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Environmentally sustainable sewage management – a case study of Ahmedabad, India

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Abstract:
With the rapid growth of urbanization and industrialization, the generation of municipal sewage is increasing on a time scale. Presently, there are least treatment facilities available in majority of class 1 and 2 towns in India. Consequently, sewage water is either being discharged into rivers, natural water courses or on low lying lands thereby polluting the water resources and causing various diseases. There exists a strong need to address this problem on a scientific scale with integrated and sustainable approach. An effort has therefore been made by the authors of the present paper to carry the case study of Ahmedabad, India in which population trends along with forecasting is done. Similarly, trends of sewage generation and forecasting on a time scale were done. An attempt has also been made to highlight the waste water treatment methods with focus on the design of Aerated lagoon method to treat the municipal sewage. The bio gas generation along with economic value have also been worked out by the authors to provide sustainability coupled with application of treated sewage waste water in raising the green infrastructure.

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I. Introduction:

The world is thriving for growth and development. But it is much lacking in sanitation and wastewater treatment. Majorly in developing countries just quarter of its sewage generated is treated, remaining sewage is disposed in haphazard ways. On an average around 78 % of wastewater goes untreated.

On an average around 1.7 million tons sewage is generated a day in India. Out of which 78% of the sewage generated remains untreated, resulting into contamination of water bodies and land area.

As we are doing studies on Ahmedabad we have some data hands on. Ahmedabad Municipal Corporation operates and maintains 9 Sewage Treatment Plants, 45 Sewage Pumping Stations and approximately 2500 kms long Sewage Network throughout the city area.All the 9 existing STPs (Sewerage treatment plant) are up to Secondary treatment. Tertiary treated water can be recycled and reuse in Industries, Plantation and Lakes/River.Municipality also sells Raw Sewage to the Industries at INR 2.60 per kiloliters for dilution and

Secondary treated sewage of S.T.P. to the Industries at INR 4.60 per kiloliters for dilution. AMC Sells S.T.P Sludge as manure at INR 285 per cubic mtr and Sells Gas at INR 9.18 per cubic mtr. From bottling plant.

II. Literature Review

India's population is increasing day by day, less employment opportunities and poor income conditions in villages are main reason that attract the rural population to the urban areas. Due to growth of population that also increases use of water and generate large volume of urban waste water that leads us to invest in wastewater system to manage flows and protect downstream areas. On an estimate 78 % of sewage water is untreated and the water is direct discharged into the land and water bodies, and contaminated the water bodies and sources of water, threatened people to cause water-borne diseases, agriculture contamination, Environmental degradation.[2] According to the WHO-UNICEF, around 638 million people do not have toilets in India which leads to 52% of people to open defection.[1] India has an enormous opportunity to develop the projects that treat wastewater for recycling and reuse. By reusing the water also increase India's Economy and generate Income.

Reclaimed water also fulfil the agriculture demand, landscape watering, toilet flushing, fire protection, dust control, air conditioning, cooling industries processes etc.
Some of the cities that adopted wastewater management system with reuse and recycling and driving their cities to the "zero discharge" [3].

- **Tokyo**

It is located at the head of Tokyo Bay, on the eastern coast of Honshu, the largest of the four main islands of the Japanese archipelago with a population of approx. 12.5 million and a population density of 5700 person/km2 [5].In Tokyo, municipal sewerage covers almost the whole area (2183km2) and 5.5 million m3 sewage is treated in a day [6]. Reuse of wastewater for toilet flushing by area wide water recycling system is supported by the metropolitan government of Tokyo [5].Through this technique the treated reclaimed water is given to the buildings for the toilet flushing use. In this method first treated secondary effluent is furthertreat by the tertiary treatment or advanced processes. This is the first project that is developed area wide in japan. In 1984, japan started area wide business of reuse of reclaimed water supply in which the reclaimed water is supplied to the office buildings or building that is use for commercial purposes. Now 4000 m3of secondary effluent treated in japan by rapid sand filtration system and given to 28 high rise building in Ochiai wastewater treatment plant. In 2006 approx. 3 million m3 of reclaimed water was produced in 3 STP. Tertiary treated wastewater from the STP by rapid sand filtration system is also discharged to urban rivers to the amount of 110,000 m3 /day in 2005.Recycled water is deepens to artificial streams or ponds in adjacent parks (after RO treatment), industries, and incineration plants of domestic waste, a railway company, and tanks for fire fighting use. "Ozone-resistant membrane" system is developed by TMG to improve the odour and colour of recycled water. This system is combination of pre-ozonation, bio-filtration, ozonation and micro-filtration after secondary treatment [5].

