A Project Report On

<u>Design of Clarifier & Flash Mixer Equipment at ETP Plant</u>
<u>(Case Study : BANTHAR PLANT UNNAO U.P)</u>

In Partial Fulfillment of the Requirements For the Degree of

BACHELOR OF TECHNIOLOGY

IN

CHEMICAL ENGINEERING

Submitted by:

Aman Yadav (1901660510006)

Harshit Upadhyay(1901660510014)

Karan Verma (1901660510017)

Pratham Tomar(1901660510030)

Priyanka Pal(1901660510033)

Rahul Kumar Yadav(1901660510036)

Under the guidance of

Dr. Ashutosh Mishra (Head of Department)

DR. AMBEDKAR INSTITUE OF TECHNOLOGY FOR HANDICAPPED KANPUR-208024

ACKNOWLEDGEMENT

It gives us a great pleasure to present the report of the B.Tech. Project undertaken during our B.Tech. Final Year. We owe special debt of gratitude to Mr. Ashutosh Mishra, our supervisor and Assistance Professor of the Chemical Department at college,Dr AITH Kanpur for his constant support and guidance throughout our work. His sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It's only through his deligent efforts that our endeavor have seen light of the day.

We also take the opportunity to acknowledge the contribution of Dr. Ashutosh Mishra Head of Department of Chemical Engineering at Dr AITH Kanpur, for his support and guidance during the development of the project.

We would also like to express our gratitude to all the faculty members of the department for their kind assistance and cooperation during the development of our project. Last but not least, we acknowledge our friends for their contributions to the completion of the project.

Signature:

Aman Yadav (1901660510006)

Harshit Upadhyay (1901660510014)

Karan Verma (1901660510017)

Pratham Tomar (1901660510030)

Priyanka Pal (1901660510033)

Rahul Kumar Yadav(1901660510036)

CERTIFICATE

This to certify that the seminar entitled, "**Design of Clarifier at ETP Plant**" in partial fulfiments for the requirements for the award of Bachelor of Technology Degree in Chemical engineering at Dr. Ambedkar Institute of Technology for Handicapped Kanpur is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the project report has not been submitted to other University/ Institute for the award for the award of any Degree or Diploma.

Date: 29/05/2023

Dr. Ashutosh Mishra(Assistance Professor**)**
Department of Chemical Engineering Dr. Ambedkar Institute of Technology For Handicapped Kanpur-208024

Declaration

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contain no material previously publish or written by anotherperson, nor material which, to a substantial extend, has been accepted for the award of any other degree or diploma for the university or other institute of higher leveling
, except where due acknowledgement has been made in the text .

Date:

Signature:

Aman Yadav (1901660510006)

Harshit Upadhyay (1901660510014)

Karan Verma (1901660510017)

Pratham Tomar (1901660510030)

Priyanka Pal (1901660510033)

Rahul Kumar Yadav (1901660510036)

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 4.5 MLD Sewage Treatment Plant and a preliminary layout is prepared for the same.

LIST OF ABBREVIATION & SYMBOLS

PST	Primary settlement tank
FST	Final settlement tank
TDS	Total dissolved solid
SS	Suspended solid
DS	Dissolved solid
DO	Dissolve oxygen
BOD	Biological oxygen demand
COD	Chemical oxygen demand
STP	Sewage treatment plant
SOP	Standard Operating Procedure
ETP	Effluent Treatment Plants
SOR	Surface overflow rate

Index

Problem Statement

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 Clarifier Equipment of a 4.5 MLD Industrial water Treatment Plant.

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.

OBJECTIVE

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.

Effluent discharged standards for Sewage Treatment Plant:

Table:-1

Parameter	Existing general effluent Standards (CPCB)	Standards for new STPs (CPCB)
BOD, mg/L	30	Not more than 10
Total Suspended Solid, mg/L	100	Not more than 20
COD, mg/L	250	Not more than 50
pH	5.5-9	6.5-9.0
Total nitrogen mg/L	100	Not more than 10
FaecalColiforms MPN/100mL	Not Specified	Less than 100

CHARACTERISTICS OF WASTEWATER

❖ PHYSICAL CHARACTERISTICS

I. 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.(2)

II. 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.(3)

III. 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-

- Particulate matters like 'grease balls'.

- 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. (4)

IV. 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.(5)

❖ CHEMICAL CHARACTERISTICS:-

The sewage has the following chemical characteristics:-

I. 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. (6)

II. 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, **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. (7)

III. 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.(8)

IV. 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:

- Free ammonia
- Albuminoid nitrogen
- Nitrites
- 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.(9)

V. 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.

❖ BIOLOGICAL CHARACTERISTICS:-

The sewage contains the following bacteria and microorganisms-

(i) 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.

(ii) MICROORGANISMS:

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

(iii) 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.(10)

METHODOLOGY

❖ MEASUREMENT OF PH VALUE:-

The negative logarithm of concentration of hydrogen ion gives the pH of a sample. pH varies from 6-8 in waste water sample, due to hydrolysis of salts of bases and acids. Carbon dioxide, Hydrogen Sulphide and Ammonia which are dissolved affect pH value of water. pH value may be more than 9 in alkaline springs and the pH may be 4 or even less than 4 for acidic ones. Industrial wastes do affect the pH as it depends on buffer capacity of water. pH value of water sample in lab changes because of losses absorption of gases, reactions with sediments, chemical reaction. taking place within the sample bottle. Therefore pH value should preferably be determined at the time of collection of sample.

pH is measured using pH meter. The pH meter is an electrical device that determines the acidity or basicity of aqueous solutions, one of the most commonly monitored parameters. To use a pH meter, the pH electrode is first calibrated with standard buffer solutions with known pH values. To make a pH measurement, the electrode is immersed into the sample solution until a steady reading is reached.(11)

Calculations-

Sample	pH-(Raw)
Sample 1	7.1
Sample 2	7.3
Sample 3	7.1
Sample 4	7.0
RESULT-	7.125

The resultant pH of the Raw Sewage is 7.125

❖ METHODOLOGY FOR THE DETERMINATION OF TOTAL SOLIDS:

➢ PRINCIPLE:

The sample is evaporated in a weighed dish on a steam-bath and is dried to a constant mass in an oven either at 103-105°C or 179-181°C. Total residue is calculated from increase in mass.In general, by evaporating and drying water samples at 179-181°C values are obtained which conform more closely to those obtained by summation of individually determined mineral salts.

