Analysis and Design of Sewage Treatment Plant: A Case Study on Vizianagaram Municipality

M. Bhargavi [#1] E. Ananta Rao [#2] T.Pravallika [#3] Y. Sri Teja [#4]
[#1] *Assistant Professor & Department of Civil Engineering & Sathya Institute of Techonology and Management , Vizianagaram, AP, India*
[#2,#3,#4] *Students & Department of civil engineering*

Abstract

The main objective of this study is carried out to design of a sewage treatment plant for a vizianagaram municipality, because it has been a developing place due to steady increase increasing population, which in results excess of sewage is produced. To avoid this problem, to construct the sewage treatment plant. This paper focuses on sewage generation in vizianagaram area, which was estimated 38.203MLD considering population of next 30 years. We are designed the various components of sewage treatment plant like screens, grit chamber, primary sedimentation tank, activated sludge process, sludge drying beds. It is proposed to design the various components of sewage treatment plant considering various standards and permissible limits of treated sewage water. The treated water will be used for irrigating the crops and the sludge which is generated after the treatment will be used as manure, so it increases the fertility of soil. Also reduce the ground water usage.

Keywords - *Sewage treatment plant, Irrigation, Sludge, Manure, Ground water, Sedimentation.*

I. INTRODUCTION

Water plays an important role in the development of any activity in the world. Due to the growth of population, consumption of water resources is more and availability is less. So the demand for water is increasing. Sewage treatment is the process of removing contaminants from waste water, primarily from household sewage. Physical, chemical and biological processes are used to remove contaminants and produce treated wastewater that is safer for the environment. A by-product of sewage treatment is usually semi-solid waste or slurry called sewage sludge. The sludge has to undergo further treatment before being suitable for disposal or application to land. Sewage can be treated close to where the sewage is created, which may be called a decentralised system. The treatment process has a series of treating units which are categorized under primary treatment , secondary treatment and tertiary treatment.

The primary treatment removes suspended & floating solids of raw sewage. It includes screening to trap solid objects and sedimentation by gravity to remove suspended solids. This level is sometimes referred to as "Mechanical Treatment" although chemicals are often used to accelerate the sedimentation process. Primary treatment can reduce the BOD of the incoming wastewater by 20-30% and the Total suspended solids by some 50-60%. Primary treatment is the first stage of sewage treatment.

The secondary treatment removes the dissolved organic matter that escapes primary treatment. Secondary treatment is typically performed by indigenous , water-borne micro-organisms in a managed habitat. It requires a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.

Tertiary treatment is sometimes is defined as anything more than primary and secondary treatment in order to allow ejection into a highly sensitive or fragile ecosystem. Tertiary treatment can remove more than 99% of all the impurities from sewage, producing an effluent of almost drinking water quality. Treated water is sometimes disinfected chemically or physically prior to discharge into a stream , river or wetland.

II. STUDY AREA

Vizianagaram is the major town of this district in north eastern, Andhra Pradesh. It is located about 18km inland from the Bay of Bengal and 40km northwest of Visakhapatnam. Vizianagaram is located at $18^{0}12^{1}$N Latitude to $83^{0}24^{1}$E Longitude. It has an average elevation of 74 metres.

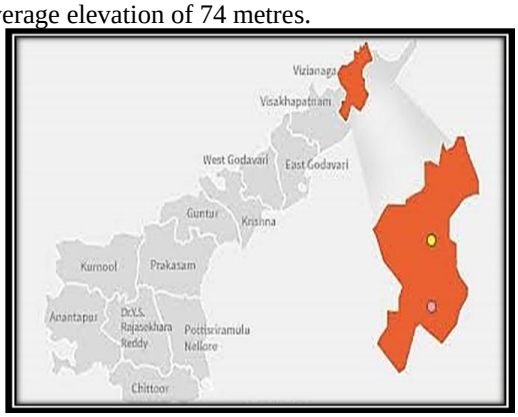

Fig 1: Study Area Of Vizianagaram

III.LITERATURE REVIEW

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.