- **Bangkok**

Bangkok, city, capital, and chief port of Thailand. It is located on the delta of the Chao Phraya River, about 25 miles (40 km) from the Gulf of Thailand. It has a projected population of 7 million by 2030, covered are is more than 1500 km^2[3]. Increasing population with increasing water demand that generate more wastewater, that is now concern for Bangkok city. The Disposal of wastewater is a huge issue that Gov. should take step towards this. 108 tons of dry matter sewage sludge was generated per day in 2005. 6 wastewater treatment plant is started in Bangkok. Area provided is 192km^2 and 992000 m^3 day-1amount of sewage treated and Bangkok metropolitan administration introduce the budget of more than 20,000 million [7]. In Thailand sludge is utilize in agriculture sector as a fertilizer, energy generation (research is going on) in this way Thailand use sludge as a profitable resources [3]. Agriculture sector is very powerful In Bangkok, around half of its population (60%) is under the agriculture sector [3]. We know the Bangkok as an urban city though, its 21,000 km^2 area is covered by agriculture land and its shows that about 14% of the Bangkok area is utilized by agriculture sector [3]. Bangkok also have a large scale export business in this sector [3].BMA's have come up with idea that they first collect and treat septic sludge by evaluating sludge's characteristics. After the treatment sludge is used as fertilizer in the city's gardens, surrounding green areas and farmland [3]. The sludge from the 12 WWTPs is used as a manure, Dewatered sludge and mix of natural rice straw make compost. This uses give boon to the economy by selling the sludge and also help to increase economy and also high amount of wastewater is treated and generate profit for the local bodies. In this way sewage treatment facility is manage by the city which driving to the more sewage collection system and generate fertilizer. After the transformation of the sludge is, it being sold and that create income that is called business for local bodies, due to this policy more and more people attracted towards these and treat the sewage. By proper management of this whole system, pollution is reduced and it can achieve the aim of Zero Discharge [3].

III. Sewage treatment Plants Technologies:

In Today's world technology plays very important role in sewage treatment plant. Growth of population result into increment of wastewater generation, which drive us to develop new advanced technologies to treat and reuse wastewater. Many technologies have already been developed to treat sewage, but suitability of technologydepends on factor such as the detailed analysis of local conditions and their needs, application of scientific knowledge, engineering judgment, past experience, consideration of federal, state, and local regulations. In some areas, there is requirement of detailed risk assessment. In the sewage, impurities such as BOD, COD, pH, TSS, Biodegradable organic constituents, pathogens, and nutrients are present in the sewage waste water. For the effective removal of this pollutants, sewage treatment technologiessuch as conventional and advanced treatment are used. Conventional technologies are usually simpler and easier to deploy, with less reliance on advanced machinery and equipment. The conventional treatment plants installed in the country usually deploy one or more main technologies.

3.1 Conventional wastewater treatment:

This treatment includes physical, biological and chemical processes and operation to remove organic matter, solids and sometimes nutrients [8].

a) Preliminary treatment: This treatment includes removal of coarser particles, floating materials, slit, larger size material that is present in the waste water. Preliminary treatment operations are coarse screening, grit removal, and, in some cases, communication of large objects. In this treatment physical and chemical processes including sedimentation, Filtration, Coagulation, Neutralization, etc. are used. [8].

b) Secondary Treatment: This treatment uses biological processes for the further removal of wastewater treatment. This treatment is uses to remove residual organic, biodegradable organic and colloidal organic matter using aerobic biological treatment processes. The treatment usually consist of biological conversation of colloidal and organic matter of biomass that can be removed. Various technologies are used in India for this treatment. Some of the commonly used and effective technologies are as following:

3.2 Up flow anaerobic sludge blanket:

- This treatment is also known as UASB reactor. This type of treatment is used for the treatment of domestic wastewater, water that contain carbohydrates, substance that adversely affect the sludge granulation, cause foaming or cause scum formation. This treatment is suitable to treat wastewater from starch or canning industries, food processing industries etc. This is one type of anaerobic treatment which required low energy and handle high Hydraulic Loading Rate, Organic Loading Rate [9].
- This is the anaerobic process or anaerobic wastewater treatment (Process without air or oxygen). It is a single tank(circular or Rectangular tank) process in which water flows from bottom to upward direction. This is the three stages reactor which allows reactor to separate gas water and sludge mixture under high turbulence. Most important element which is consider while designing is influent distribution system, the solid-gas separator, effluent withdrawal [10]. As the wastewater is passing through the sludge blanket reactor, microorganism in the sludge break down organic matter by anaerobic digestion and produces the biogas. Treated effluent is collected from the top.
- This treatment doesn't requires high energy or mechanical equipment, thus design is simple and cost-effective.