The apparatus used are:

- Evaporating Dish
- Drying Oven
- Desiccator
- Analytical Balance

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. The difference between the total solids and the suspend solids represents dissolved solids plus colloidal.(12)

Sample	Raw (mg)		
	TS	SS	DS
Sample 1	934	272	662
Sample 2	470	132	338
Sample 3	2096	1270	826
Sample 4	569	38	531
RESULT	1017	428	590

The resultant -

RAW (mg)		
TS	SS	DS
1017	428	590

❖ METHODOLOGY FOR DETERMINATION OF 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.(13)

SAMPLE	RAW(mg/l)
Sample 1	114
Sample 2	96
Sample 3	93
Sample 4	89
RESULT	98

Chloride content of raw sewage is- 98mg/l

❖ METHODOLOGY FOR DETERMINATION OF 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:

- Freeammonia
- Albuminoid nitrogen
- Nitrites
- 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.(14)

SAMPLE	RAW(mg/l)
Sample 1	60
Sample 2	20
Sample 3	45
Sample 4	20
RESULT	36.25

Free ammonia present in the sample is – 36.25mg/L

- **METHODOLOGY FOR DETERMINATION OF PRESENCE OF FATS OILS & GREASES**

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.

SAMPLE	RAW(mg/l)
Sample 1.1	24.8
Sample 2.1	8.4
Sample 3.1	46.8
Sample 4.1	7.6
RESULT	21.9

The resultant oil & greases in the sample – 21.9mg/l

The biochemical oxygen demand (BOD) test is based mainly on the classification of biological activity of a substance. A procedure measures the dissolved oxygen consumed by micro-organisms while capable of taking and oxidizing the organic matter under aerobic conditions. The standard test condition lets in incubating the sample in an air tight bottle, in dark at a required temperature for specific time.

The apparatus used are:

(i) INCUBATION BOTTLES: The bottle has capacity of 300 ml. It has narrow neck with even mouth and has ground glass stoppers. New bottles are cleaned with 5 N hydrochloric acid or sulphuric acid and rinsed with distilled water. In normal use, bottles once used for Winkler's procedure should only be rinsed with tap water followed by distilled water. During incubation water is added to the flared mouth of the bottle time to time, to ensure proper sealing.

(ii) AIR INCUBATOR: Air incubation with thermostatically controlled 27°C +-1°C. Light is avoided to prevent possibility of photosynthetic production of oxygen.

➢ PROCEDURE:

After taking water in incubation bottles, 4 gm of NaOH is kept at the neck of the bottle. A magnetic stirrer is retained inside the bottle. The magnetic stirrer continuously revolves inside the bottle. Special caps attached with an electronic meter keep the bottle air tight. The instrument directly records BOD reading at every 24 hour. After that the bottles are preserved in the incubators for days as per need of study. The same procedure follows for BOD 3 days and BOD 5 days.(15)

SAMPLE	RAW(mg/l)
Sample 1	144
Sample 2	226
Sample 3	186
Sample 4	200
RESULT	189

The resultant BOD of the sample is – 189mg/L

S.No.	PARAMETER	CALCULATED VALUE	PERMISSIBLE LIMITS
1.	pH	7.125	7-8.5
2.	TDS	1017mg/l	100 mg/l
3.	SS	428mg/l	N/A
4.	DS	590mg/l	N/A
5.	FREE AMMONIA	36.25mg/l	50 mg/l
6.	CLORIDE	98mg/l	600 mg/l
7.	OIL & GREASE	21.9mg/l	10 mg/l
8.	BOD	189mg/l	30 mg/l

GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS PART-A : EFFLUENTS

PROCESS INVOLVED IN SEWAGE TREATMENT-

Sewage can be treated in different ways. Treatment process are often classified as:-

(i) Preliminary treatment

(ii) Primary treatment

(iii) Secondary (or Biological) treatment

(iv) Final treatment

i. PRELIMINARY TREATMENT

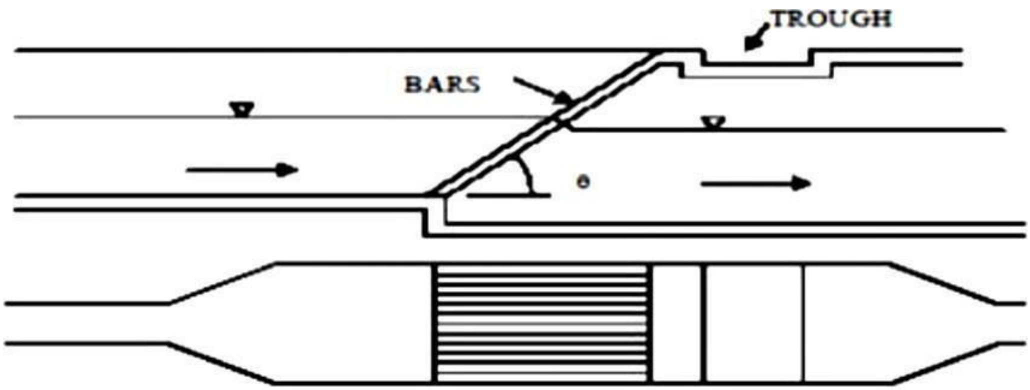
Preliminary treatment consists solely in separating the floating materials (like dead animals, tree branches, papers, pieces of rags, wood, etc.), and also the heavy settleable inorganic solids. It also helps in removing the oils and greases, etc. from the sewage. This treatment reduces the BOD of the wastewater, by about 15 to 30%. The process used are screening for removing floating papers, rags, clothes, etc., Grit chambers or Detritus tanks for removing grit and sand., and skimming tanks for removing oils and greases.

