Design & Analysis of Sewage Treatment Plant for Shirpur Town

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***Abstract*—** Sewage is generated by residential, institutional, and commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into grey water and black water is becoming more common in the developed world, with grey water being permitted to be used for watering plants or recycled for flushing toilets.

Keywords*— *WSS: Water Supply Scheme, WWTP: : Waste Water Treatment Plant

I. INTRODUCTION

The earth is divided into the lithosphere or land masses and the hydrosphere or the oceans, lakes, streams and underground waters. Energy problems came to the attention of the world in 1973 as a result of the Arab oil embargo and the actions of the Organization of Petroleum Exporting Countries (OPEC). Transport and Alterations of Chemicals in the Environment

Humans are part of the flow of energy; in the biosphere we interact with thousands of plants and animals. Because of our power and productivity, we have the ability to alter the ecosystems of the Earth, of which we are a part, in a part of beneficial or harmful manner. Sewage may include storm water runoff, Sewerage systems capable of handling storm water are known as combined systems. Combined sewer systems are usually avoided now because precipitation causes widely varying flows reducing sewage treatment plant efficiency combined sewers require much larger and more expensive treatment facilities than sanitary sewers. Heavy storm runoff may overwhelm the sewage treatment system, causing a spill or overflow. Sanitary sewers are typically much smaller than combined sewers, and they are not designed to transport storm water. Backups of raw sewage can occur if excessive Infiltration/Inflow is allowed into a sanitary sewer system.

Environmental Problems And Human Health The decay of the environment and the resultant effect on human health grows daily. The sun is shrouded by the smoke of industry and dwellings. Sewage may include storm water runoff, Sewerage systems capable of handling storm water are known as combined systems. Combined sewer systems are usually avoided now because precipitation causes widely varying flows reducing sewage treatment plant efficiency combined sewers require much larger and more expensive treatment facilities than sanitary sewers. Heavy storm runoff may overwhelm the sewage treatment system, causing a spill or overflow. Sanitary sewers are typically much smaller than combined sewers, and they are not designed to transport storm water. Backups of raw sewage can occur if excessive Infiltration/Inflow is allowed into a sanitary sewer system.

Sewage is a turbid liquid containing solid materials in suspension and solution. When fresh, it is a grey in color and has a musty odor. It carries a variety of floating materials, including fecal solids, pieces of food, garbage, paper and sticks. When old, sewage changes from grey to black, develops a foul odor and produce black solids that float on the surface or though out the liquid. At this point, the sewage is called septic. Sewage consists of over 99.9% of water by weight.

The other, roughly 0.1 %, contains such solids as grit, suspended solids, or dissolved solids. The average domestic sewage contains 600ppm of total of solids. Of this group, 200ppm is suspended solids that contain settle able solids of 120ppm and colloidal solids of 80ppm. The settle able solids are 90ppm and 30ppm inorganic. The colloidal are 55ppm organic and 25ppm inorganic. The 400ppm of dissolved solids consists of 40ppm of colloidal solids and 360ppm of dissolved. Solids. These colloidal solids are 30ppm organic and 10ppm inorganic. These dissolved solids are 125ppm organic and 235ppm inorganic.

II. CHARACTERISTICS OF SEWAGE:

1.pH value:

The pH value of sewage indicates the logarithm of reciprocal of hydrogen ion concentration present in sewage. It is thus an indicator of acidity or alkalinity of sewage. If the pH value is less than 7, the sewage is acidic, if the pH value is more than 7, the sewage is alkaline.

2. **Chloride Contents:**

Chlorides are generally found present in municipal sewage and are derived from the kitchen waste, human faeces and urinary discharges etc. The normal chloride content of domestic sewage is 120 mg/l, whereas the permissible chloride content for water supplies is 250mg/l. However, large amount of chlorides may enter from the industries like ice cream plants, meat salting, etc., thus increasing the chloride content of sewage

3. **Nitrogen Content:**

The presence of nitrogen in sewage indicates the presence of organic matter, and occurs in one or more the following forms:

(a) Free ammonia
(b) Albuminoid nitrogen
(c) Nitrites
(d) Nitrates

4. Presence Of Fats, Oil And Grease :

Grease, fats and oils are derived in sewage from the discharges of animals and vegetable matters or from industries like garages, kitchens of hotels and restaurants, etc. These matters from scum on the top of sedimentation tanks and clog the voids of the filter media. They thus interfere with the normal treatment methods and hence need proper detection and removal.