3.3 Activated SludgeProcess:

- The activated sludge process is a biological process. In activated sludge process, Aerobic treatment is used in which oxygen is forced into sewage resulting in biological floc. Due to the floc, the organic content of the sewage is reduced. Due to this method, biochemical oxygen demand (BOD) and total suspended solids are reduced. Biological nitrification and denitrification of the wastewater is incorporated in the process .Nitrogen and phosphorus can be removed by this method. It can be used to oxidize carbonaceous organic matter and oxidizing nitrogenous matter.

3.4 Trickling Filter :

- In trickling filter treatment system, there is a media which comes in contact with wastewater resulting in development of microorganisms on media (also called biofilm). This film stabilize organic matter. The media can be stone, plastic, wood and ceramic etc. Aerobic condition are maintained in this treatment system. Biofilm removes pollutants by adsorption and absorption of organic compounds and inorganic compounds like nitrate and nitrite .Filter media is chosen in such way so that it can give high surface to volume ratio. The biochemical oxidation releases carbon dioxide, water and oxidized end products. Secondary sludge is formed when biofilm layer becomes heavy and it drowns into liquid flow.

3.5 Karnal Technology :

- In the Karnal technology trees are grown on ridge 1m wide and 50cm high. Untreated sewage is disposed in the furrows. The quantity of the sewage disposal is managed properly that it is absorbed in the soil in 12 -18 hoursdepending on the factors such as types and age of plants, climatic condition, soil condition and quality of the effluent. In this technique entire biomass is supplied to the soil & plants as a nutrient. Trees which are growing fast and transpire highamount of water are suitable for this purposes. This technology is cost-effective, require less maintenance and also don't need any skilled person [12].

3.6 Sequential Batch Rector (SBR):

- SBR is aerobic treatment of wastewater in which one tank is being used to carry various treatment operation.It is one type of fill and draw activated sludge system [13].
- In this system wastewater is added into the batch rector where all the operation occurs batch wise and wastewater is treated for removal of unwanted substances and component and then discharged [13].

- This system is also used for the treatment of industrial wastewater along with sewage water [13].
- This system consists of 5 stages: 1) Fill 2) settle 3) Ideal 4) react 5) decant [7].
- In the first phase the wastewater from the primary treatment is filled in the reactor along with activated sludge (Food and microbes) which is responsible for the biochemical reaction. This stage also allow mixing and aeration process in the tank .In the react phase there is no mixing and aeration occurs only reactions are take place. In this phase microorganism break down the organic matter in the presence of oxygen. Carbonaceous BOD is removed in this phase and nitrification occurs. Then in the next stage sludge is settled down and then treated supernatant is removed. After ideal phase tank, is ready for next batch process. Pollutants removal efficiency: BOD5: 95%, COD: 90%, TSS: 95%, pathogen: N/A [14].

3.7 Rotating Biological contactor:

- Rotating biological contactor (RBC) Consists of moving disc and it is type of fixed media filter. Discs are coated with biological slime. Due to movement of disc , the slime comes in contact with wastewater for some time and then come in contact with air for some time so that it take up oxygen from air and break down BOD. There is no need of aerators in this process. This process removes organic matter and ammonia from water. The efficiency of RBC is 85% [11].

a) Tertiary or Advanced Treatment: This is the combination of physical, chemical biological processes. This treatment used for the removal of remaining inorganic pollutants and nutrients such as nitrogen, phosphorus, TDS, color, odor etc. which are not removed by primary or secondary treatment. This treatment is also used to achieve legal standard and also for reuse purposes. The type of advanced treatment used depends on the purpose of reuse, factor in which treated water is used and type of pollutants present in the wastewater.

IV. Case study of the Ahmedabad:

Ahmedabad – anurban metropolitan city, with growing populationis situated near the banks of the Sabarmati River. It is also known as Industrial hub and is the 5th largest city by population in India according to the census 2011 [16].

We have come up with the forecasted population for several decades with an average sewage generation per day. We have made a case study on Ahmedabad city sewage treatment plant having economic advantages and having minimal treated sewage going into discharge. In order to estimate the economic value in STP we have to calculate future projected population, amount of sewage generation and how much amount of sewage is being treated for reuse.

Ahmedabad has a population of about 5,577,940 in 2011 according to the census data. The projected population of the Ahmedabad has been estimated with the three methods referred below and the projected population is shown in table 1 and reflected in figure 1..

1) Arithmetic increase method
2) Incremental increase method
3) Geometric increase method

4.1Population projection:

Population projection has been done using three methods as shown above and its values reflected in table 1 below and also shown in figure 1. The average of three methods taken for the study purpose.

