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A RESEARCH PAPER ON DESIGN OF A SEWAGE TREATMENT PLANT (30 MLD)

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ABSTRACT

A sewage treatment plant is quite necessary to receive the domestic and commercial waste and removes the materials which pose harm for general public. Its objective is to produce an environmentally-safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer).A study on domestic waste water characterization has been performed followed by the design of sewage treatment plant. The present study involves the analysis of pH value, total solids, total suspended solids, hardness, acidity, oils fats & greases, chloride, BOD and DO etc. The samplings of the domestic waste have been done in different times of the day to have an average data of the measured parameters. Depending upon the values of these parameters, calculations are done for designing the different units of a 30 MLD Sewage Treatment Plant and a preliminary layout is prepared for the same.

INTRODUCTION

Pollution in its broadest sense includes all changes that curtail natural utility and exert deleterious effect on life. The crisis triggered by the rapidly growing population and industrialization with the resultant degradation of the environment causes a grave threat to the quality of life. Degradation of water quality is the unfavorable alteration of the physical, chemical and biological properties of water that prevents domestic, commercial, industrial, agricultural, recreational and other beneficial uses of water. Sewage and sewage effluents are the major sources of water pollution. Sewage is mainly composed of human fecal material, domestic wastes including wash-water and industrial wastes. The growing environmental pollution needs for decontaminating wastewater result in the study of characterization of waste water, especially domestic sewage. Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. It includes physical, chemical, and biological processes to remove various contaminants depending on its constituents. Using advanced technology it is now possible to re-use sewage effluent for drinking water. The present study comprises the study on quality of domestic waste water and industrial waste water(mixed sewage) .The study includes characterization tests for pH value, acidity, alkalinity, chloride, turbidity & BOD etc. Depending upon the values of these parameters, calculations are done for designing the different units of a 30 MLD Sewage Treatment Plant and a preliminary layout is prepared for the same.

Objectives of the study:

The objective of municipal and industrial waste water treatment is to extract pollutants, remove toxicants, neutralize coarse particles, kill pathogens so that quality of discharged water is improved to reach the permissible level of water to be discharged into water bodies or for agricultural land.

Treatment of water thus aims at reduction of BOD, COD, total solids, nitrogen content etc. of receiving water bodies and prevention of bio-magnification of toxic substances in food chain. The effluents to be disposed of without danger to human health or unacceptable damage to the natural environment.

The objective of this project can be summarized as-

- ➢ Physical, chemical and biological characterization of waste water.
- ➢ Comparison with the prescribed standard
- ➢ Design of the sewage treatment plant.

Literature Review

Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater (or treated effluent).A by-product of sewage treatment is usually a semi- solid waste or slurry, called sewage sludge, that

has to undergo further treatment before being suitable for disposal or land application. The objective of sewage treatment is to reduce the polluting substances to the Central Pollution Control Boards (CPCB) Norms

Characteristics of waste water:

Physical characteristics-

Odour:-

It depends on the substances which arouse human receptor cells on coming in contact with them. Pure water doesn't produce odour or taste sensations. Thus waste water which contains toxic substances has pungent smell which makes it easy to distinguish. Odour is recognized as a quality factor affecting acceptability of drinking water. The organic and inorganic substance contributes to taste or odour. The ultimate odour tasting device is the human nose. The odour intensity is done by threshold odour test.

Colour:

Colour in water results from the presence of natural metallic ions such as Fe or Mg, humus and peat materials, planktons and weeds. It is removed to make water suitable for general and industrial applications.

After turbidity is removed the apparent colour and that due to suspended matter is found out. Tristimulus, Spectroscopic and Platinum cobalt method is used.

Floatables:

One important criterion for evaluating the possible effect of waste disposal into surface water is the amount of floatable material in the waste. Two general types of floating matters are found-

(i) Particulate matters like 'grease balls'

(ii) Liquid component capable of spreading as thin visible film over large areas.

It is important because it accumulates on the surface and may contain pathogenic bacteria and viruses.

Temperature:

The normal temperature of sewage is generally slightly higher than the temperature of water. The average temperature of sewage in India is 20°C.

The temperature has an effect on the biological activity of bacteria present in sewage. Biological activities in sewage are higher at greater temperature. Temperature also affects the solubility of gases in sewage. In addition, temperature also affects the viscosity of sewage, which in turn affects the sedimentation process in its treatment.

Chemical Characteristics:-

The sewage has the following chemical characteristics:-

1) **Total Solids**:-

The sewage normally contains very small amount of solids in relation to the huge quantity of water. It only contains about 0.05 to 0.1 % of total solid matters.

