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Design of Sewage Treatment Plant for a Growing Town Ulavapadu, Andhra Pradesh, India.

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Abstract- Sewage is a most common type of waste water arriving from every human community. The irresponsible disposal of the sewage into atmosphere will cause pollution to environment and destroy the health of human beings through water borne diseases. So, it is required to treat the sewage before disposing it into atmosphere.

The present project involved in the design of a sewage treatment plant for a town Ulavapadu. Ulavapadu is a growing town in Prakasam District of Indian state, Andhra Pradesh. The steady increment in population of the town results in the increase of domestic sewage generation. But still there is no treatment plant for treating the sewage. So, I decided to propose a design of sewage treatment plant to the respective Government bodies of the town. The project deals with the design of various primary and secondary treatment units of sewage treatment plant such as screen chamber, grit chamber, skimming tank, primary clarifier, aeration tank, secondary clarifier and sludge drying beds. By the execution of the project, the entire sewage of the town can be treated effectively and efficiently.

Index Terms: *Aeration, Sewage treatment plant, Ulavapadu, Sedimentation tank, BOD, Sludge drying beds, Screen*

I. INTRODUCTION

1.1 Necessity Of Treatment Of Sewage

In general, the liquid waste or the waste water coming out from communities or from industries, called as sewage. This sewage contains various kinds of unwanted gases, organic matters and micro organisms as its composition. With passage of time from its generation in a community, sewage becomes harmful and toxic to environment as well as human health, due to bio degradation of organic matter by microorganisms, and due various chemical reactions present in it. After three to four hours from its generation, the properties of sewage get changing, and start becoming harmful. The disposal of such sewage pollutes the environment, soil and human health.

It is important that, to know those parameters or compounds of sewage, which make it as harmful. Those are, undesirable concentrations of acidity, alkalinity, total solids, organic matters, mainly sulphur compounds, carbon compounds, nitrogen compounds, dissolved oxygen, chemical oxygen demand, bio-chemical oxygen demand, evolution of various gases like, H_2S, CO_2, forms of nitrogen due to biological actions and changes in temperature. All these parameters are responsible for making sewage harmful to environment. By reducing all these parameters into their recommended concentrations, we can dispose into environment without causing environmental pollution.

1.2 Flow Diagram Of Treatment Plant

The following **figure-1** shows the sequence of treatment methods to be employed for treating sewage in sewage treatment plants. The major treatment techniques includes screening, grit removal, sedimentation, activated sludge process, and sludge disposal. The units include screens, grit chambers, primary sedimentation tank, aeration tank, secondary sedimentation tank, sludge digestion tank in order.

II. ABOUT ULAVAPADU

Ulavapadu is a town located in Prakasam District of Indian State of Andhra Pradesh. It is located nearly 43 kilo meters away from the district head quarter Ongole. Almost for the entire town the environment is plain. The town is situated at the altitude of 15.1667^0N latitude and 80.0^0E longitude. The soil of the area is being gravel, rocky and a large proportion of clay and gravel. According to the census 2011, the population of the town was 13, 106 and now in this year 2018, the population of the town is not less than 14,000.

III. EXPERIMENTAL METHODOLOGY

For this present project work, I followed the following methodology:

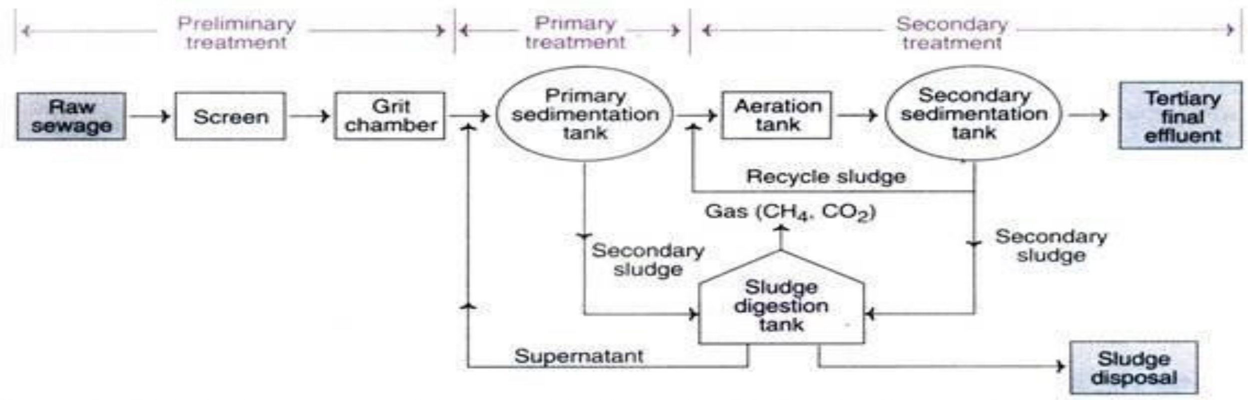

Figure-1
Flow diagram of treatment plant

3.1 Survey On Basic Features Of The Town

The basic features of town means the population, growth rate of population, culture of local people, climate, living style and economic status of people etc. All these data were observed and predicted the suitable data for designing a sewage treatment plant the town. And this data helps in the selection of location of sewage treatment plant.

3.2 Analysis Of Various Parameters Of Sewage

From the town, the sewage samples were collected and analyzed the following parameters in laboratory, as shown in **table-1**

Table-1 characteristics of sewage

Parameters	Raw sewage of Ulavapadu
Ph	6.4
BOD	300 mg/l
COD	600 mg/l
Oil & grease	50 mg/l
Total suspended Solids	600 mg/l
Nitrogen	61 mg/l
Ammonia Nitrogen	50 mg/l
Total phosphorus (as PO_4)	5 mg/l
Total coil form	100000 MPN/ml

3.3 Deciding Treatment Various Units

Based on the characteristics of the sewage analyzed, the following treatment units are decided to design for the treatment of sewage. They are: screens, grit chambers, primary sedimentation tank, aeration tank, secondary sedimentation tank, sludge digestion tank in order.

IV. DESIGN OF SEWAGE TREATMENT PLANT

4.1 Deciding Design Period

The design period of the treatment plant was decided as 40 years. It means the sewage treatment plant is designed will serve for the next 40 years.

4.2 Population Forecast

By using incremental increase method, the well-known method of population forecasting, the population at the end of design period i.e. in 2051, was estimated as 26, 710 persons. However, the population of Ulavapadu town is 13, 106.

4.3 Quantity Of Sewage To Be Treated Per Day

Ultimate design period = 40 years
Population at 2051 = 26, 710
Per capita water supply = 135 lpcd
Assume, average sewage generation per day = 80% of supplied water
Therefore, average sewage generation per day = 0.03 cumecs
Maximum sewage to be treated per day = 3 times of average discharge i.e. 0.1 cumecs

4.4 Design Of Preliminary And Primary Treatment Units

4.4.1 Details of receiving chamber

Design flow = 0.1 cumecs
Detention time = 60 seconds
Volume = 6 m^3
Provided: length = 2m, width = 1m and depth = 3m

4.4.2 Detail of Screens

Table-2 Details of screen

Parameters/ Components	Values/ Dimensions
Coarse Screen	
Peak discharge of sewage	$0.1m^3/sec$
Velocity of flow through screen	0.8 m/sec
Size of clear openings between bars	0.03 m
Assumed width of channel	1m
Inclination screen to	60^0

horizontal	
Therefore, velocity through screen	1.8 m/sec
Number of openings	43 no.s
Number of bars	44 no.s
Final dimensions of coarse screen chamber/ channel	1.8mX0.71m(SWD)+0.3m(FB)
Fine Screen	
Peak discharge flow of sewage	0.1m^3/sec
Velocity of flow through screen	0.8 m/sec
Size of openings	0.01m
Assumed depth of channel	3m
Width of channel	3.13 m
Number of openings	156 no.s
Final screen dimensions	3.13mX3m+0.3m(FB)