Table 1: showing projected population for different decades

FORECASTING OF POPULATION				
Year	Arithmetic Increase Method	Geometric increase method	Incremental increase method	Average projected population
2021	63,76,213	72,60,536	65,14,479	67,17,076.04
2031	71,74,487	94,50,690	75,89,283	80,71,486.64
2041	79,72,760	1,23,01,509	88,02,352	96,92,207.09
2051	87,71,033	1,60,12,282	1,01,53,691	1,16,45,668.92

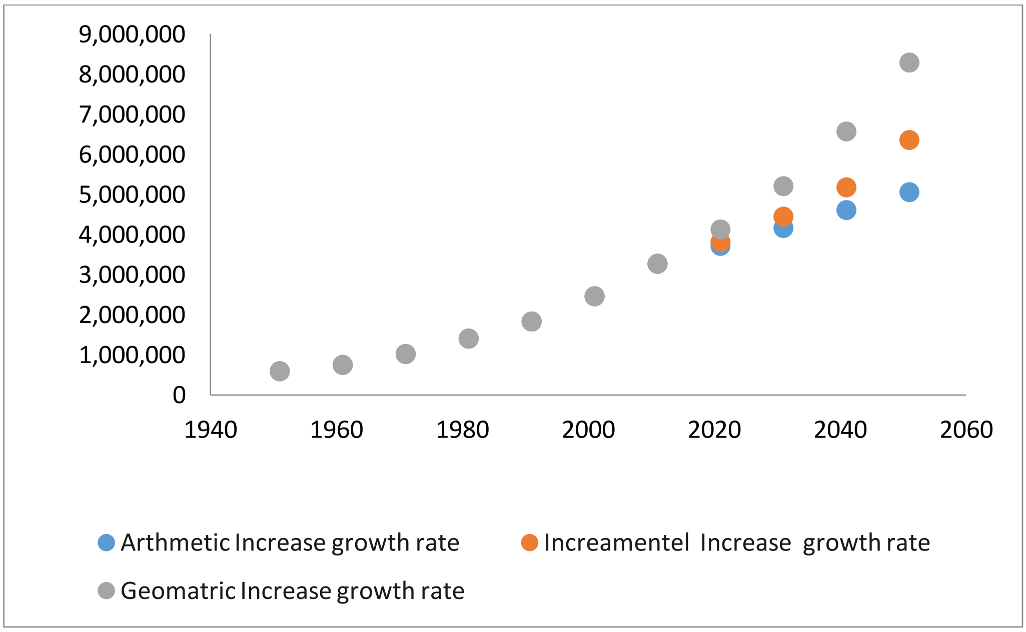


Figure 1: Showing population projection from different method for different decades

4.2 Projected water consumption and sewage generation:

Now, for the estimation of sewage generation, we have made calculations for water consumption of projected years and after that calculated total sewage generation on the base of water consumption data's. By projecting population of various decades , we have taken water consumption as 135 liter per capita per day and then taking sewage generation factor as 0.7 as not all the water consumed goes into sewage.**(Table 3, Table 4)**

Table 3: Showing projected water consumption during different decades

Water consumption	
2021	906,805,265.91
2031	1,089,650,696.50
2041	1,308,447,957.30
2051	1,572,165,304.57

Table 4: Showing projected sewage generation during different decades

Sewage treated per day	LPD	m3/day	m3/sec
2021	634,763,686.14	634,763.69	7.35
2031	762,755,487.55	762,755.49	8.83
2041	915,913,570.11	915,913.57	10.60
2051	1,100,515,713.20	1,100,515.71	12.74

4.3 DESIGNING OF A WASTEWATER TREATMENT PLANT

Wastewater is treated by four processes, that is:-

- Preliminary Treatment – This treatment usedBar screening and Grit removal unit for the removal of pollutants.
- Primary Treatment – This treatment useprimary Clarifier as a unit.
- Secondary Treatment – This treatment use Aeration tank and Secondary Clarifier as aunt.
- Tertiary Treatment – This treatment uses Filtration, Disinfection and Nutrient removal for remaining pollutants