➢ SCREENING

Screening is the first unit operation used at wastewater treatment plants (WWTPs). Screening removes objects such as rags, paper, plastics, and metals to prevent damage and clogging of downstream equipment, piping, and appurtenances. Some modern wastewater treatment plants use both coarse screens and fine screens.

- **TYPES OF SCREENS:-**

Screens can be broadly classified depending upon the opening size provided as coarse screen (bar screens) and fine screens. Based on the cleaning operation they are classified as manually cleaned screens or mechanically cleaned screens. Due to need of more and more compact treatment facilities many advancement in the screen design are coming up.



BAR SCREEN

- **FINE SCREEN:**

Fine screens are mechanically cleaned screens using perforated plates, woven wire cloths, or very closely spaced bars with clear openings of less than 20 mm, less than 6 mm typical. Commonly these are available in the opening size ranging from 0.035 to 6 mm. Fine screens are used for pretreatment of industrial wastewaters and are not suitable for sewage due to clogging problems, but can be used after coarse screening. Fine screens are also used to remove solids from primary effluent to reduce clogging problem of trickling filters.

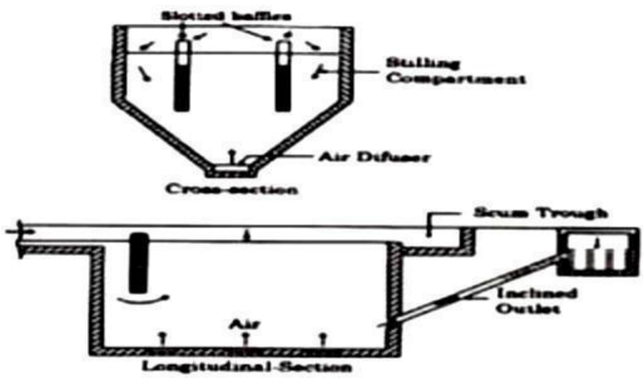
- ## COARSE SCREEN:-

It is used primarily as protective device and hence used as first treatment unit. Common type of these screens are bar racks (or bar screen), coarse woven-wire screens, and comminutors. Bar screens are used ahead of the pumps and grit removal facility. This screen can be manually cleaned or mechanically cleaned. Manually cleaned screens are used in small treatment plants. Clear spacing between the bars in these screens may be in the range of 15 mm to 40 mm.(16)

➢ SKIMMING TANKS

A skimming tank is a chamber so arranged that the floating matter like oil, fat, grease etc., rise and remain on the surface of the waste water (Sewage) until removed, while the liquid flows out continuously under partitions or baffles. It is necessary to remove the floating matter from sewage otherwise it may appear in the form of unsightly scum on the surface of the settling tanks or interfere with the activated sludge process of sewage treatment. It is mostly present in the industrial sewage. In ordinary sanitary sewage, its amount is usually too small. The chamber is a long trough shaped structure divided up into two or three lateral compartments by vertical baffle walls having slots for a short distance below the sewage surface and permitting oil and grease to escape into stilling compartments. The rise of floating matter is brought about the blowing air into the sewage from diffusers placed in the bottom. Sewage enters the tank from one end, flows longitudinally and leaves out through a narrow inclined duct. A theoretical detention period of 3 minutes is enough. The floating matter can be either hand or mechanically removed.

Grease traps are in reality small skimming tanks designed with submerged inlet and bottom outlet. The traps must have sufficient capacity to permit the sewage to cool and grease to separate. Frequent cleaning through removable covers is essential for satisfactory operation. Grease traps are commonly employed in case of industries, garages, hotels and hospitals.(17)

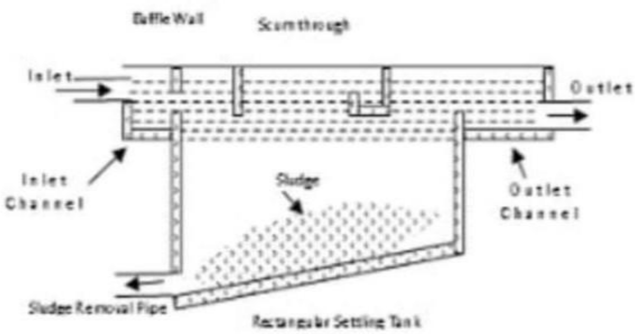


Skimming Tank

ii. PRIMARY TREATMENT

Primary treatment consists in removing large suspended organic solids. This is usually accomplished by sedimentation in settling basins. The liquid effluent from primary treatment, often contains a large amount of suspended organic material, and has a high BOD(about 60% of original). Sometimes, the preliminary as well as primary treatments are classified together, under primary treatment. The organic solids, which are separated out in the sedimentation tanks (in primary treatment), are often stabilized by anaerobic decomposition in a digestion tank or are incinerated. The residue is used for landfills or soil conditioners.