Pramod sambhaji patil et.al.(2016) studied on design of sewage treatment plant for dhule city . Some treatment units are designed like screens, grit chamber, storage tank, settling tank, aeration tank and skimming tank. The effluent can also be used for artificial recharge of ground water, flushing, foam control, fire protection, lawn sprinkling .

Murthy polasa et.al (2014) reviewed about design of sewage treatment plant for gated community. In this project three types of treatment unit operations are conducted. Like physical, chemical and biological processes. By increasing the detention time of sewage in each treatment unit increases the efficiency of removal unwanted impurities .

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.

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.

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.

IV.METHODOLOGY

Vizianagaram 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

.

Table no:1 Population Data:

YEAR	POPULATION	POPULATION RATE	AVERAGE RATE OF POPULATION
1998	171873	-	
2008	195801	13.92	15.26
2018	228720	16.22	15.26
2028	263852	15.26	15.26
2038	304380	15.26	15.26
2048	351132	15.26	15.26

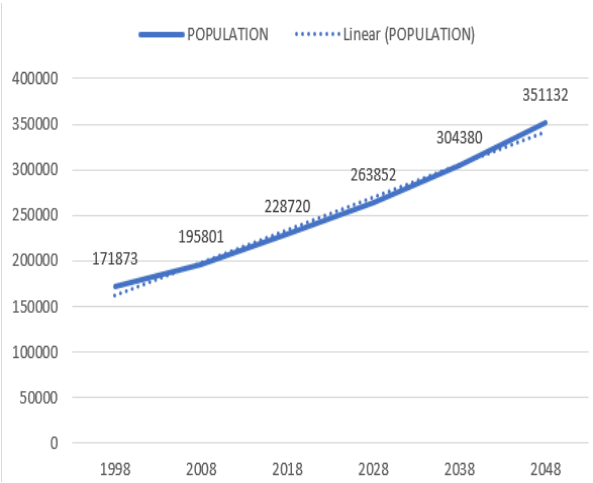

Fig2:Graphical representation of population forecast

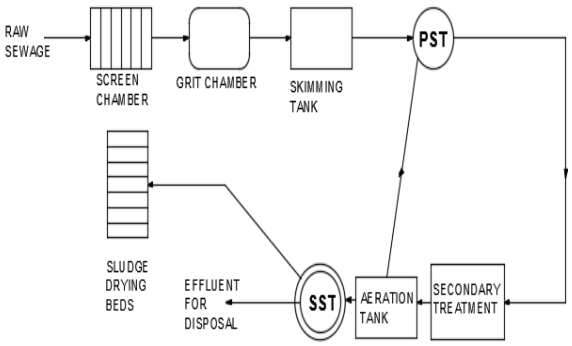

Fig3: Schematic Diagram Of Sewage Treatment Plant

Schematic diagram of sewage treatment plant

Quantity of effluent in lit/day:

136 x 351132

= 47753592 lit/day

Volume of sewage : 80% of wastage

V. DESIGN OF TREATMENT UNITS

Population as calculated by geometrical increase method : 3,51,132
Sewage: 136 lit/capita/day
=80/100 (47753592)=38203 .162 m^3/day

***Design of screen chamber*:**
Total flow of sewage = 38203.162m^3/day
***Design of trickling filter* :**
BOD concentration = 230 mg/lit
BOD left in sewage entering the filter unit is
W = 8786.70 x 0.7 = 6150.683 kg / day
Efficiency of filter = 81.36%
Volume of filter = 12012.700 m^3
Recirculation ratio = 1.5
Surface area of filter = 6673.722 m^2
Dia of trickling filter = 46.09 m
Depth of trickling filter = 1.8 m

***Design of aeration tank*:** Discharge of aeration tank = 37916.80 m^3/day
Capacity of aeration tank = 19988 m^3
Detention Period of aeration tank = 13hrs
$\frac{F}{M}$ ratio = 0.2334 kg BOD per day / kg of MLSS
***Design of sludge drying beds*:**
Volume of wet sludge = 388.8 m^3 /day
Area of each bed = 454.11 m^2
No of beds = 100
Size of drying bed = 15m x 30.3 m