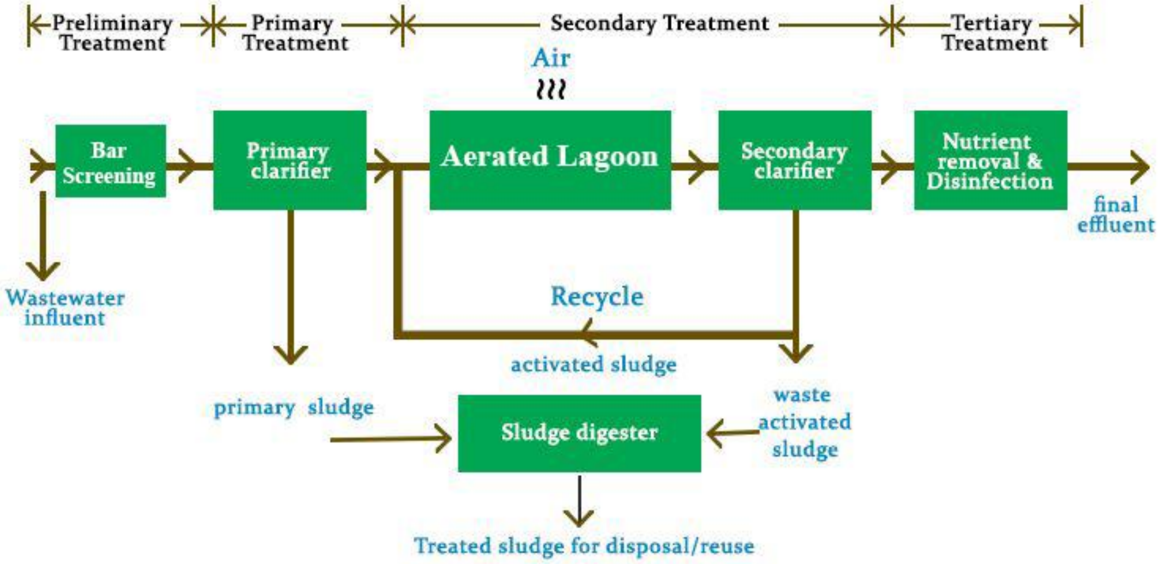


Fig. 2. – **Shows the Wastewater Treatment Process and the various stages involved**

After the Tertiary treatment the water is given to achieve standards of the effluent after that the treated water is ready to be reused in many sectors such as such as irrigation, domestic purposes and alsodischarged into river, pond or surface water bodies to increase the water level. Also activated sludge is being produced during the treatment of primary and secondary treatment.

4.3.1 DESIGNING OF SCREEN CHAMBER

Screen Chamber is made up of rectangular bars and is a part of the preliminary treatment in the wastewater treatment plant. It is one of the initial stages of wastewater treatment. Screen chambers is a mechanical filter and is used to remove large objects such as rags, plastic, metal containers etc. [17]

In order to design a screen chamber the projected sewage of a particular projected decadal year needs to be considered. In this case, we are considering the projected population and the sewage generated of the year 2021. Thus the calculations are as follows:-[17]

Volume of the amount of sewage being produced in the year 2021 is = 634,763.69 m3/day

Assuming the design rate flow is 1.5 times of the average regular flow.
Hence, the total volume to be handled by the screen chamber is = 1.5 x 634,763.69
=952145.535m3/day =11.02m3/sec
The velocity assumed for the ideal velocity flow throughout is 0.6m/s.
Total area required to accommodate the wastewater flow = 11.02 /0.6 = 18.43 m2
Depth of the wastewater flow = 0.706 meter
Let the width of the opening of the chamber with rectangular bars be 2.55 meters = 2550 mm
Using 12mm rectangular bars at 50mm centre to centre distance and
Clear opening= 40mm
End clearance=40mm
Let number of bars in the screen chamber be n
Total width of opening= (n+1) x 40
Or, 2550 = (n+1) x 40
Therefore, n= 62.75 = 63 numbers
Henceforth,
Total width of the screen chamber= 155+79 x 1.2=330.6 cm = 3.306 m
Total length of the screen chamber= 18.43/3.306 = 5.57 m [17]

