly in separating the floating material like trees branches, papers, pieces of rags and wood etc. and heavy settable solids .

- Screening - to remove floating paper ,pieces of rags and clothes
- Grid Chamber - to remove grit and sand
- Skimming Tank - to remove oil and greases.

2.4 Primary Treatment

Primary treatment consists in removing large suspended organic solids. It is usually accomplished by sedimentation in settling basins. The liquid effluent from the primary treatment often contains a large amount of suspended organic material and has a high BOD.

2.5 Secondary Treatment

Here the effluent from primary treatment is treated though biological decomposition of organic matter carried out either aerobic or anaerobic conditions.

Aerobic Biological Units:

1) Filters (Intermittent sand filter, trickling filter)
2) Activated sludge plant (feed of active sludge, secondary settling tank and aerobic tank)
3) Oxidation ponds and Aerated lagoons.

Anaerobic Biological Units:

1) Anaerobic lagoons
2) Septic tank

The effluent from the secondary treatment contains a little BOD (5% to 10% of original) and may contains several milligrams per liter of DO.

2.6 Tertiary Treatment

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment. More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also known as “effluent polishing”

III RESULT AND DISCUSSION

3.5 Calculation

3.5.1 Population Forecasting

No. of students in hostels = 1400 head
In 2051,
No. of students in hostel = 2300 head
By population forecasting method
P_{2021} = 12199 head
P_{2051} = 22640 head
Water consumed = 25000x150x.9

= 3.375MLD
No. Of Industries = 35
Generate sewage = 1.5x35x50000
= 2.625MLD

Water Consumed = 5.495 MLD
Avg. Sewage generated = 85% of Supplied water
= 0.85 x 5.495 = 4.67 MLD
= 4670 KLD
Avg. Sewage per hour = 4670/24
= 194.58m^3/hr
Peak Factor = 3
Design flow capacity = 194.58 X 3
= 583.74m^3 /hr
= 0.162$\boldsymbol{m}^3$ /sec.

3.5.2 Sizing Calculation For Collection Pit

Retention time required = 4hr.
Avg. Design flow = 194.58m3 /hr
Capacity of collection sump = 4 x 194.58
=778.32m^3
Assume liquid depth = 6m
Area, required for collection pit = 778.32/6
Area = 129.72$\boldsymbol{m}^2$
Let it is a circular tank.
Now, 129.72 = πr^2
r = 129.72/ π = 41.29 m
r = 41.3m
III. Design of sewer chamber
Qmax = 0.162m3 /sec
Assumption;
Shape of bar = M.S. Flats Size
= 10 mm X 50 mm
Clear spacing between the bars = 20 mm.
Inclination of bars = 80 deg.
Assume avg. Velocity to sewer = 0.8 m/sec
At peak flow,
net inclined area required = 0.162/0.8
= 0.203 sq. m
Gross inclined area = 0.203 x 1.5
= 0.305 sq. m
gross vertical area required = 0.305x sin80
= 0.3 sq. m
Provide submergence depth = 0.3 m
Width of channel = 0.3/0.3 = 1m
Provide bars of 10 mm x 50 mm at 20 mm clear spacing.

3.5.3 Design Of Grit Chamber

Flow from screen channels shall be taken into grit chamber, provided in duplicate 2 no C.I gates, one each at inlet and outlet are provided for each grit chamber.
Design Flow = (2.5 x4.67)/2 = 5.837 MLD
(OR) 5837m3 /day
Surface Loading = 1100 $\boldsymbol{m}^3$ /sq. m/day
To account for turbulence and short circuiting, reduce the surface loading to about
800 m3 /sq. m/ day.
Area required = 5837/800 = 7.3 sq. m
Provide 7.3m dia.
Chamber (Circular)
Detention time= 60 sec.
Volume = (5837 x 60) / (24 x 3600)
= 4.05m3
Liquid depth = $Volume/Area$ = 4.05/7.3
= 0.554 m.
Size of grit chamber = 7.3 x (0.554+0.6)
= 7.3 x 1.15 m

V. Design Of Primary Sedimentation Tank
Detention time = 2hr.
Volume of sewage = max. Quantity of sewage/(detention time x 24)
= 5837/(2 x 24) = 121.6m^3
Provide depth = 3m.
Surface area = Volume/Depth = 121.6/3
= 40.5 sq. m
(π/4) x d^2 = 40.5
d = 7.1m