The Primary Settlement or sedimentation tanks are designed to reduce the velocity of the wastewater flow, allowing heavier organic solids (called raw sludge) to settle. They are the first stage of treatment after the removal of rags and grit in the inlet works. Scrapers present in the tank move continuously along the floor of the tank to deposit the raw sludge in hoppers for removal. The scum which floats to the surface is directed by water jets or scum boards to the sludge sump. The raw, settled sludge is removed by pump or gravity feed to a sludge treatment process, either on site or via tanker to a larger processing centre. Approximately 60% of suspended solids and 35% of BOD removal efficiency can be achieved at this stage.(18)



PRIMARY SEDIMENTATION TANK

iii. SECONDARY TREATMENT

Secondary treatment involves further treatment of the effluent, coming from the primary sedimentation tank. This is generally accomplished through biological decomposition of organic matter, which can be carried out either under aerobic or anaerobic conditions. In these biological units, bacteria will decompose the fine organic matter, to produce clearer effluent.

The treatment reactors, in which the organic matter is decomposed (oxidized) by aerobic bacteria are known as aerobic biological units; and may consist of Filters (intermittent sand filters as well as trickling filters). Aeration tanks, with the feed of recycled activated sludge (ie. the sludge, which is settled in secondary sedimentation tank, receiving effluents from the aeration tank). Oxidation ponds and Aerated lagoons. Since all these aerobic units, generally make use of primary settled sewage, they are easily classified as secondary units.(19)

➢ ACTIVATED SLUDGE PROCESS

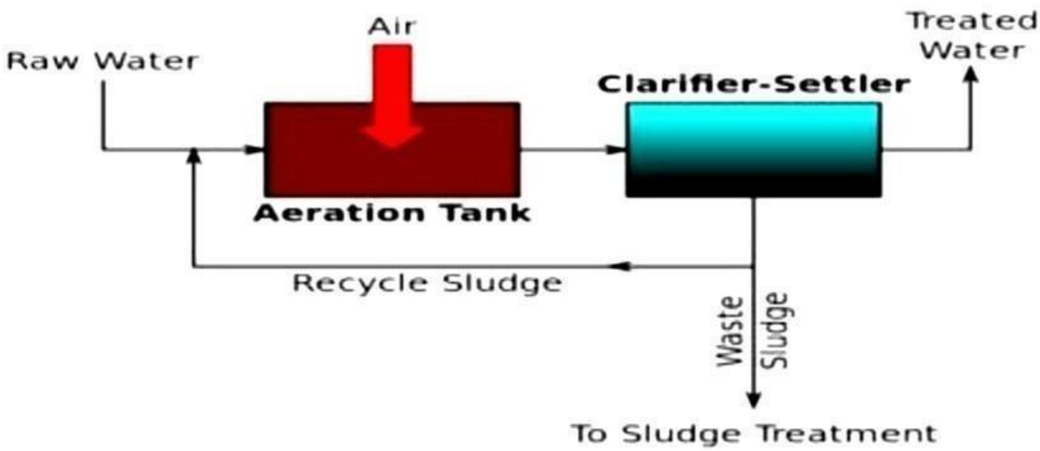
The activated sludge process is a type of wastewater treatment process for treating sewage. The general arrangement of an activated sludge process for removing carbonaceous pollution includes the following items: An aeration tank where air (or oxygen) is injected in the mixed liquor. This is followed by a settling tank (usually referred to as "final clarifier" or "secondary settling tank") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.

The general arrangement of an activated sludge process for removing carbonaceous pollution includes the following items:

- Aeration tank where air (or oxygen) is injected in the mixed liquor.

- Settling tank (usually referred to as "final clarifier" or "secondary settling tank") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.(20)

Treatment of nitrogenous matter or phosphate involves additional steps where the mixed liquor is left in anoxic condition (meaning that there is no residual dissolved oxygen).



ACTIVATED SLUDGE PROCESS

➢ SLUDGE PRODUCTION

Activated sludge is also the name given to the active biological material produced by activated sludge plants. Excess sludge is called "surplus activated sludge" or "waste activated sludge" and is removed from the treatment process to keep the ratio of biomass to food supplied in the wastewater in balance. This sewage sludge is usually mixed with primary sludge from the primary clarifiers and undergoes further sludge treatment for example by anaerobic digestion, followed by thickening, dewatering, composting and land application.

The amount of sewage sludge produced from the activated sludge process is directly proportional to the amount of wastewater treated. The total sludge production consists of the sum of primary sludge from the primary sedimentation tanks as well as waste activated sludge from the bioreactors. The activated sludge process produces about 70-100 kg/ML of waste activated sludge (that is kg of dry solids produced per ML of wastewater treated; one mega litre (ML) is 10' m^3). A value of 80 kg/ML is regarded as being typical. In addition, about 110-170 kg/ML. of primary sludge is produced in the primary sedimentation tanks which most - but not all of the activated sludge process configurations use.

A variant of the activated sludge process is the Nereda process where aerobic granular sludge is developed by applying specific process conditions that favour slow growing organisms.

➢ PROCESS CONTROL

The general process control method is to monitor sludge blanket level, SVI (Sludge Volume Index), MCRT (Mean Cell Residence Time), F/M (Food to Microorganism), as well as the biota of the activated sludge and the major nutrients DO (Dissolved oxygen), nitrogen, phosphate, BOD (Biochemical oxygen demand). and COD (Chemical oxygen demand). In the reactor/aerator and clarifier system, the sludge blanket is measured from the bottom of the clarifier to the level of settled solids in the clarifier's water column; this, in large plants, can be done up to three times a day.

The SVI is the volume of settled sludge in milliliters occupied by 1 gram of dry sludge solids after 30 minutes of settling in a 1000 milliliter graduated cylinder. The MCRT is the total mass (lbs) of mixed liquor suspended solids in the aerator and clarifier divided by the mass flow rate (lbs/day) of mixed liquor suspended solids leaving as WAS and final effluent. The F/M is the ratio of food fed to the microorganisms each day to the mass of microorganisms held under acration. Specifically, it is the amount of BOD fed to the aerator (lbs/day) divided by the amount (lbs) of Mixed Liquor Volatile Suspended Solids (MLVSS) under aeration. Note: Some references use MLSS (Mixed Liquor Suspended Solids) for expedience, but MLVSS is considered more accurate for the measure of microorganisms. Again, due to expedience, COD is generally used, in lieu of BOD, as BOD takes five days for results.