4.4.3 Grit chamber

Table-3 Details of grit chamber

Parameters/ Components	Values/ Dimensions
Flow of sewage	0.1 m^3/sec
Assume average detention period	180 sec
Aerated volume	18 m^3
volume of one aerated chamber	9 m^3
Assumed depth	3m
Width to depth	2:1
Length provided	0.6 m
Designed grit chamber dimensions	0.6m X 6m X 3m

4.4.4 Skimming tank

Table-4 Details of skimming tank

Parameters/ Components	Values/ Dimensions
The surface area required for the tank	0.149 m^2 ≈0.2 m^2
Depth provided	2.2m
length breadth ratio	1.5: 1
Skimming tank dimensions	1.5m X 1m X 3m + 0.5m (FB)

4.4.5 Primary sedimentation tank

Table-5 Details of Primary sedimentation tank

Parameters/ Components	Values/ Dimensions
Max. quantity sewage	2.9 MLD
Surface loading	40 m^3/m^2/day
Detention period	2 hrs
Volume of sewage	61
Provide effective depth	2.5 m
Surface Area the tank	73 m^3
Diameter of the tank	9.64m ≈ 10 m
Primary sedimentation tank is designed for the dimension of	10 m (dia) X 2.5 m (depth) + 0.5m (FB)

4.5 *Design Of Secondary Treatment Units*

Table-6 Details of Activated sludge process plant

Parameters/ Components	Values/ Dimensions
Type of secondary treatment method chosen	Activated sludge process
Treatment unit	Aeration tank
No. of aeration tanks	1
Design flow	2.9 MLD
BOD at inlet (Y_o)	0.8 x 300 = 240 mg/l (20 % of BOD removed at Grit chamber)
BOD should be at outlet (Y_E)	20 mg/l
Therefore, minimum efficiency required	91.7 %
MLSS (X_t)	3000 mg/l
Volume the aeration tank required	580 m^3
Assumed liquid depth of the tank	4.5 m
Width to Depth ratio	2.2
Volume provided	2745 m^3
Aeration tank dimensions	54 m X 10 m X 4.5 m + 0.5 m (FB)

(i) check of aeration period:

Hydraulic Retention Time (HRT) = t = (V X 24)/Q
= (2745 x24) /2900
= 22.7 hrs

Since it lies between 3-6 hrs. it is OK.

(ii) check for volumetric loading:

Volumetric loading = (Q X Y_o)/V
= (2900 X 240) /2745
= 253.55 g/m^3
= 0.254 kg/m^3

Since it lies between 1.0 – 1.3. It is OK.

(iii) SVI=sludge volume index

SVI is defined as the volume occupied in ml by 1 gram of MLSS for 30 minutes from 1 liter of sewage sample.

SVI=53 ml/gm

This lies in between 50ml/gm-100 ml/gm

(iv) Check for solid retention time (θ_c) :

Return activated sludge $= VxX/(Q_w x\ X_u + Q_e\ x\ X_e)$

Where,

θ_C = Solids Retention Time (SRT)

$Y_o = 240$ mg/l

$Y_E = 20$ mg/l

$V = 2430\ m^3$

$X_t = 3000$ mg/l

$Q = 13280\ m^3/day$

$\Theta_c = 7.12$ days

It lies between 5-8 days. The deign is OK

4.6 Design Of Secondary Sedimentation Tank

Table-7 Details of secondary sedimentation tank

Parameters/ Components	Values/ Dimensions
No. of Secondary clarifiers	1
Average flow	2900 m^3/day
Re-circulated flow	1537 m^3/day
Total inflow	4437 m^3/day
Provide hydraulic detention period	2 hrs
Volume of the tank	369.75 m^3
secondary sedimentation tank dimensions	16 m (dia) X 3.5 m (depth) + 0.5 m (FB)