3.5.4 Design Of Aeration Tank

No. Of tanks = 2
Avg. Flow to each tank = 5.837 MLD/2
= 2.92 MLD
Q = 2920m^3 /**day**
Total BOD entering STP = 295 mg/L
Assuming that negligible BOD is removed in screening and grit chamber (since it mainly removes inorganic solids).
The BOD of sewage coming to aeration tank
= Y_0 = 295 mg/L
BOD Left in the effluent= Y_E = 20 mg/L
BOD removed in activated plant = 295 – 20
= 275 mg/L
Minimum efficiency required in the activated plant = 275/295 = 0.93 = 93% (OK) Volume of aeration tank can be designed by assuming a suitable values of MLSS and 'θc ' (or F/M ratio) = 3000 mg/L
(Between 3000 – 3500 mg/L)
F/M ratio = 0.15 (Between 0.18 – 0.10)
F/M = Q/V = Y_0 /X_T
Therefore, Q = 716 m^3 /day
V= ?
Y_0= 295 mg/L
$X_{(T)}$ = 3000 mg/L
F/M = 0.12 /0.15= (2920 x 295)/v x 3500
V = (2920 x 295)/(3000 x 0.12)
V = 2392.78m^3
Aeration tank dimensions; Let us adopt an aeration tank of liquid depth 5m, 9m width then; length of the tank = V/ B x D
l = 2392.78/(5x9)
l = 53m

3.5.6 Design of second clarifiers

No. of clarifiers = 1 no.
Avg. Flow = 5837KLD
Recirculated flow, say 50% = 2918.5 m^3/d
Total inflow = 5837 + 2918.5= 8755.5 m^3/d
provide hydraulic detention time = 2hrs
Volume of tank = 8755.5 x 2/24 = 729.63m^3
Assume liquid depth = 5m
Area = 8755.5/5=7151.1 m^2
Surface loading rate of avg. flow = 15m^2
Surface area to be provided = 5837/15
= 390m^2
Dia of circular tank (d);
d=7m
MLSS solids inflow = 3000 mg/L
Total solids inflow = (1147 + 716) x 3
= 5589 kg/day
Solids loading = 589/77 = 72.58 kg/day/ m^2
Provide a clarifier a 10m dia having liquid depth as 3.5m
Hopper slope shall be 1 in 12.
Free board will be 0.3m.

3.5.7 Return Sludge Pump House

Total return flow = 1728 m^2

Detention time = 15min.

Volume of wet well = 0.497 x 15

Provide wet well = 2.5m x 1.5 x 1.8m

SWD

provide dry well = 2.5m x 2.5m

Size of annexe control room = 2.5m x 2.5m

provide 2nos pumps each of 0.716MLD capacity in the dry well for returning the sludge to the aeration tank.

The return sludge pipe line should be 150mm Ø.

3.5.8 Design Of Sludge Drying Beds

Sludge applied for drying beds@100 kg/MLD

Sludge applied = 125 kg/day

Specific gravity = 1.015

Solid contents = 1.5%

Considering monsoon etc. Total no of cycle in 1yr. = 33

Period of each cycle = 365/33 = 11 days.

Volume of sludge = 8.2 X 11 = 90.2m ^{3}

Spreading a layer of 0.3 m/cycle area of beds required = 90.2/0.3 = 300.67

Provide 4 beds of 1.2mX7m

3.5.9 Filtrate Pump House And Sump

Excess water sludge, θc = V.XTQw .X

20.09d = 598 X 3000 Qw . XR

Qw . XR= (598 X 3000)/20.9 = 85837 gm/d =85.8 gm/d

Thus excess sludge provided = 85.8 gm/d

Assuming the excess sludge to contain 1% solids and specific gravity = 1.015

volume of excess sludge = 85.81000 x 1.015 X 1%

Taking detention time as 8hrs.

Volume of wet will = 8 X 0.35 = 2.8m^3

for 1% concentration.

provide liquid depth = 1m

Area required for 1% concentration of solids = 2.8/1 = 2.8m^2

Dia. of wet well = 2.8 m

IV CONCLUSION

A successful technical project involves the integration of various knowledge from different field. This is an attempt to combine several aspects of environmental, biological, part of chemical and mostly civil engineering from which the knowledge were acquired .Due to increase in population in recent days and looking on the future aspect, it was quite necessary to construct a sewage treatment plant. The plant is designed perfectly to meet needs and demands of approximate 10000 populations with a very large period of time. The project consist of the design of complete Sewage treatment plant components starting from receiving chamber, screening, grit chamber, skimming tank, sedimentation tank, secondary clarifier, activated sludge tank and drying bed for sewage.

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