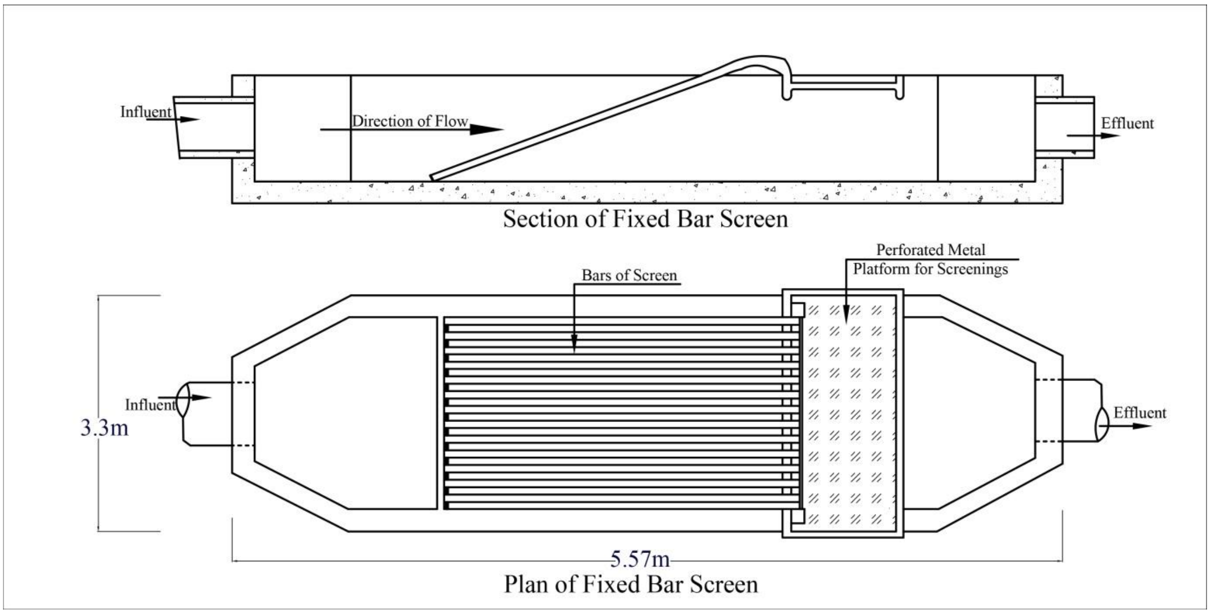


Fig. 3. – Shows the Plan and section of the proposed Screen Chamber

4.3.2 DESIGNINGOF PRIMARY CLARIFIER

After the preliminary treatment the wastewater inserted into a sedimentation tank also known as primary clarifier. Thus, a Primary Clarifier is used for the removal of solids physically by using gravity and allows the solids and organic matter to settle down. Primary clarifier is a apart of primary treatment. [17]

While designing primary clarifier, following assumptions are taken into considerations,[17]
High performance flow rate=20 m3/m2/day and
Clear water depth= 3 meters
Design calculations:
Assume the number of clarifier to be 20
Sewage Production= Wastewater quantity / No. of clarifiers
= 634,763.69/ 20 =31,738.18 = 31,738
Loading rate = 20 = Sewage Production /(π/4) x D2
= 11052 / (π/4) x D2(Where, D is the Depth)
Therefore, D = 44.96 meters = 45 meters
Volume of clarifier= 20 x ((π/4) x D2= 31,808.62m3 = 31,809 m3
Since, Waste water quantity= 634,763.69m3/day = 634,764 m3/day
So, Detention time= Volume in m3/ Waste water quantity
= 31,809/634,764 = 0.05 days = 1.2 hours
The primary clarifier removes almost 30% of the influent BOD and 80% of the suspended solids.
Hence, BOD after passing from the primary clarifier = 0.7*283= 198 .1mg/l=200 mg/l

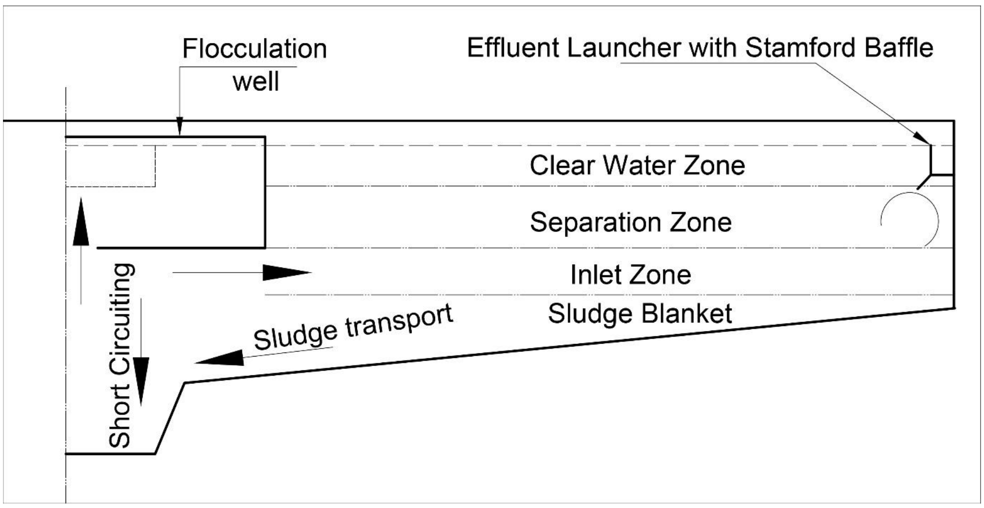


Fig. 4. – Shows the Section of the proposed Primary Clarifier

Table 5: Shows the characteristics of water of the sewage wastewater..