Based on these control methods, the amount of settled solids in the mixed liquor can be varied by wasting activated sludge (WAS) or returning activated sludge (RAS)

- **<u>SLUDGE DIGESTION PROCESS</u>**

The residue that accumulates in sewage treatment plants is called sludge (or bio solids). Sewage sludge is the solid, semisolid, or slurry residual material that is produced as a by-product of wastewater treatment processes. This residue is commonly classified as primary and secondary sludge. Primary sludge is generated from chemical precipitation, sedimentation, and other primary processes, whereas secondary sludge is the activated waste biomass resulting from biological treatments. Some sewage plants also receive sewage or septic tank solids from household on-site wastewater treatment systems. Quite often the sludge is combined together for further treatment and disposal.

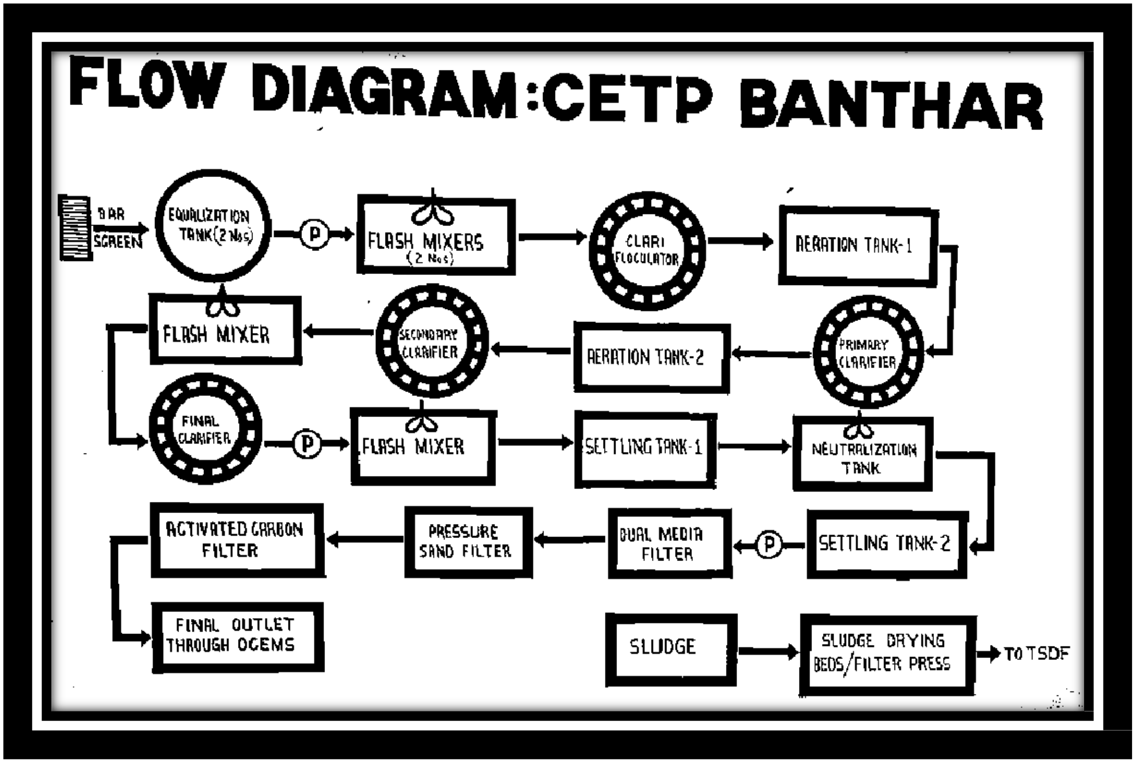
Treatment and disposal of sewage sludge are major factors in the design and operation of all wastewater treatment plants. Two basic goals of treating sludge before final disposal are to reduce its volume and to stabilize the organic materials. Stabilized sludge does not have an offensive odour and can be handled without causing a nuisance or health hazard. Smaller sludge volume reduces the costs of pumping and storage.

Sludge digestion may also take place aerobically-that is, in the presence of oxygen. The sludge is vigorously aerated in an open tank for about 20 days. Although aerobic systems are easier to operate than anaerobic systems, they usually cost more to operate because of the power needed for aeration. Aerobic digestion is often combined with small extended aeration or contact stabilization systems.

Aerobic and conventional anaerobic digestion convert about half of the organic sludge solids to liquids and gases. Thermal hydrolysis followed by anaerobic digestion can convert some 60 to 70 percent of the solid matter to liquids and gases. Not only is the volume of solids produced smaller than in conventional digestion, but the greater production of biogas can make some wastewater treatment plants self-sufficient in energy.(21)

iv. THE FINAL OR ADVANCED TREATMENT

This treatment is sometimes called tertiary treatment, and consists in removing the organic load left after the secondary treatment, and particularly to kill the pathogenic bacteria. This treatment, which is normally carried out by chlorination, is generally not carried out for disposal of sewage in water, but is carried out, while using the river stream for collecting water for re-use or for water supplies.(23)



DESIGN OF SEWAGE TREATMENT PALNT

1. DESIGN OF PRIMARY SEDIMENTATION TANK

Retention Time = 4hrs

Qantity of Sewage Treated in 1 hrs = $V = 4500 \frac{4}{24}$

$$V = 750\ m^3$$

Now assuming that the low velocity through the tank is $0.075 \frac{m}{min}$

The length of the tank required is $= velocity\ of\ low \times Retention\ Time$

$$= 0.075 \times 4 \times 60$$

$$= 18\ m$$

Crossection Area of Tank Required $= \frac{Capacity\ of\ Tank}{Length\ of\ Tank}$

$$= \frac{750\ m^3}{18\ m}$$

$$= 41.66\ m^2$$

Assuming depth of Tank to be 13 m.

