DESIGN APPROACH FOR SEWAGE TREATMENT PLANT: A CASE STUDY OF GUNTUR GREATER MUNICIPALITY, ANDHRA PRADESH, INDIA

Janaki Vallakeerthi[1], Aenumula Mallikarjun[2]
[1,2]Assistant Professors, TKR Engineering College (R9), Hyderabad, Telangana State

Abstract

Guntur city has been a developing place due to the steady increase in city population, which in turn resulted in the increase of domestic 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. 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 paper focuses on the sewage generation in the Guntur city area and sewage treatment plant is designed. In one day the total sewage generated was estimated 22.2 MLD considering the projected population of Guntur town for the next 30 years. The various components of sewage treatment plant are screening, grit chamber, primary sedimentation tank, biological reactor, secondary clarifier, activated sludge tank; drying beds. It is proposed to design the various components of sewage treatment plant considering the various standards and permissible limits of treated sewage water. The treated water will be supplied 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; Design approach; Waste water; Sedimentation; Sludge

Introduction

One quarter of the world's population is affected by economic water scarcity. Due to the growth of population, consumption of water resources is more and availability is less, so the demand for water is increasing. In India from urban areas, the waste water generated about 5 billion liters per day (bld) in 1947 which has Increased to about 30 bld in 1997 [1]. According to the Central Pollution Control Board (CPCB), 16 bld of wastewater are generated from Class-1 cities (population >100,000), and 1.6 bld from Class-2 cities (population 50,000-100,000). Of the 45,000 km length of Indian rivers, 6,000 km have a bio-oxygen demand above 3 mg/l, making the water unfit for drinking [2]. An estimated 80% of wastewater is generated by developing countries, especially China and India, is used for irrigation [1]. The irrigated area with waste water varies around 10% of the world's total irrigated area so the waste water can be used efficiently. To prevent the adverse effects on the receiving water bodies, whether it is used for gardening, recreation, water supply, or any other purposes adequate treatment of water is necessary. Municipal waste water/sewage treatment is the process of removing contaminants from waste water by using physical, chemical and biological process.

Literature Review

Maiti et al. [3] reported that the sewage effluent and sludge of Calcutta city was made to survey their manorial qualities. Sewage were normal to marginally alkaline in response and contained abnormal state fundamental tones, especially in winter, bicarbonate and chloride Ions were at toxic levels. Despite the fact that sewage effluents and slugged were rich in nutrient the toxicity levels.

In Venezuela, 97% of the nation's sewage is being released crude into nature [4] while, the greater part of Sub-Saharan Africa is without wastewater treatment. In a moderately developed Middle Eastern Nations, for example, Iran, absolutely untreated sewage has been infused into the Tehran city's groundwater [5]. All things considered urban drainage system ought to be considered as a critical base in expelling both wastewater and water from the city that is rain water to anticipate unhygienic conditions and to maintain a strategic distance from damage and flooding [6].

Wastewater or sewage treatment is one such option, wherein numerous procedures are planned and worked keeping in mind the end goal to imitate the normal treatment procedures to diminish the contamination burden to a level that nature can deal with. In such manner, exceptional consideration is important to survey the natural effects of existing wastewater treatment offices [7].

Chemical expansion indicates incorporate primary settling, during secondary treatment, or as a major aspect of a tertiary treatment process [11]. The procedure is more perplexing than anticipated by research center pure chemical tests, and that arrangement of and sorption to carbonates or hydroxides are vital factors. Actually, full-scale frameworks may perform superior to the 0.05 mg/L limit anticipated [12].

Wastewater or sewage treatment is one such alternative, wherein many processes are designed and operated in order to mimic the natural treatment processes to reduce pollutant load to a level that nature can handle. In this regard, special attention is necessary to assess the environmental impacts of existing wastewater treatment facilities [7].

Design Parameters

The design of wastewater treatment plant has three units (**Table 1**):

Parameters	**pH**	**BOD Mg/L**	**COD Mg/L**	**Oil & Grease Mg/L**	**Solids Mg/L**	**Total Coliform**
Raw sewage	6.4	200	600	50	600	100000 MPN/ml
Effluent	5.5-9.0	≤ 20	≤ 250	≤ 5	≤ 30	≤ 1000 no/100 ml

Table 1: Design parameters for influent and effluent.

1. Primary treatment which consists of screening, grit removal and sedimentation
2. Secondary treatment consists of a bioreactor
3. Sludge treatment consists of sludge thickening, gravity thickening and drying beds.

In a day at different times, the flow rate and concentration of water are varied which are subjected to seasonal variations. For example, the flow rate and BOD value are high in the morning. In rainy season due to surface run-off the solid contents are more.