Peak flow = 0.4421 m^3/day
Size of screen chamber = 9 mm x 50mm
***Design of grit chamber*:**
Total flow of sewage = 38203.162 m^3/day
Detention period of grit chamber =50sec
Size of grit chamber = 15m x 1.5m x1m
Design of skimming tank:
Surface area of skimming tank = 0.660 m^2
size of skimming tank = 0.83 x0.8m
***Design of primary sedimentation tank*:**
Capacity of tank required = 3183.60 m^3
Detention time = 2hrs
Size of sedimentation tank = 76m x 18m x4m

VI. RESULTS AND DISCUSSIONS

This deals with the Analysis and Design of sewage treatment plant for the population of vizianagaram town. The vizianagaram district is located at $18^0 12'$ N latitude $83^0 42'$ E longitude. The location of sewage treatment plant should be nearer to the point where sewage is disposed finally.
The designed considerations and parameters for the sewage treatment plant are given below:

- The design period should be in between 25 to 30 years
- Estimated population by the year 2048 is 351132 numbers

A. Screens: generally the standard parameters of screens are width should be in between 6mm to 20mm, depth should be in between 30mm to 80mm, dia of bars should be in between 6mm to 12mm and the spacing between the bars should be in between 6mm to 40mm. After designing the screens obtained values are width is 9mm, depth is 50mm, dia of bars is 6mm, and spacing of bars is 36mm.

B. Grit Chamber: generally the standard parameters of grit chamber are length should be in between 7.5m to 20m, width should be in between 1m to 7m, depth should be in between 1m to 5m. After designing the grit chamber obtained values are length is 15m, width is 1.5m, and depth is 1m.

***C. Skimming Tank*:** 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.

***D. Sedimentation Tank*:** generally the standard parameters of sedimentation tank are length should be maximum up to 90m, width should be maximum 30m, depth should be minimum 2m, and free board should be 0.6(max). After designing the sedimentation tank obtained values are length is 76m, width is 18m, depth is 4m, and free board is 0.5m

***E. Trickling Filter*:** generally the standard parameters of trickling filter are dia should be in between 30m to 60m and depth should be in between 1.2m to 1.8m. After designing the trickling filter obtained values are dia is 41.5m and depth is 1.8m.

***F. Aeration Tank*:** generally the standard parameters of aeration tank are length should be in between 30m to 100m, width should be in between 5m to 10m, and depth should be in between 3m to 4.5m. After designing the aeration tank obtained values are length is 85m, width is 10m, and depth is 3.6m.

***G. Drying Beds*:** generally the standard parameters of sludge drying beds are length should be in between 30m to 45m, and width should be in between 6m to 15m. after designing the sludge drying beds obtained values are length is 30.3m, and width is 15m

DESIGN PARAMETERS	DESIGNED VALUES	STANDARD VALUES
Dimension of screen	Width = 9mm	Width = 6mm – 20mm
	Depth = 50mm	Depth = 30mm – 80mm
	Bars = 6mm	Bars = 6mm – 12mm
	Spacing = 36mm	Spacing = 6mm – 40mm
Grit chamber	Numbers = 1	……
	Length = 15m	Length = 7.5m - 20m
	Width = 1.5m	Width = 1m - 7m
	Depth = 1m	Depth = 1m - 5m
Skimming tank	Length = 0.83m	Length = 0.6m – 1.2m
	Width = 0.8m	Width = 0.5m – 1m
	Depth = 1m	Depth = 1m -1.5m
Sedimentation tank	Length = 76m	Length = 90m (max)
	Width = 18m	Width = 30m (max)
	Depth = 4m	Depth = 2m (min)
	Free board = 0.5m	Free board = 0.6m (max)
Trickling filter	Dia = 41.5m	Dia = 30m - 60m
	Depth = 1.8m	Depth = 1.2m - 1.8m
Aeration tank	Numbers = 10	……
	Length = 85m	Length = 30m – 100m
	Width = 10m	Width = 5m – 10m
	Depth = 3.6m	Depth = 3m – 4.5m
Sludge drying beds	Length =30.3m	Length =30 m-45m
	Width = 15m	Width = 6m -15m
	Depth =0.5m	Depth =0.5 m

VII. CONCLUSIONS

1. The project deals with design parameters of sewage treatment plant.
2. The design has been done for predicted population of 30 years (2018-2048).
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 300000 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.

