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Design of Sewage Treatment Plant of WCEM, Nagpur

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***Abstract*: All educational institutions do not have proper treatment unit for treating the sewage created by it. So it is required to construct a Sewage Treatment Plant with sufficient capacity to treat the sewage. This project deals with the proper design of a complete treatment of sewage and its major components such as Screen chamber, Skimming Tank, Primary Sedimentation Tank, ASP (Activated Sludge Process) Tank, Secondary Sedimentation Tank and Disinfection of sewage. By the execution of this design project the entire sewage treatment of an educational institution can be done effectively and efficiently.**

***Keywords*: wastewater, sludge, BOD, COD, Reuse, sewage, TDS**

1. Introduction

A. Sewerage – general considerations

Sewage treatment is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a treated effluent and a solid waste or sludge suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds. Sewage implies the collecting of wastewaters from occupied areas and conveying them to some point of disposal. The liquid wastes will require treatment before they are discharged into the water body or otherwise disposed of without endangering the public health or causing offensive conditions. As the cities have grown, the more primitive method of excreta disposal have gain place to the water-carried sewerage system. Even in the small cities the greater safety of sewerage, its convenience, and freedom from nuisance have caused it to be adopted wherever finances permit.

B. Objectives of wastewater treatment

Methods of wastewater treatment first developed in response to the concern for public health and adverse conditions caused by discharge of wastewater to environment. Besides this, the enlargement of cities resulted in the deficiency of land available for wastewater disposal principally by irrigation and intermittent filtration so the purpose of developing other methods of treatment was to accelerate the forces of nature under controlled conditions in treatment facilities of comparatively smaller size .In general from about 1900 to early 1970s, treatment objectives were concerned with:

- Removal of suspended and floatable material
- Treatment of biodegradable organics.
- Elimination of pathogenic organisms.

Unfortunately, these objectives were not uniformly met throughout the United States as is evidenced by the many plants that were discharging partially treated wastewater into wells since 1960s.From early 1970s to about 1980, wastewater treatment objectives were based primarily on aesthetic and environmental concerns. Thee arlier objectives of biological oxygen demand (BOD), suspended solids and pathogenic organism's reduction continued but at higher levels. Removal of nutrients such as nitrogen and phosphorus also began to bead dressed particularly in some of the inland streams and lakes. State and Federal agencies undertook a major effort to achieve more effective and widespread treatment of wastewater to improve the quality of surface waters. This effort resulted in part from

- An increased understanding of the environmental effects caused by wastewater discharges
- A developing knowledge of the adverse long term effects caused by discharge of some of specific constituents found in wastewater; (c)development of national concern for environmental protection. The result of these efforts was a significant improvement in the quality of surface waters.

Since 1980, because of increased scientific knowledge and an expanded information base, wastewater treatment has begun to focus on health concerns related to toxic and potentially toxic chemicals released to the environment. Water quality improvement objective of 1970s have continued but emphasis has shifted to the definition and removal of toxic and trace compounds that may cause long term health effects. As a consequence, while the early treatment objective remains valid today, the required degree of treatment has increased significantly and additional treatment objectives and goals have been added. The removal of toxic compounds such as refractory organics and heavy metals are examples of additional treatment objectives that are being considered. Therefore, the treatment objectives must go hand in hand with water quality objectives or standards established by federal, state and regional.

C. Treatment of sewage

The treatment of sewage consists of many complex functions. The degree of treatment depends upon the characteristics of the raw inlet sewage as well as the required effluent characteristics.

Treatment processes are often classified as:

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary treatment.