5. Hydrogen Sulphide Gas :

The presence of hydrogen sulphide gas in sewage indicates the anaerobic decomposition. Its presence in large amount may cause corrosion of concrete sewers and may produce bad odors at the treatment plant. However, H2S is kept below 1.0 ppm in raw sewage; no such troubles may be anticipated.

6. **Dissolved Oxygen (D.O.):**
The determination of dissolved oxygen present in sewage is very important, because while discharging the treated sewage into some river stream, it is necessary to ensure at least 4 ppm of D.O. in it; as otherwise fish are likely to be killed, creating nuisance near the vicinity of disposal. To ensure this, D.O. test is performed during sewage treatment process.

7. **Biological Oxygen Demand :**
The biological oxygen demand of sewage is the quantity of oxygen required for the biochemical oxidation of the decomposable organic matter at specified temperature within the specified time. During natural decomposition the life activities of organisms are stimulated by high temperature and decrease at low temperature, therefore, the temperature and time during B.O.D. tests are specified. The standard time and temperature for this test in America is 5 days and 200C respectively.

8. **Chemical Oxygen Demand:**
This test is a measure of the amount carbon in organic matter of sewage. It is useful in identifying the performance of the various steps of treatment plants. It is also useful in determining the strength of industrial waters in sewage, which cannot be determined by BOD. test.
Etc.

VALUES OF B.O.D. FOR RAW AND TREATED SEWAGE

Nature of sewage	5 day 20^0C B.O.D in ppm or mg/1
Strong sewage	450 to 550
Average sewage	350
Weak sewage	250
Standard filter sewage effluent	20
Very good filter sewage effluent	5 to 10

III SEWAGE COLLECTION AND DISPOSAL

A system of sewer pipes (sewers) collects sewage and takes it for treatment or disposal. The system of sewers is called sewerage or sewerage system in British English and sewage system in American English. Where a main sewerage system has not been provided, sewage may be collected from homes by pipes into septic tanks or cesspits, where it may be treated or collected in vehicles and taken for treatment or disposal. Properly functioning septic tanks require emptying every 2–5 years depending on the load of the system.

IV TREATMENT

Sewage treatment is the process of removing the contaminants from sewage to produce liquid and solid (sludge) suitable for discharge to the environment or for reuse. It is a form of waste management. Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

- **Primary Treatment** consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.

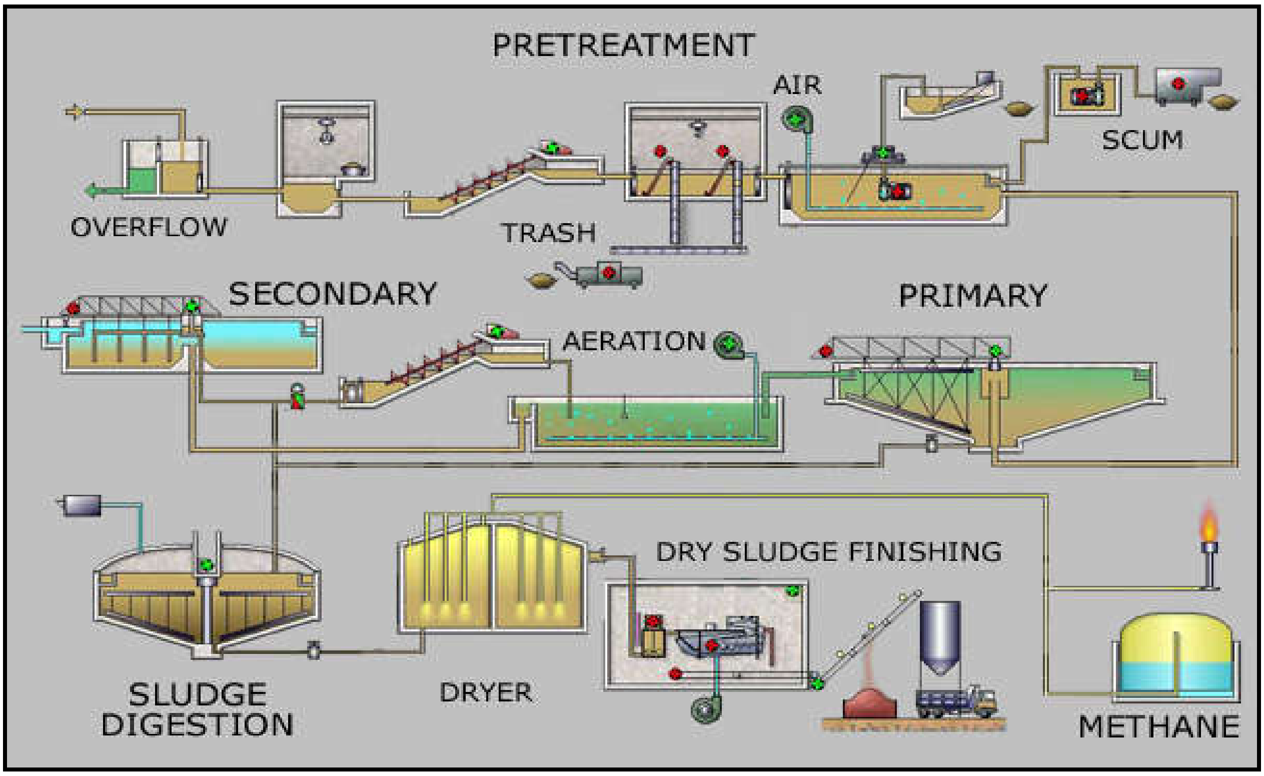
- **Secondary Treatment** removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.