Location of Treatment Plant and Design Considerations

The location of treatment plant should be nearer to the disposal point. If the generated sewage is disposed finally into the river, the treatment plant should be constructed near the river bank (Krishna) at Guntur (**Figure 1**, **2** and **Table 2**).

Figure 1: Waste water treatment plant flow diagram.

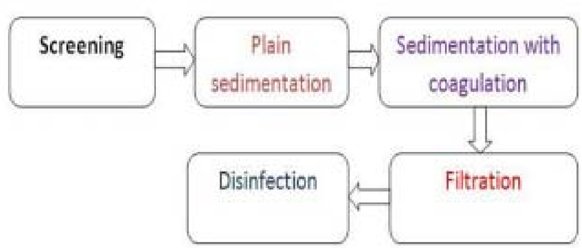
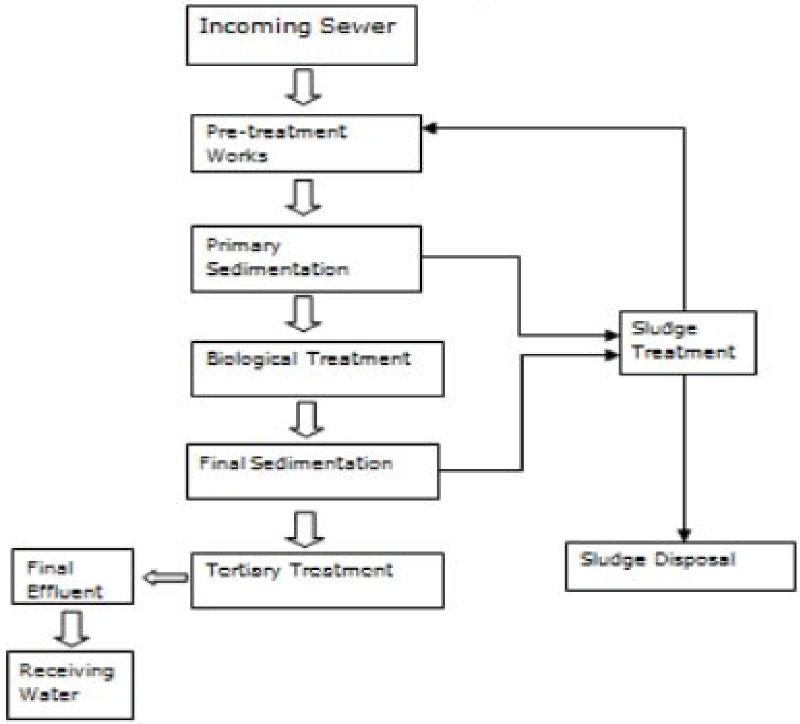


Figure 2: Function decomposition



Design Parameter	**Value**
Design period	30 years
Estimated population by the year 2046	179,000 numbers
Water supply per capita	155 L/h/d
Total volume of sewage water estimated from the population of GUNTUR city	22.2 MLD
Average discharge	0.25 m^3/sec
Maximum discharge	0.5 m^3/sec
Dimension of screen	Width 0.59 M Depth 1 M Provide 10 media 16 bars
Dimension of Girt chamber	Number 2 Length 205 M Width 10 M Depth 3 M
Dimension of primary sedimentation tank	Length 34.4 M Width 8.6 M Depth 3.6 M Free board 0.6

Design Parameter	Value
Dimension of trickling filter	Dia 25 M Depth 5 M
Dimension of aeration tank	Number 4 Length 22 M Width 11 M Depth 5.3 M
Dimension of sludge drying bed	Length 0.25 M Width 20 M Depth 0.5 M

Table 2: The design calculations for wastewater treatment plant.

Design considerations are:

1. The design period ought to be taken in between 25 to 30 years.
2. The configuration ought not to be done on the hourly sewage stream basis, yet the average residential stream basis.
3. Instead of providing one major unit to every treatment more than two number little units ought to provide, which will give in the operation and also no stoppage amid of the maintenance and repair of plant.
4. At every place of the plant, self-cleaning velocity should develop.
5. The configuration of the treatment units ought to be efficient; easy in maintenance ought to offer adaptability in operation.

Materials and Methods

The district Guntur is located at 16° 18" North and 80° 27" East altitudes. The altitude of the place above mean sea level is 93.0 m. The climate is generally tropical and humid. The mean daily maximum temperatures are in the range of 27.7°C to 34.0°C and mean daily minimum temperature varies between 7.5°C and 27.8°C. The annual mean relative humidity is 77%. The average annual rainfall is 974 mm. The dominant wind direction in general is from the SW towards the NE. The two monsoons that cover the area are the South-West monsoon (June to September) and North-East monsoon (October to December).

