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A Feasibility Study of 40 KLD – Sewage Treatment Plant.

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Abstract - Water is the most essential resource useful for the humans. Due to the scarce supply of the potable water, it is necessary to reuse the water and achieve maximum usage out of it. In any industry, the water is used for various purpose like drinking, washroom, floor washing, processing, etc. The waste water then generated needs to be treated before release. A sewage treatment plant is set up for the treatment of waste water generated from Canteen, Urinals, Washrooms, etc. It does not contain any industrial effluent in it. For any waste water treatment plant to work efficiently and up to its working standards, it is necessary to optimize the working cycle. And to optimize the same, a feasibility study is to be carried out which takes into consideration the existing facilities, their outcomes and any corrections required for the shortcomings.

***Key Words*:** Sewage, Optimization, Feasibility Study, STP

1. INTRODUCTION

Water is the scarcest resource for the humans and all living beings. Currently the quality and availability of fresh water is the most concerning challenges faced by us. It may not seem so pressing to today's generation, but it is going to impact to the future generations. Due to rapid urbanization, increase in population, change in lifestyle, increased industrialization has led to a huge burden on the current water sources. So it is necessary for us to use the water with great caution. This situation requires urgent remedial measures through radical methods and water quality management system.

From the standpoint of sources of generation, wastewater may be defined as a combination of the liquid (or water) carrying wastes removed from residences, institutions, commercial and industrial establishments, together with such groundwater, surface water and storm water as may be present.

In any industry, water is used extensively for various purposes like drinking, washing, processing, etc. The waste water generated from the cafeteria, urinals, washrooms, etc. is termed as Sewage water. i.e Sewage consists of mixture of water along with human waste, food preparation waste, washing waste, etc.

2. Sewage Treatment Plant:

2.1 Plant Description:

The Sewage Treatment Plant (STP) under consideration has waste water inlet from different sources like Urinals, Washrooms, Canteen, Car Washing, etc. The STP has the following elements:

a. Influent Sewage Tank.
b. Bar Screen.
c. Oil & Grease Trap.
d. Equalization Tank.
e. Activated Sludge Process Tank.
f. Secondary Clarifier.
g. Activated Carbon Filter & Pressure Sand Filter.
h. Vegetated Bed – *Kardal* Plantation.
i. Sprinkler Tank.
j. Final Treated Sewage Storage Tank.
k. Sludge Drying Bed.

The units are designed in such a way to treat the influent sewage water which consists of urinal water, detergents used for washing hand, canteen washings, septage, etc. The sewage inlet line is standalone and no Industrial effluent gets mixed with the same.

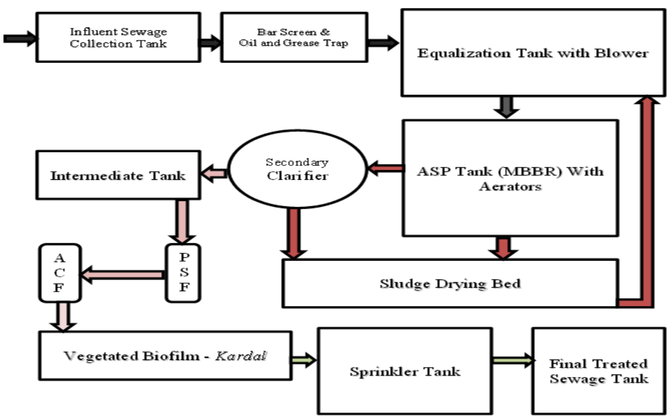

Fig. 1. Flow Diagram of STP.

2.2 Process Description:

A] Primary Treatment: In primary treatment, floating and suspended solids are settled and removed from sewage. Following this, discharge from the sewers enters a screen/bar rack to remove large, floating material such as rags, sticks, leaves, plastic objects, wrappers, etc. In Oil and Grease Trap, the effluent is passed in a tank to remove oil and grease from the waste water. The removal of oil & grease is very important part of the primary treatment. If the removal is not proper then the process of secondary treatment (Biological treatment) gets affected. After oil and grease removal the waste water further taken in to ASP Tank for Biological Treatment for reduction of BOD/COD. Sludge that settles to the bottom of the clarifier is pumped out, dewatered using a Sludge Drying Bed (SDB) and safely disposed of in a landfill. The water content from the sludge is then directed back towards the Equalization Tank.