S.No.	Parameters	Concentration		
		Minimum	Maximum	Average
1	BOD in mg/l	176	390	283
2	COD in mg/l	308	760	534
3	TSS in mg/l	84	1182	633

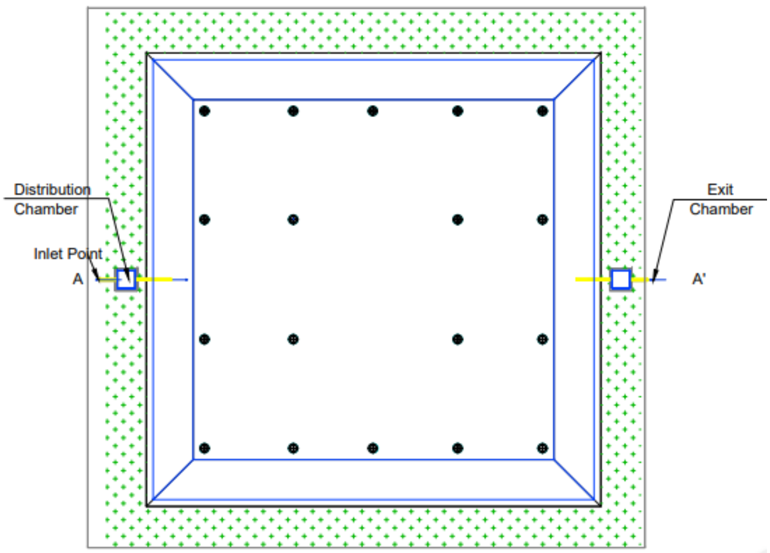
4.3.3 DESIGNING OF AERATED LAGOON

Aerated Lagoon or Aerated pond is a part of the secondary treatment of the wastewater treatment system. It consists of a pond that provides artificial aeration that promotes biological oxidation of wastewaters. Thus the proccess and the considered factors of designing an Aerated Lagoon is as follows: [17]

Influent BOD entering the Aerated Lagoon from the Primary Clarifier = Li = 200 mg/l
System Rate Constant = K = 0.12 / day
Oxygen requirement for 90 percent removal of BOD = 1.4kg/kg
Oxygen capacity of surface aerators=1.36 kgO2/H. P/hr
Depth of the Liquid = 3 meters
Width of the Free Board = 0.3 meters
Since Aerated Lagoon is rectangular in shape, henceforth,
The ratio of Length: Breadth = 2:1 and Side Slope = 1 vertical: 1 horizontal
Effluent BOD after treatment through Lagoon = Le = 83 mg/l

4.3.4 Design calculations for the size of the Aerated Lagoon:

Detention time, t= log (Li/Le)/K
= 3.18 days= 4 days approximately[17]
Volume of the lagoon, V= Quantity of Sewage Production x Detention Time = Q x t
= 634,763.69x 4= 2,538,946.76 m3
As in total 8 Aerated Lagoons are being provided of equal size, thus
Volume of each Lagoon = Va = 2,538,947.76/ 8 =317,381.84 m3=317,382m3
Since,Va = 317,382 = [((2a x a) + (2a-6) (a-6)) x 3] / (8)
Therefore, a= 462.25 meters
Henceforth, width of each Lagoon = 462 meters
Assuming that BOD reduction is 90% and
Since, oxygen requirement = 1.4 kg/kg of BOD applied
Therefore, Total amount of BOD applied = 634,763.69x 283 x 200 / 106 = 35,927.62 kg/ day
Total Oxygen required in the process = 1.4 x 35,928 kg O2/ day = 2,095.8 kg/hr. =2096 kg/hr.



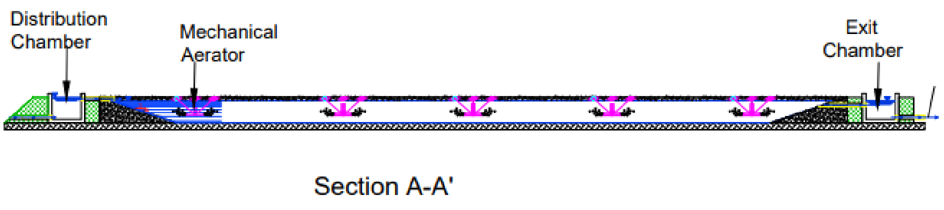


Fig. 5. – Shows the Plan and section of the Aerated Lagoon

- **Horse power requirement:**

Assuming surface aerators capable of transferring 1.36 kg of O2/ H.P/ Hour at lagoon condition[17]
Therefore, Total Horse Power required = 2,096 /1.36 = 1,541.17 H. P
Thus, by providing 23 aerators of 67.1 H. P capacity each, each aerated lagoon compartment is supposed to have 4 aerators