The solid matters present the sewage may be in any of the four forms:

- Suspended solids,
- Dissolved solids,
- Colloidal solids,

• Settleable solids,

It has been estimated that about 1000 kg of sewage contains about 0.45 kg of total solids, out of which 0.225 kg is in solution, 0.112 kg is in suspension, and 0.112 kg is settleable. Colloidal solids remain either in solution or in suspension.
Further, the solids in sewage comprise of both organic as well as inorganic solids. The organic matter is about 45% of the total solids and the remaining about 55% is the inorganic matter.
The total amount of solids present in a given sewage can be determined by evaporating a known volume of sewage sample and weighing the dry residue left.
The quantity of suspended solids can be determined by passing a known volume of sewage sample through a glass-fiber filter apparatus and weighing the dry residue left.

2) pH Value:-
The pH value is defined as the logarithm of reciprocal of hydrogen ion concentration present in water. It is used to designate the acidity and alkalinity of water.

Thus,

$$\text{pH value} = -\log [H^+]$$

Nature of fresh sewage and treated sewage is alkaline and the septic sewage is acidic in nature. The pH value of fresh and treated sewage is generally more than 7 & the pH value of septic sewage is less than 7. The pH value can measured quickly and automatically with the help of a potentiometer.

3) Chloride Content:-
Chlorides are derived from the kitchen wastes, human excreta and industrial discharge.The normal chloride content of domestic sewage is 120 mg/lit. High chloride content of sewage indicates the presence of industrial sewage or infiltration of sea water.
The chloride content can measured by titrating the waste water with standard silver nitrate solution, using potassium chromate as indicator.

4) Nitrogen Content:-
The presence of nitrogen in sewage indicates the presence of organic matter. It may occur in one or more of the following forms:
a) Free ammonia
b) Albuminoid nitrogen
c) Nitrites
d)Nitrates

Presence of free ammonia indicates the very first stage of decomposition of organic matter. Albuminoid nitrogen indicates quantity of nitrogen present in sewage before the decomposition of organic matter is started.
The nitrites indicate the presence of partly decomposed organic matter. Nitrates indicate the presence of fully oxidized organic matter.
The amount of free ammonia present in sewage can be easily measured by simply boiling and measuring the ammonia gas. The amount of albuminoid nitrogen can be measured by adding strong alkaline solution of potassium permanganate to the already boiled sewage sample and again boiling the same. The amount of nitrites or nitrates present in sewage sample can be measured by color matching methods.

5) Presence of fats, greases and oils:-
These are derived in sewage from the discharges of animals, kitchens of hotels, industries etc. In order to determine the amount of fats, greases etc, a sample of sewage is first evaporated. The residual solids left are then mixed with ether and the solution is then evaporated, leaving behind the fat, grease as a residue.

Biological Characteristics:-

The sewage contains the following bacteria and microorganisms-

1)Bacteria:
Bacteria are microscopic unicellular organisms .They may be following types:-

a) Pathogenic bacteria - These are responsible for all water borne diseases.
b) Non-pathogenic bacteria - These are harmless.
c) Aerobic bacteria - It helps the decomposition of sewage in oxidation ponds, lagoons etc.
d) Anaerobic bacteria - It helps the decomposition of sewage in septic tank, cesspool etc.
e) Facultative bacteria - It has no function in sewage treatment.

2)Microorganisms
The microorganism like algae, fungi and protozoa help the process of decomposition of sewage by photosynthesis or by breaking the organic compounds.

3)Biochemical Oxygen Demand:
Biochemical Oxygen Demand (BOD, also called Biological Oxygen Demand) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a surrogate of the degree of organic pollution of water.
BOD can be used as a gauge of the effectiveness of wastewater treatment plants. It is listed as a conventional pollutant in the U.S. Clean Water Act.
BOD is similar in function to chemical oxygen demand (COD), in that both measure the amount of organic compounds in water. However, COD is less specific, since it measures everything that can be chemically oxidized, rather than just levels of biodegradable organic matter

Methodology

a) Methodology for determination of pH value
b) Methodology for determination of total solid
c) Methodology for determination of chloride content
d) Methodology for determination of nitrogen content
e) Methodology for determination of presence of oil & grease
f) Methodology for determination of BOD