Sewage treatment is the process of removing organic and inorganic matter present in wastewater and household sewage, both runoff (effluents) and domestic. It consists of physical, chemical, and biological treatment processes to remove physical, chemical and biological parameters which are present in waste water. Its main aim is to produce a treated effluent and sludge which are suitable for discharge without any adverse effects on the environment also the treated water or effluent is used for irrigation, industrial purposes. The sludge consists of many toxic organic and inorganic compounds. Sewage means the collection of wastewaters from all the areas of city that is domestic sewage and conveying them to some point of disposal. The liquid wastes or the sewage will require treatment before they are discharged into the near water body that is Krishna River or otherwise disposal of untreated water will results to endangering the public health and also causing adverse effects on aquatic life.

Sewerage is the process of collection, treatment and ultimately disposal of the sewage. Sewage is liquid, which consists of any one means liquid waste origins from urinals, latrines, bath rooms, kitchens, commercial building or institutional buildings. Storm sewage is a liquid flowing in sewer during a period of rainfall and results in reduce the concentration of influent.

Treatment of sewage

The sewage treatment consists of many processes to remove different parameters present in waste water. The degree of treatment depends upon the characteristics of the raw sewage or influent and the required effluent characteristics. Sewage treatment processes are classified as:

1. Preliminary treatment
2. Primary treatment
3. Secondary treatment
4. Tertiary treatment

Screens and grit chamber

The purpose of screens is to remove large floating material and coarse solids from wastewater. Screens regularly comprise of wedge wire. It is done in two stages. In the first stage also called coarse screening, the measure of the opening is 20 mm to 30 mm. It catches the large articles. In the second stage called fine screening the openings differ between 1.5 mm to 6.4 mm. The cross segment range of the screens is commonly 1 m2. For a daily flow rate 22.2 MLD feed of waste water the pollutants removed this stage are almost 0.2 MLD. At the point when the head loss over the tank exceeds 0.6 M. The screens should be cleaned. Grit removal chambers are the sedimentation tanks placed before the fine screen to remove inorganic particles having specific gravity 2.65 like sand, egg shells and other non-putrescible materials may damage pumps due to abrasion. The grit basin is intended to scour the lighter particles while the heavier grit particles remain settled down [13].

Primary sedimentation

Sedimentation is the process of removing solid particles heavier than water by gravity settling i.e., the particle size less than 0.2 mm and specific gravity 2.65. In wastewater treatment, sedimentation is used to remove both inorganic and organic materials which are settle able in continuous-flow conditions [14]. The sedimentation tank comprises of a tank with 2 settling pipes where solid waste settles down. Baffles are provided to improve the settling process. At this stage the removal percentage of suspended solids are 60% to 65% and BOD from sewage is 30% to 35% [15]. Skimmers are used to remove the floating impurities like grease and oil on the water surface during sedimentation.

Biological treatment

The biological unit process of sewage is a secondary treatment in which colloids and dissolved solids of sewage, from primary sedimentation. The attached growth process, i.e., trickling filter, the microorganisms containing aerobes remain attached with filter media [16]. The effective size of the particle of filter media is of plastic material 25 cm to 75 cm, with a filter depth commonly 2 M to 3 M. The larger stones of size 8 cm to 10 cm placed in 15 cm to 20 cm thick and small size stones 2.5 cm at the base. 30% to 35% of BOD is removed from sedimentation, in this reactor, nearly 90% of sewage is removed [17].

Sludge digestion

The solids sediment from different units might be dried and disposed off. It also involves the treatment of highly concentrated wastes in the absence of oxygen by anaerobic bacteria. Sludge thickening used at medium to large plants is gravity thickening, dissolved air flotation, and centrifugation. Sludge dewatering is also known as sludge drying in which sand bed consists of a coarse sand 15 cm to 25 cm in depth. The drying period is 10-15 days and moisture content is 60% to 70% in sludge cake [18].

Conclusion

In the present study a scheme for the waste water treatment plant and management of sewage generated from Guntur city were analyzed. The utilization of treated water will reduce the ground water consumption and also supply for irrigated lands. The treated sludge is used as manure, will increase the fertility of soil.

Important units of the sewage treatment plant have been designed for a specific case are:

1. The design of primary sewage treatment is for the predicted population of 179,000 and estimated sewage of 22.2 MLD.
2. The dimension of screen is 0.59 m × 1.0 m.
3. The dimension of grit chamber with aeration is 2.5 m × 10 m × 3 m.
4. The dimension of the primary sedimentation tank is 34.4 m × 8.6 m × 3.6 m.
5. The dimension of the trickling filter is diameter of 25 m and depth 5 m.
6. The dimension of the aeration tank is 22 m × 11 m × 5.3 m.
7. The dimension of sludge dry bed is 0.5 m × 20 m × 0.5 m.

The construction of the sewage treatment plant will prevent the direct disposal of sewage in Krishna River and the use of treated water will reduce the surface water and contamination ground water.

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