- **Tertiary Treatment** is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs.). Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

V OBJECTS OF SEWAGE TREATMENT

Following are the main object of treatment of sewage:

1. Reduce organic content of sewage. If the rich in organic matter is disposed into natural water courses without treatment, it will start decomposing and will consume the dissolve oxygen in water and reduce it to such an extent that the aquatic life will not survive in such water. This process also emits various obnoxious gases. Moreover, if the water polluted by sewage is to be used for drinking purpose, it will cause health hazards.
2. To remove inorganic matter such as sand, grit etc. as these may obstruct the secondary treatment of sewage.
3. To remove substances, which are toxic or hazardous to aquatic life.
4. To remove odor and colour.
5. To kill pathogenic (disease-causing) organisms.
6. To make the disposal of sewage or sludge on land easier and free from nuisance.



WWTP LAYOUT

VI TREATMENTS OF SEWAGE

PRE- TREATMENT

1 Screening
2 Grit removal
3 Flow equalization
4 Fat and grease removal

PRIMARY TREATMENT

SECONDARY TREATMENT

1 Activated sludge
2 Drying beds
3 Surface aerated basin (lagoon)
4 Trickling filters
5 Secondary settling tank
6 Filter beds
7 Constructed wetlands
8 Soil bio-technology
9 Biological aerated filters
10 Rotating biological contactors
11 Membrane bio-reactors
12 Secondary sedimentation

TERTIARY TREATMENT

1 Filtration
2 Lagooning
3 Nutrient removal
4 Nitrogen removal
5 Phosphorous removal
6 Disinfection
7 Odor control
8 Waste management

VII METHODS OF FORECASTING POPULATION

1. Arithmatical increase method
2. Geometrical increase method
3. Decrease rate method
4. Incremental increase method
5. Simple Graphical method
6. Comparative Graphical method
7. Logistic curve method

Population of Shirpur:	69 545 people
Latitude of Shirpur:	21,3500 (2121'0.000"N)
1. Longitude of Shirpur:	74,8833 (7452'59.880"E)
Altitude of Shirpur:	158 m

Year	Population	Total Incremental	% INCREASE
1951.00	16332.00		
1961.00	20846.00	4514.00	27.64
1971.00	26000.00	5154.00	24.72
1981.00	34013.00	8013.00	30.82
1991.00	45473.00	11460.00	33.69
2001.00	61694.00	16221.00	35.67
2011.00	76905.00	15211.00	24.66
2041.00			
	281263	60573.00	177.20
		10095.5	29.53

Geometrical Increase Method

VIII DESIGN OF TREATMENT UNITS

Population as calculated by decrease rate method: 8,16,728
Sewage: 85lit/day/capita
Quantity of effluent in lit/day:

$$\frac{85 \times 816728}{3}$$

$$= 23140626.67 \approx 23140627$$

Volume of sewage:

$$\frac{23140627}{1000} = 23140 \text{ m3/day}$$

Design of screen chamber:
Total flow of sewage = 23140 m3/day
Standing period of screen chamber is 10 minutes.
∴ Volume of screen chamber = 160.69 ≈ 161m3.
If we considered screen chamber of 2m height, then size will be 12.5m×6.5m×2m.