4.3.5 DESIGNING OF SECONDARY CLARIFIER:
Quiescent Settling Zone also known as Secondary Clarifier is a settling pond which uses the principles of sedimentation to remove suspended solids and turbidity from wastewater which is being created from the biological process while the wastewater passes through Aerated Lagoon. The factors considered and the process for designing the Setting basin is as follows [17]
This zone may be a diked-off portion of the aerated basin
Assuming detention time for quiescent settling = 2 days
Thus, Volume of settling basin = 8 x 634,764= 5,078,112 m3
Since one settling basin is provided for each aerated lagoon,
Hence, Volume of each basin = 5,078,112/8 = 634,764m3

Assuming that the width of the basin = 274 meters and Depth of the basin = 3 meters,
Length of settling basin = 634,763.69/274*3= 772.25 meters = 772 meters

4.3.6 DESIGNING OF SLUDGE DISPOSAL UNIT:
The residual by product that gets accumulated in Sewage treatment plants is called Sludge (or Bio solids) after the wastewater treatment process, it is mainly in the form of solids, semi – solids or slurry. Sludge can be classified into Primary Sludge and Secondary Sludge. Primary Sludge is extracted by chemical precipitation and sedimentation. Whereas, Secondary sludge is the biomass which is generated by biological treatment. Thus the amount of suspended solids and the volume of the settled sludge is given below. [17]

Average suspended solids = 633 mg/l(as per Table 5)
Assuming 80 percent removal of suspended solids from the Sludge extracted
Thus, Total Suspended solids removed = 633 x 0.8 = 506 mg/l
Also, Quantity of settled solids = 506 x 634,763.69x 1000/ 106= 126,254.1 kg/day
Assuming, that Primary sludge contains 4% solids by dry weight
Hence, the volume of settled sludge=32286 x 100/4= 422047 litres/day =4220.5 m3/day

V. Economic value:

An attempt has also been made to workout economic value of sewage treatment, particularly from sludge so generated from treatment. This sludge is proposed to be used for producing bio fuel and subsequent assessing its economic value to make the system sustainable. The amount of expected bio fuel produced and its economic value is reflected in table 6 below.

Table 6: Showing bio fuel generation and its economic value
We can generate income from biogas and have good economic value. Sewage sludge contain organic matter, pathogens, nutrient etc. so that sewage sludge is good source for the generation of biogas that produces energy.
Calculation:
Density of the sewage sludge: 1.03 g/cm3 = 1030 kg/m3 [18]
Volume of the sewage generated = 4220.5 m3 /day (as shown above in 4.3.6)
Density of the sludge = Mass
Volume
Mass = Density of sludge * Volume = 1030 kg/m3 * 4220.5 m3 = 43, 47,115 kg

44.82 ml of biogas generate from 1 Kg of sludge [19]
So, The generation of biogas from 43,47,115 Kg of sludge = 19,48,37,694.3 ml/day = 1,94,837.69 L/day
1,94,837.69 Litter Biogas is generate from 43,47,115 kg of sludge per day in Plant.
The cost of biogas = Rs.45/litter
So that, The cost of 1,94,837.69 litter of biogas is Rs.87,67,696.05 per day.

VI. Application of treated sewage:

The treated wastewater has various applications which include the development of green belts, vegetative cover in the vicinity of the wastewater treatment plant taking into consideration hydraulic loading concept. The treated waste water contains ample amount of nutrients and hence, the treated wastewater can be used for growing this vegetative cover without using the fertilizers. The selected plant species can be grown taking the local conditions into consideration. This enhances the green infrastructure within the city which helps in reduction of the odour produced from wastewater treatment plant and also helps in reducing the water and air pollution. The greenhouse gases evolved from the waste are absorbed by this green belt and this also restricts the waste water to directly join the main water body flowing from the city. A symbolic green infrastructure is shown in figure 6 below.

Figure 6: Showing green infrastructure developed from treated sewage wastewater

VII. Conclusion:

With rapid increase in urban population, the municipal sewage in increasing not only in India but on global scale. Such a huge quantity of sewage is being discharged untreated in majority of the countries. The treatments of sewage generated require huge money. But discharging of sewage untreated, caused multi dimensional problems. It pollute our surface water bodies, ground water, land, and responsible for various diseases caused to human beings. It would thus be proper to evolve environmental sustainable approach to address the problem. The sustainable approach would be achieved if technological plans are prepared on time scale with futuristic projections and the compatible technology linked with financial benefits. The authors of the present paper have tried on this sustainable approach having environmental benefits. The municipal authorities should also evolve sustainable approach to deal with such an emerging issue.

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