ACKNOWLEDGMENT

We would like to express my gratitude to all people behind the screen who helped us to transform an idea into real application.

We express our sincere thanks to Ms. P.SUMANJALI, Head of the Civil Engineering Department for her support and guidance for doing the project.

We express our gratitude to our guide Ms. M.BHARGAVI, Assistant professor of Civil Engineering Department for his guidance and care taken by her in helping us to complete the project work successfully. Throughout this project work, his useful suggestions and constant encouragement has gone a long way in helping us in completing in project.

Finally we would like to acknowledge with gratitude for the encouragement and support given by my friends and parents.

REFERENCES

[1] G.S Birdie, J.S Birdie, "Watersupply and Sanitary engineering",Dhanpat Rai Publishing Company(p) ltd, New Delhi, 1969.

[2] Dr.B.C Punmia, Er.Ashok k.Jain, Dr.Arun k.Jain "Waste water engineering",laxmi publications(p) ltd, jodhpur,1996.

[3] S.K Garg, "Sewage disposal and air pollution engineering", khanna publishers, New delhi,1996.

[4] Prof.Pramod sambhaji patil, Shaikh Hujefa, Deo prasad, "Design of sewage treatment plant for Dhule city" volume no.5, pp:353-355.

[5] Puspalatha and Kalpana, "Design approach for sewage treatment plant: A case study of srikakulam greater municipality",India, volume no.12.

[6] Fatima Hussein ABD ALI "design of waste water treatment plant", 2011.

[7] EZE Brendan Ifeanyi "Dimensional equation for sludge drying bed",2008.

[8] Prof M.Bhargavi, L.Pavan sai, M.pavan kumar yadav, S.Jnanachanal, S.Ganesh "Treated municipal waste waterfor irrigation" India,2016.

[9] G.Tortora, B.Funke, C "Sewage Treatment"

[10] Benujah B.R, Mrs.G.Devi, "Site Suitability Evaluation for Sewage Treatment plant in Nager Coil Municipality,tamilnadu using Remote Sensing Techniques",India.

[11] Prof. Dr.Bin Jiang, Mr.Makku Pyykonen, Dizhao, "Using Gis-based Multicriteria Analysis for optimal Site Selection for a Sewage Treatment Plant" China, 2015.

[12] Franziska Meinzinger, "GIS-Based Site identification for the Land application of waste water" Newzealand.

[13] Gorani M.A, Jordan Ebraheem, "Location optrimization of waste water treatment plant using GIS' A case study in Umm Durmain/Karary", USA, 2012.

[14] D.S.Munasinghe, P.G.R.N.I. Pussella, M.D.E.K, Gunathilaka, "Integration of GIS and AHP for suitable site selection of Domestic waste water Treatment Plant: A case study of Akkaraipattu Municipal Council", Srilanka, 2015.

[15] Bharathi Battu, Prof. Murthy Polasa, "Design of Sewage Treatment Plant for a Gated community", Hyderabad, India, Vol no3, 2014.

[16] Mr.Chakor Bushan D, Mr.Kolhatkar Servesh H, Mr. Rathod Govind U, Mr.Trimbaka Dhiraj, "Design of Sewage Treatment Plant for Lottegaon Village", Pune, India, Volume No4, 2017.

[17] Aswathy. M, Hema priya, "Analysis and design of Sewage Treatment Plant of Apartments in Chennai", India, Vol no13,2017.

[18] Ms.S.Ramya, Aswani Krishna, Athulya Babu, Harsha K.Rajan, "Design of Sewage Treatment plant and characterstics of sewage", 2015.

[19] Swati Shree Samal, "Design of Sewage Treatment Plant", vol 13, 2016.