Design of grit chamber :
Total flow of sewage = 23140 m3/day
Standing period of grit chamber is 10 minutes.
∴ Volume of one grit chamber = 160.69 ≈161m3.
If we considered grit chamber of 2m height , then size will be 12.5m×6.5m×2m.

Design of storage tank:

Total flow of sewage = 23140 m3/day

Standing period of storage tank is 2 hours.

∴ Volume of storage tank is 1928.33 m3

If we considered height of storage tank is 9m then diameter of storage tank will be 17m.

Design of settling tank and aeration and skimming facility:

Total flow of sewage = 23140 m3/day

Standing period of settling tank is 6 hours.

∴ Volume of settling tank is 5785m3.

We assume three settling tanks then volume of one settling tank will be 1930m3.

If we considered height of settling tank is 8m then diameter of tank will be 18 m.

We assume free board 100 cm.

Design of dosing tank and trickling filter:

Total flow of sewage = 23140 m3/day.

There is no standing period for dosing tank therefore dosing tank of 1m×1m×1m.

Standing period trickling filter is 20 minutes.

Volume of dosing tank and trickling filter in combination will be 321.38m3.

Assuming height of dosing tank and trickling filter is 3m.

Then diameter will be 12m. Assuming free board 100cm.

Design of secondary settling tank :

Total flow of sewage 23140 m3/day.

Standing period of 6 hours.

Total volume of secondary settling tank will be 5785m3.

Provide total three units for secondary settling tank then volume will be 1928.33≈1930m3.

Assuming height of tank is 8m.

Diameter of tank will be 18m.

Design of sludge digestion tank:

Assuming the following data:

Total suspended solids in the raw sewage = 350mg/liter

Volatile suspended solids = 250mg/liter

Moisture content of the digested sludge = 87%

65% of sludge removal is done in the primary settling tank and the fresh sludge has water contents of 95%.

∴ Volume of sludge collected in the primary settling tank

$$V = \frac{65}{100} \times \frac{350}{1000} \times 23.14 \times 10^6 \times \frac{100}{5} \times \frac{1}{10^3} \times \frac{250}{1000} = 26321.75 litres = 26.32 cu.m/day$$

Volume of digested sludge at 87% by using formula

$$V = \frac{V_1(100 - P_1)}{100 - P} \qquad (5)$$

Where,

V= volume of the sludge (wet)

V1= volume of the sludge (dry or semi dry)
P= percentage of water in the sludge (wet)
P1= percentage of water in the sludge (dry or semi dry)

$$26.32 = \frac{V_1(100-87)}{100-95}$$

$$26.32 \times 5 = 13 \times V_1$$

$$V_1 = \frac{26.32 \times 5}{13}$$

$$V_1 = 10.12 cu.m / day$$

∴

Assuming the digestion period as 30days
Capacity required.

$$= t\left[v\frac{2}{3}(v-v_1)\right]$$

$$= 30\left[26.32 - \frac{2}{3}(26.32-10.12)\right]$$

$$= 465.6 cu.m.$$

∴ Providing 6.0 m depth, the diameter of the sludge digestion tank

$$\frac{\pi}{4}d^2 = \frac{465.6}{6}$$

$$d = \sqrt{\frac{465.6}{6} \times \frac{4}{\pi}}$$

=10m.
∴ Provide 6m deep 10m diameter sludge digestion tank.

Design of sludge drying beds:
Volume of sludge will be reduced to 5/8 times the quantity of sludge.
Quantity of sludge in drying bed will be 291m3.
Providing 8 units of drying beds volume will be 36.38m3.
Provide height of 0.3m, area will be 121.26m3.
Dimensions of drying beds will be 16×8m.

IX CONCLUSIONS

Sewage is a dilute mixture of various types of wastes from the residential, public and industrial places. The characteristics and composition of sewage mainly depend on its source. Sewage contains organic and inorganic matter which may be in dissolved, suspension and colloidal state.
Some of this matter is harmful to human and animal life therefore there is a need for sewage treatment plant.

- **Gas collection from sludge digestion tank :**
- **Effluent disposal and utilization :**
- **Disposal of digested solid sludge :**

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