Width of the Tank Required $= \frac{41.66\ m^2}{13\ m}$

$$= 3.08m$$

Assuming free board of 0.5 m

Overall depth of the tank = 13m + 0.5m

$$= 13.5\ m$$

Crossection of Rectangular Sedimentation Tank $= 18m \times 3.08m \times 13.50m$

2. DESIGN OF SECONDARY CLARIFIER

No of second clarifier $= 1$

Average Flow$= 4500 \frac{m^3}{day}$

Assuming Recirculated Flow $= 2250 \frac{m^3}{day}$

Total inflow $= 6750 \frac{m^3}{day}$

Retention Period$= 4hrs$

Volume of Tank$= 6750 \times \frac{4}{24}$

$= 675m^3$

Assume Liquid depth$= 13m$

Surface loading rate of avg flow$= 25 \frac{m^3}{m^2hr}$

Surface Area Provided $= \frac{6750}{25}$

$= 270m^2$

Diameter of Circular Tank $= \frac{\pi d^2}{4}$

d$= 18.54m$

Size of Secondary Clarifier $= diameter\ of\ clarifier = 18.54m$

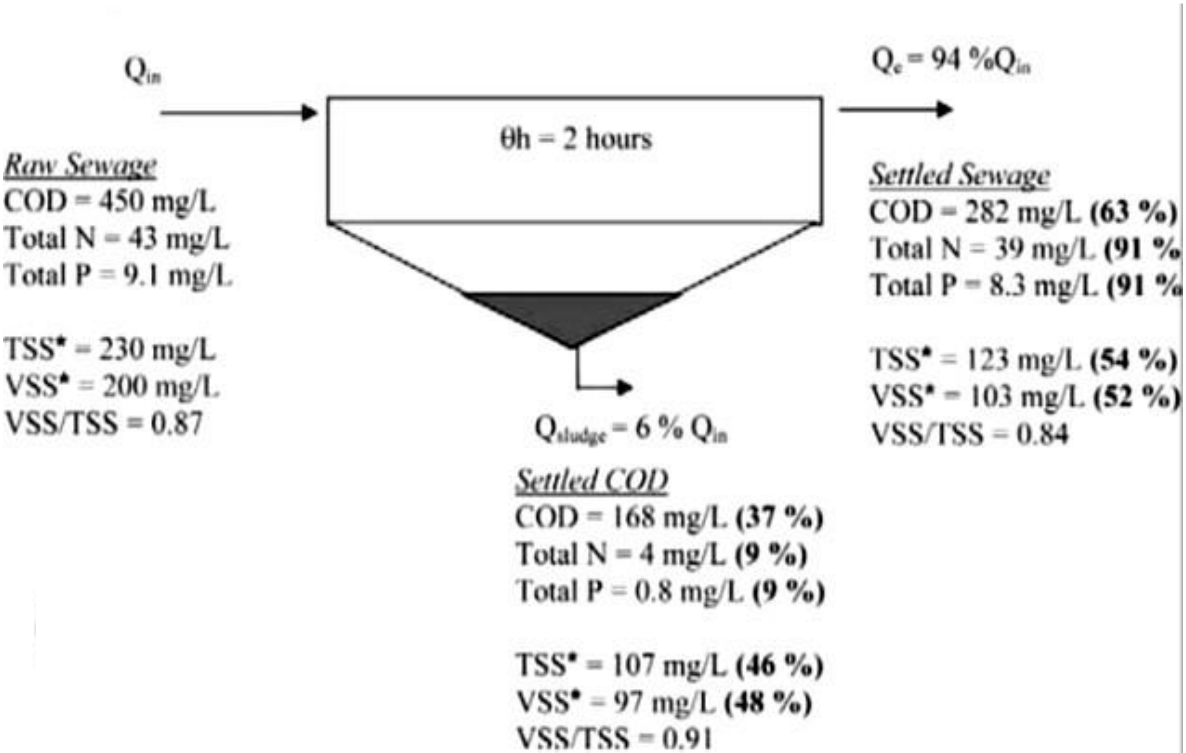
With an overall depth $= 13.5m$

COST ESTIMATION OF PRIMARY AND SECONDARY CLARIFIER (32)

As per Standard 50 kg of a cement bag		$0.0345m^3$
1 bag cement		50Kg
Pipe diameter		0.015m
Pipe length		5m
Cost of pipe per m		100Rs
1 CFT		68.15Kg
Floor bed:		
Quantity of Floor work		
Outer diameter area	2*3.14*d1/2	7.128m
Inner diameter area	2*3.14*d2/2	2.952m
Quantity of outer diameter floor		$4.312m^3$
Quantity of inner diameter floor		$1.785m^3$
Brick work:		
Total quantity of brick work		$6.093m^3$
We have, 1 m^3	500 bricks	
No of bricks		3046.65Nos
Plain cement concrete (PCC):		
Quantity of Inner bed PCC	((3.14/d2)/4)*Ft	$0.125m^3$
Quantity of Outer bed PCC	(3.14/d1)/4)*Ft	$0.052m^3$
Deduction:		
Inner area	(3.14*((d1+t)^2))/4	$1.075m^3$
Overall deduction		
Inner		$4.045m^3$
Outer		1.075m3
Total Quantity		2.970m3
Assumed Plastering thickness		0.01m
Total quantity of plastering of wall		0.157m3