B] Secondary Treatment: This is the next level treatment where the bacteria in sewage are used for further purification of the sewage. It's a biological process that removes about 85% or more of the organic matter in sewage compared with primary treatment. These processes are variations of what is called the Moving Bed Bio Reactor (MBBR) process, which provide a mechanism for bacteria, with air added for oxygen, to come in contact with the wastewater to purify it.

In the moving bed bio-reactor process, flow from Equalization Tank goes into an aeration tank, where compressed air is mixed with sludge in the presence of synthetic media on which the purifying organisms grow and contact the wastewater, removing contaminants in the process. The activated sludge allows bacteria to feed on the "food" provided by the new wastewater in the aeration tank, thus purifying it. The flow, along with excess organisms that build up on the media during the purification, then goes to a Clarifier.

C] Tertiary Treatment: Clarified effluent is then sent to the Intermediate Tank where it is passed on to the "Pressure Sand Filter' and 'Activated Carbon Filter'. Excess sludge is produced by the process and is sent to the Sludge Drying Bed for dewatering. This sludge is then used as manure for gardening purposes. Some amount of sludge is also recycled back into the Aeration Tank for balancing purpose. Then permeate generated from the SDB is then sent back to the Equalization Tank for treatment. The waste water is then passed through the bio film – Kardal plantation bed and sent to a sprinkler to increase its Dissolved Oxygen content. Later the treated waste water is then stored into a collection tank and is used for gardening purposes.

Table 1. Unit size and Hydraulic Retention Times.

Sr. No.	Unit Name	Dimensions	Volume Capacity	HRT
1	Influent Sewage Collection Tank	1m x 1m x 1m	1 m^3	35 mins
2	Equalization Tank	7m x 7m x 2m	98 m^3	2.5 Days
3	Activated Sludge Process Tank	4m x 4.4m x 3m	53 m^3	1.3 Days
4	Secondary Clarifier Tank	3m (Dia)	7 m^3	3.5 Hrs
5	Intermediate Tank	3m x 1.5m x 1.6m	7.2 m^3	4.3 Hrs
6	Pressure Sand Filter	600 mm Dia 1200 mm Height	--	--
7	Activated Carbon Filter	500 mm Dia 1800 mm Height	--	--
8	Kardal Plantation	25m x 10m x 2m	500 m^3	12.5 Days
9	Sprinkler Tank	12m x 6m x 2m	144 m^3	3.6 Days
10	Treated Waste Water Storage Tank	10m x 4m x 2.5m	100 m^3	2.5 Days
11	Sludge Drying Beds	2 X 1.5 X 1.5 each (4 in total)	1 m^3	3-7 Days

3. Feasibility Study:

A feasibility study tells us how the waste water might be treated. If the study is carried out carefully and correctly then we can clearly identify the problem or hindrances in achieving the design specifications of the treatment plant. A series of sampling and analysis is to be carried out over the influent and effluent to study the characteristics of the waste water over a period of time. Based off the results of sample analysis and quality required at the disposal end we can depict the efficiency of the plant and can judge the quality of the treatment plant.

The obtained results can be compared to design specs as well as to local Pollution Control norms. This will help in avoiding a non-compliance related to Pollution Control activities. The feasibility study also may give us scope to improve upon the treatment plant by employing a new method or new technology

3.1 Sewage Analysis:

To know the working efficacy of any plant, sampling and testing of sewage samples is necessary. A series of samples were collected over a period of 10 days for every step in the treatment cycle. The average results of it are shown below:

Table 2. Average values of parameters at each step.