4.7 Design Of Tertiary Treatment Units

Table-8 Details of sludge drying beds

Parameters/ Components	Values/ Dimensions
Treatment unit	Sludge drying beds
Sludge applied to drying bed at the rate of	100kg/MLD
Sludge applied	300kg/day
Specific gravity	1.015
Solid content	2%
Volume of sludge	14.778m^3/day
Number of cycle in one year	37 cycles
Period of each cycle	10 days
Volume of sludge per cycle	147.78 m^3
Area of bed required	492.6 m^2 ≈ 500 m^2
No. of beds provided	5
Area of each bed	100m^2
Dimensions of each sludge drying bed	12.5mX8m

4.8 Plant Details

Table-9 Details of Sewage treatment plant designed for Ulavapadu

S. No.	Treatment Unit	Type	No. of units	Dimensions
1	Receiving chamber	Rectangular	1	2m X 1m X 3m (SWD)+0.3 FB
2	Coarse screen	1 manual 1 mechanical	2	1.8mX0.71m(SWD)+0.3m(FB)
3	Fine screen	Disc type, mechanical	2	3.13m X 3m + 0.3m (FB)
4	Grit chamber	Horizontal flow type	2	0.6m X 6m X 3m
5	Skimming tank	Air diffuser + chlorine gas	1	1.5m X 1m X 3m + 0.3m (FB)
6	Primary clarifier	Circular type, radial flow	1	10 m (dia.) X 2.5 m (depth) + 0.3 m (FB)
7	Aeration tank	Combined dorocco type	4	13m X 10m X 4.5m + 0.3m (FB)

8	Secondary clarifier	Circular type, radial flow	3	16 m (dia.) X 3.5 m (depth) + 0.3 m (FB)
9	Sludge drying bed	Sand + Graded gravelled	5	12.5m X 8m

4.9 Effluent Disposal

While considering the characteristics of Ulavapadu it is preferred that effluent irrigation is suitable for the disposal of effluent from the treatment plant due to the following reasons:

(i) Ulavapaduu is a coastal village i.e. sea is reachable.
(ii) Ongole does not have any perennial river makes impossible for dilution.
(iii) The nearby river stream Poturaju kaluva has very small amount of dry weather flow. In summer season it runs dry.
(iv) The Sewage Treatment Plant is designed according to Indian Standards which produces effluent having lesser hazardous characteristics than the standards of land disposing.
(v) It is an alternative source of water for irrigation and it contains the manure and some amount of NPK compounds

V. RESULTS AND DISCUSSIONS

The overall details of the project are described in the following table:

Table-10 Overall details of the project

S. No.	Attribute	Details
1	Project	Sewage treatment plant for Ulavapadu
2	Sewerage type	Partially separate sewerage system
3	Population as per census 2011	13, 106
4	Method of forecasting	Incremental increase method
5	Population at the ultimate year 2051	26, 708
6	Per capita water supply	135 lpcd
7	Units designed	Receiving chamber, Screen chamber, Grit chamber, Primary and secondary clarifiers, aeration tank and sludge drying beds.

Since, at Ulavapadu, there is no proper treatment plant for sewage, it is necessary to construct a Sewage Treatment Plant. The plant is designed perfectly to meet the future expansion for the next 40 years in accordance with Indian Standards provisions. This project consists of the design of the complete components of a Sewage Treatment Plant from receiving chamber, screening chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier, active sludge tank and sludge drying beds for sewage.

VI. CONCLUSION

As already discussed that, for the disposal of sewage in to the atmosphere without causing pollution to environment and harmful health hazards to human beings, the sewage should be treated before its disposal. The projects like design and construction of sewage treatment plant are involved in an attempt to combine several aspects of environmental, biological, chemical and civil engineering fields. The design of various treatment units of sewage treatment plant has been completed successfully.

Since at the present particular location, there is no proper disposal of sewage, it became necessary to construct a sewage treatment plant. This project consists of the design of the complete components of a sewage treatment plant from receiving chamber, screen chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier, activated sludge tank and sludge drying beds for sewage. The plant designed is perfectly to meet future expansion for the next 40 years in accordance with Indian code provisions.

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