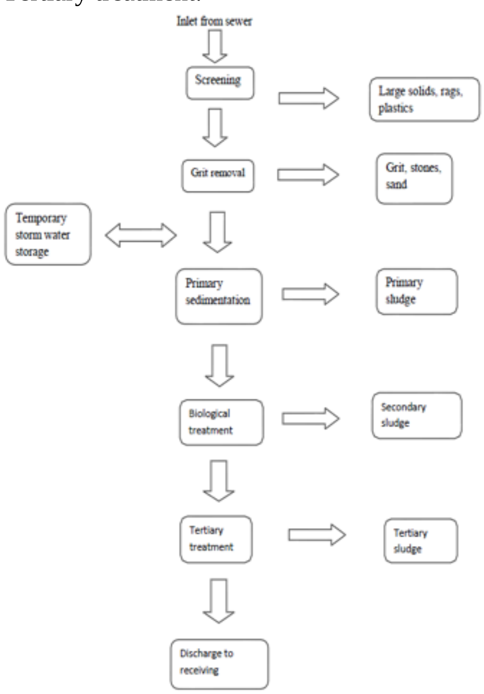

Fig. 1. Flowchart of process of sewage treatment plant

2. Preliminary treatment

A. Screening

Screening is the very first operation carried out at a sewage treatment plant and consists of passing the raw sewage through different types of screens so as to trap and remove the floating matter such as tree leaves, paper, gravel, timber pieces, rags, fibre, tampons, cans, and kitchen refuse etc.

1) Purpose of Screening

- Screening is essential in sewage treatment for removal of materials which would otherwise damage the plant, interfere with the satisfactory operation of treatment unit or equipment.
- To protect the pumps and other equipment from the possible damages due to floating matter.
- To remove the major floating matters from the raw sewage in a simple manner before it reaches into the complex high energy required process.

Table 1
Details of primary sedimentation tank

S. No	Parameter	Range
1	Diameter	3-60 m
2	Depth	3-4.9 m
3	Velocity	0.6-1.2 m

Table 2
Design parameters

S. No.	Design parameter	Value
1	Quantity of sewage	0.00224m^3/sec
2	Volume of primary sedimentation tank	16.12 m^3
3	Detention period	2 hours
4	Surface area of primary sedimentation tank	3.74 m^2
5	Depth of primary sedimentation tank	4.6 m
6	Diameter of primary sedimentation tank	3 m

3. Secondary treatment

Secondary treatment is a treatment process for sewage to achieve certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a biological process to remove dissolved and suspended organic compound. After this kind of treatment, the wastewater may be called as secondary –treated wastewater. Secondary treatment is the portion of a sewage treatment sequence removing dissolved and colloidal compounds measured as biochemical oxygen demand (BOD). Secondary treatment is traditionally applied to the liquid portion of sewage after primary treatment has removed settleable solids and floating material. Secondary treatment is typically performed by indigenous, aquatic microorganisms in a managed aerobic habitat bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, and organic short – chain carbon molecules from human waste, food waste, and detergent) while reproducing to form cells of biological solids. Biological oxidation processes are sensitive to temperature and, between 0˚C and 40˚C the rate of biological reactions increase with temperature. Most surface aerated vessels operate at between 4˚C and 32˚C. The secondary treatment is carried out by changing the character of the organic matter and thus converting it into stable forms. The character of sewage may be changed by different methods- broadly c1assified as under:

- Filtration
- Activated Sludge Process.

A. Design of Primary Sedimentation Tank

Total amount of water to be treated = 0.00224 m^3/sec
Quantity of sewage to be treated in 2 hours
Volume =Discharge x detention time

= 0.00224 x 2 x3600
= 16.12 m^3
Provide depth = 4.3m
Surface area = volume/depth
= 16.12/4.3
= 3.74 m^2

Diameter of the tank = $\sqrt{(3.74 \times 4/\pi)}$
= 2.18 m
D ≈ 3 m
We know, free board = 0.3m
Hence, actual depth = 4.3+0.3 = 4.6m
Primary sedimentation tank is designed for the dimension of 3m x 4.6m

4. Conclusion

A successful technical project involves integration of various fields. This is an attempt to combine several aspects of environmental, biological and chemical and civil engineering. The plant is designed perfectly to meet the future expansion for the next 30 years in accordance with Indian Codal provisions. This project consists the design of the complete components of a Sewage Treatment Plant from receiving chamber, screening chamber, grit chamber, skimming tank, sedimentation tank, secondary clarifier for sewage

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