Sr. No.	Step Name	Characteristic Parameter									
		pH	TDS	TSS	Bio-chemical Oxygen Demand @27 degC for 3 days	Chemical Oxygen Demand	Oil & Grease	Chloride (as Cl)	Sulphate (as SO4)	Phosphate (as PO4)	Total Metal
UNIT		–	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	STP Inlet	6.83	461.33	90.25	171.73	356	3.88	94.38	46.3	17.98	0
2	After Bar Screen	6.94	400.4	203.8	199.15	456	4.3	100	75.4	16.79	0
3	Equalization Tank	7.04	345	90.8	156	308	5.2	67.5	21.15	17.41	0
4	ASP Tank	6.96	1235.5	3311.6	98.3	297.5	4.6	62.3	34.8	14.3	0
5	Secondary Clarifier	5.84	533	57.5	43.32	96	2.2	63.6	39.5	14.1	0
6	After Filter	5.85	368.5	33.85	25.67	62	1.5	66.5	37.45	8.53	0
7	After Kardal	6.3	359.4	30.05	18.24	56	2.45	71	40.15	9.75	0
8	Final Treated	6.88	769.4	9.1	13.85	36	0.95	69.5	46.5	9.63	0

3.2 Comparison with the Design Specifications:

The observed values over the period of time of study are summarized below for the characteristic parameters and are compared with the design specifications at which the plant was designed.

Table 3. Design and Observed characteristics comparison.

Sr. No.	Parameter	Design Characteristics	Observed Characteristics	Unit
1	pH	5.5-9	6.88	--
2	Total Dissolved Solids	< 2100	769.40	mg/L
3	Total Suspended Solids	< 200	9.10	mg/L
4	Bio-chemical Oxygen Demand @27^{0}C for 3 days	< 100	13.85	mg/L
5	Chemical Oxygen Demand	< 250	36.00	mg/L
6	Oil & Grease	< 10	0.95	mg/L
7	Chloride (as Cl)	< 600	69.50	mg/L
8	Sulphate (as SO_4)	< 1000	46.50	mg/L
9	Phosphate (as PO_4)	NA	9.63	mg/L
10	Total Metal	< 10	0	mg/L

With the help of above table, we can see that the values for characteristic parameters like pH are well within the range used while designing of the plant. For other characteristics like TDS and TSS, the observed values are very low when compared to the design specifications. BOD parameter which refers to the organic content is also good. Parameter like Phosphate was not considered while design of the plant and hence it cannot be compared along the design specifications. Values for Total Metal were observed to be nil for every sample tested.

3.3 Analysis of Feasibility Study:

The Feasibility study carried out has enabled us to know more about the existing STP and its efficacy in treating waste water. After carefully studying the trend of the STP treatment cycle, it is seen that the STP plant is working according to the design specifications.

It is seen that the Phosphate (as PO4) at the STP inlet is in the range of 8-20 mg/L. This is a great amount for any Sewage sample. The source of the same needs to be found out as there is no process in the Industry which does not make use of Phosphate for example. Phosphate coating of metal parts. Some amount of Phosphate is introduced in the sewage through the 'Human Excreta' but not in this high content. Therefore it is necessary to look for reduction of the same. Phosphate removal from the treated sewage waste water can be boiled down to two methods, viz. Reduction at Source and another is Chemical Treatment.

a. Reduction at Source: It is necessary to find out the source of Phosphate in the inlet stream of sewage waste water. By taking out samples at various locations of inlet to sewage we can find out the area which introduces Phosphate in the stream. Another possible area to investigate might be the types and content of soap, detergent, etc. By finding out the chemical contents of the detergent and soap used we may find out for sure. By replacing the source with a good alternative this can be achieved. This method is less cost invasive and will require minimal work to carry out.

b. Chemical Treatment: If the source for Phosphate is not found, then we must go for the chemical treatment. To remove Phosphate from the sewage waste water, generally Iron Salts are added. These salts then precipitate out along with the Phosphate. Most widely used iron salt is Ferric Chloride (FeCl3) which can be a good option for treatment. Since there will be precipitate generation and it will be of chemical nature and not organic, provision of a Clarifier needs to be done before the Aeration Tank, The sludge can be settled and removed for further disposal. Therefore, this method of Phosphate removal will prove cost invasive and will require design and construction of a new clarifier.

4. CONCLUSIONS

The feasibility study carried out on the Sewage Treatment Plant gave us some good outcomes. By collecting a series of samples and testing for the characteristic parameters, we saw the treatment cycle and the change in the characteristics. Some areas of improvement are identified and possible suggestions are listed for better efficacy of the plant. With the help of this study it is seen that the plant is running according to its design specifications and it complies with the legal compliances prescribed by the local Pollution Control Board.

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