Total quantity of concrete		6.427m3
Earthwork excavation		
Quantity of earthwork excavation		6.736m3
Quantity of Cement, Sand, Coarse		
No of bags of Cement	Total quantity/standard	186.29bags
Quantity of cement	bags*kg	9314.58kg
Quantity of sand	from 1:2:4	18629.17 kg
Quantity of coarse aggregate		
Vol of floor + PCC		9.067m3
Quantity	(vol/0.0345)*50kg*Proportion	52565.04 kg
Assumed liters of paint		40liters
Abstract table		
Rate of a cement bag		410Rs
Rate of a Wire cut brick		9 RS
Rate of a Sand load		1.514RS/Kg
Rate of Coarse aggregate		1.57Rs/Kg
Cost of Brick		27419.85 Rs
Cost of Pipe		500Rs
Cost of painting		10000Rs
Cost of labours		
Mason		9800Rs
Male helper		7000Rs
Female helper		5600Rs
Estimated cost		237856Rs
Contractors profit	10%	23785.57Rs
Total Estimated Cost		261641Rs

MASSS AND ENERGY BALANCE



2. DESIGN OF FLASH MIXER

Diameter of flash mixture (D) = 2.3 m

Depth of water H = 5.05m

Velocity Gradient G = 300

Co-efficient of viscosity M = 0.0010087

POWER CALCULATION

Volume Provided V = 20.98424 m3

With velocity gradient considered as 300, power input shall be worked out.

Power $P = M \times G^2 \times V$ Watts

P= power in watts, M = coefficient of Viscosity = (1.0087 x 10)-3 kg/cm2

P = 1905 watts

WITH CONSIDERING, EFFICIENCY OF

Efficiency of gear box = 80%

Efficiency of motor = 80%

Rating of motor = 2977 watts

Providing motor = 4 HP

CALCULATION FOR SIZE OF BLADE

Dia of impeller d = 0.30 x tank dia. (As per CPHEEO

= 0.69 m

RPM of shaft n = 100 rpm

Tip velocity v = $2 \times 3.14 \times \frac{D}{2} \times \frac{n}{60}$

= 3.611 m/s

Relative velocity of blade $V_f = 0.75 \times v$

$= 2.70825 m/s$

Power $P = 0.5 \times C_d \times p \times A_p \times V_r 3$

P =power in watts, C_d = coefficient of dynamic Viscosity in kg/cm2

Area of Paddle Ap = 0.107 m^2

Providing Number Of Blade = 6

Width of Blade W = 0.1 m

Length of Blade L = 0.178 m

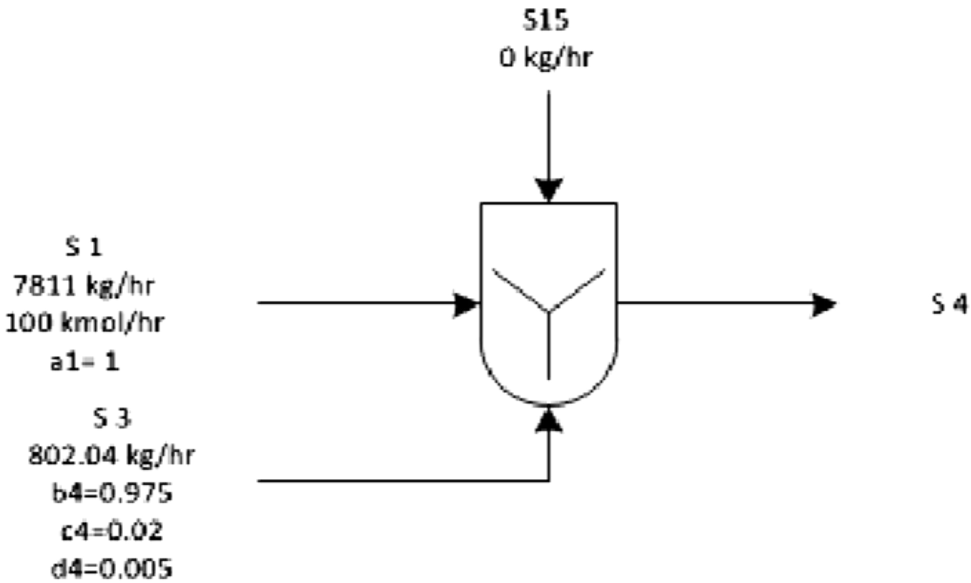
Provide 6 Number of blades of size 0.10 m X 0.350 m

COST ESTIMATION OF FLASH MIXER

Roof top cover thickness		0.15 m3
As per Standard 50kg of a cement bag		0.0345 m3
1 bag cement		50 kg
Pipe diameter		0.015 m
Pipe length		5 m
Cost of pipe per m		100 Rs
Assumed liters of paint		10 litres
Floor bed:		
Quantity of Floor work	Le*Be*Ft	0.002 m3
Brick work:		
Outer area	L*No of walls*D*t	0.036m3
Inner area	Be*No of walls*D*t	0.012m3
Total quantity of brick work		0.048m3
We have, 1 m3	500 bricks	
Therefore, no of bricks	brick work*nos	24nos
Plain cement concrete (PCC):		
Quantity of PCC	Lp*Bp*Dp	0.072m3
Plastering of wall:		
Length of inner wall	L*No of walls*D	0.36m2
Breadth of inner wall	B*No of walls*D	0.36m2
Length of outer wall	Le*No of walls*D	0.12m2
Breadth of outer wall	Be*No of walls*D	0.12m2
Total quantity of plastering of wall		0.0092m3
Roof top slab		
Quantity of concrete	L*B*tr	0.014m3
Assumed Plastering thickness		0.01m
Total quantity of concrete		0.096m3
Earthwork excavation		
Quantity of earthwork excavation	L*B*(Dg+Dp)	0.018m3
Quantity of Cement, Sand, Coarse		

Vol of floor + PCC		0.074m3
Quantity	(vol/0.0345)*50kg*Proportion	426.087kg
Rate of a Labour		
Mason		700 Rs/day
Male helper		500 Rs/day
Female helper		400 Rs/day
No of Mason		2 nos
No of Male helper		2 nos
No of Female helper		2 nos
Working days		3 days
Cost estimation		
Cost for cement		1144 Rs
Cost for sand		279 Rs
Cost of coarse aggregate		668.9565 Rs
Cost of Brick		214.4104 Rs
Cost of Pipe		500 Rs
Cost of painting		2500 Rs
Cost of labours		
Mason		4200 Rs
Male helper		3000 Rs
Female helper		2400 Rs
Estimated cost		14906 Rs
Contractors profit	10%	1490.614 Rs
Total Estimated Cost		**16397 Rs**

MASS AND ENERGY BALANCE



SCOPE FOR FUTURE REFERENCE

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 can also be taken as secondary treatment unit and are designed. The design values & other parameters related to it are compared . The best alternative should be selected as the final one.