Process involved in Sewage Treatment

1) Preliminary treatment

a) Screening
b) Grit chamber
c) Skimming tank

2) Primary treatment

a) Primary sedimentation Tan

3) Secondary (or Biological) treatment

a) Aeration tank

4) Sludge digestion & disposal

Design of sewage treatment plant

I. Design of screening

II. Design of grit chamber

III. Design of skimming tank

IV. Design of primary sedimentation tank

V. Design of aeration tank

a) Aerator sizing

VI. Design of secondary clarifier

VII. a) Design of sludge digestion tank

b) Estimation of gas produced from digester tank

c) Disposal of sludge

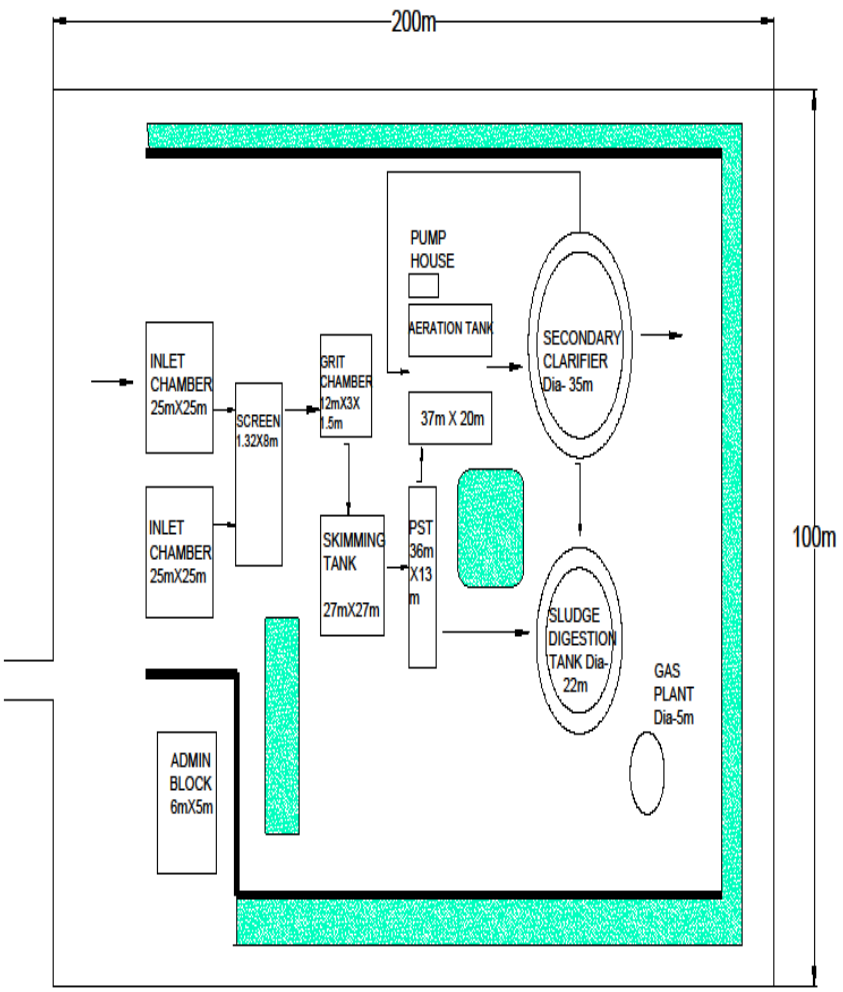
RESULTS & DISCUSSION –

After following the designing procedure, the size of different treatment units required are as follows-

- ➢ SIZE OF SCREEN – 1.32m x 0.8m
- ➢ SIZE OF GRIT CHAMBER – 12m x 3m x 1.50m
- ➢ SIZE OF SKIMMING TANK – 27m x 27m
- ➢ SIZE OF PST – 36m x 13m x 6m
- ➢ SIZE OF AERATION TANK – 37m x 20m x 5.5m
- ➢ SIZE OF AERATOR – 11 GENERATORS OF 30 HP
- ➢ SIZE OF SECONDARY CLARIFIER – DIA 35m with 5.5m DEPTH
- ➢ SIZE OF SLUDGE DIGESTION TANK – DIA 22m with 6m DEPTH
- ➢ GAS PRODUCED FROM DIGESTION TANK – 3154.79 cu. M

AS THESE PARAMETERS ARE COMING WITHIN SPECIFIED RANGE HENCE, THE DESIGN IS OKAY.

LAYOUT OF SEWAGE TREATMENT PLANT



SCOPE FOR FUTURE :-

As per future perspective of this project, the characteristics of different units designed in this project can be compared with alternate treatments units and their treatment efficiencies are calculated for designing the STP.

For example – We choose activated sludge process in secondary treatment, but any other treatment processes like trickling filters, aerated lagoons, RBCs can also be taken as secondary treatment unit and are designed. The design values & other parameters related to it are compared and the graphs are plotted accordingly. The best alternative should be selected as the final one.

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