REFRENCES

1) TABLE – 1 (BOIS : FOREWORD AND CLAUSE 4)

2) BOIS : FOREWORD AND CLAUSE 4

3) HTTPS://WWW.DEP.STATE.PA.US/DEP/DEPUTATE/WATEROPS/REDESIGN/TABLESNFORMULAS/PAGES/PLANTPIPECOLOR.HTM

4) (BOIS : SCHEDULE 6 , ANNEX - 1)

5) (BOIS : SCHEDULE 6 RULE NO.1)

6) (BOIS: ANNEX-A CLAUSE 4)

7) (BOIS: ANNEX-A CLAUSE 4)

8) BOIS : ANNEXA – A CLAUSE 2 PART 32 : 1998

9) BOIS : ANNEX – A CLAUSE 2 PART 34 : 1998

10) BOIS:ANNEX–C CLAUSE 4.3.10 ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

11) ANNEX B(*CLAUSE* 4.2.7) POLYMERASE CHAIN REACTION (PCR) METHOD

12) HTTPS://WWW.THEWATERTREATMENTS.COM/WATER-QUALITY/DETERMINATION-TOTAL-SOLIDS/

13) IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE, VOLUME 267, ISSUE 6

14) EPA: MANUAL: NITROGEN CONTROL, EPA 625/R-93/010,

SEPTEMBER 1993

(15)HTTPS://ONLINELIBRARY.WILEY.COM/DOI/FULL/10.1111/WEJ.1243

(16) HTTPS://CPHEEO.GOV.IN/UPLOAD/UPLOADFILES/FILES/ENGINEERING_CHAPTER5.PDF

(17) HTTPS://CPHEEO.GOV.IN/UPLOAD/UPLOADFILES/FILES/ENGINEERING_CHAPTER5.PDF

(18) HTTPS://CPHEEO.GOV.IN/UPLOAD/UPLOADFILES/FILES/ENGINEERING_CHAPTER5.PDF5.2 UNIT OPERATIONS IN BIOLOGICAL TREATMENT

(19) HTTPS://CPHEEO.GOV.IN/UPLOAD/UPLOADFILES/FILES/ENGINEERING_CHAPTER5.PDF5.2 SECONDARY BIOLOGICAL TREATMENT PROCESS

(20) HTTPS://CPHEEO.GOV.IN/UPLOAD/UPLOADFILES/FILES/ENGINEERING_CHAPTER5.PDF CHAPTER 5: DESIGN AND CONSTRUCTION OF SEWAGE TREATMENT FACILITIES 5.3.1.1 ACTIVATED SLUDGE PROCESS

(21) BELT FILTER PRESS. FACT SHEET". *BIOSOLIDS*. EPA. SEPTEMBER 2000. EPA 832-F-00-057.

(22) HTTPS://OSSF.TAMU.EDU/FINAL-TREATMENT-AND-DISPOSAL/

(23) MANUAL ON WATER SUPPLY AND TREATMENT.C.P.HEEO, MINISTRY OF URBAN DEVLOPMENT; GOVERNMENT OF INDIA.

(24) MANUAL ON SEWERAGE AND SEWAGE TREATMENT, C.P.H.E.E.O., MINISTRY OF URBAN DEVLOPMENT; GOVERNMENT OF INDIA NEW DELHI.

(25) JAYSHREE DHOTE, SANGITA INGOLE (2012); REVIEW ON WASTEWATER TREATMENT TECHNOLOGIES PUBLISHED IN INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH AND TECHNOLOGY. PP. 2-5.

(26) SCITECH ENCYCLOPAEDIA (2007) HTTP://WWW.ANSWER.COM/TOPIC/SEWAGETREATMENT 5)A.K. JAIN, ENVIRONMENTAL ENGINEERING, KHANNA PUBLISHING HOUSE.

(27) S.K. GARY: WATER SUPPLY AND SEWAGE DISPOSAL ENGINEERING VOL 1&2, KHANNAPUBLICATIONS

(28) LOGAN, B.; REGAN, J. (2006). "MICROBIAL FUEL CELLS—CHALLENGES AND APPLICATIONS". *ENVIRONMENTAL SCIENCE & TECHNOLOGY*. **40** (17):51725180. BIBCODE:2006ENST................L. DOI

(29) CENTRIFUGE THICKENING AND DEWATERING. FACT SHEET". EPA. SEPTEMBER 2000. EPA 832-F-00-053.

(30) SHARMA, SANJAY KUMAR; SANGHI, RASHMI (2012). *ADVANCES IN WATER TREATMENT AND POLLUTION PREVENTION*. SPRINGER SCIENCE & BUSINESS MEDIA. ISBN 978-94-007-4204-8.

(31) HTTPS://M.INDIAMART.COM/PRODDETAIL/HIGH-RATE-WATER-CLARIFIER-2198636712.HTML

(32) JOURNAL OF INNOVATIVE RESEARCH IN SCIENCE, ENGINEERING VOL 8.