Synopsis

On

Characterization of sewage and design of sewage treatment plant for Anjuman – I – Islam's Kalsekar Technical Campus New Panvel

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This is certify that the project entitled ***“ Characterization of sewage and Design of sewage Treatment Plant”*** is bonafide work of ***Kawade Ankita Suresh (12CE03) , Lokhande Archana Ramkrushna (12CE05)*** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of degree of “Bachelor of Engineering” in Department of civil Engineering.

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PROJECT REPORT APPROVAL FOR B. E.

This is report entitled **" Characterization of sewage and Design of sewage Treatment Plant"** by Kawade Ankita Suresh (12CE03) , Lokhande Archana Ramkrushna (12CE05) is approved for the degree of " Bachelor of Engineering" in "Department of Civil Engineering" .

Examiners

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Supervisors

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately citied and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresents or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly citied or from whom proper permission has not been taken when needed.

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ACKNOWLEDGEMENT

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ABSTRACT

There are two fundamental reasons for treatment of waste water viz. prevention of pollution and thereby protecting the environmental and protecting the public health by safe guarding water supplies and preventing the spread of water borne diseases. when untreated sewage is discharged sewage may be washed up on to the shore, near the point of disposal, where they decomposes and create foul smells and bad odours. The discharged sewage will contaminate the natural body water i.e. river, lake etc with pathogenic bacteria.

The Anjuman – I – Islam's Kalsekar technical campus, New Panvel is important educational institutes in the Navi Mumbai with a large number of students studying in its campus consisting of various department laboratories, classrooms, canteen, bathroom and academic blocks. There will be hostel of 500 students capacity and residential quarters will be constructed in future.

It is absolutely necessary to study the Characteristics and behavior of sewage, to ensure its safe disposal. This study will help in determining the degree and type of treatment required to be given to given sewage, and thus avoid the pollution of the source of its disposal. The present study involves the analysis of pH value, total solids, total suspended solids, hardness, acidity, alkalinity, chloride, chlorine, BOD and DO.

The samplings of the domestic waste from college have been done in different times of the day to have an average data of the measured parameters. The average values of pH, Turbidity, Acidity, Chloride, Residual Chlorine, Hardness, Total Solid, BOD, DO, Alkalinity.
A sewage treatment plant has been designed with the treatment units, a bar screen, an aeration tank and a collection pit.

Keywords: Characterization, sewage, treatment plant.

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MLSS	Mixed liquor suspended solids
HRT	Hydraulic retention time
SVI	Sludge volume index
BOD	Bio–chemical oxygen demand
DO	Dissolved oxygen
COD	Chemical oxygen demand
F/M ratio	food to micro-organism ratio
MLD	Million liter per day

KLD	Kilo Liter per day

CHAPTER 1

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.

The growing environmental pollution needs for decontaminating waste water result in the study of characterization of waste water, especially domestic sewage. In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants.

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 that is discharged from the campus canteen, laboratories of various department and bathrooms Kalsekar technical campus, New Panvel, through the kitchen outlets and bathroom effluents. The study includes characterization tests for pH value, acidity, alkalinity, chloride, residual chlorine, and turbidity, DO, COD and BOD.

1.01 General

1.1.1 Physical characteristics of waste water:

Odour: Fresh sewage is practically odourless. But, however, in 3 to 4 hours, it becomes stale with all oxygen present in sewage being practically exhausted. It then starts omitting offensive odours, especially that of hydrogen sulphide gas, which is formed due to decomposition of sewage. The ultimate odour tasting device is the human nose. The odour of wastewater can be measured by a term called the **THRSHOLD ODOUR NUMBER (TON**), which represents the extent of dilution required to just make the sample free from odour. The minimum odour of the sample that can be detected after successive dilutions with odourless medium is thus,, known as Threshold odour. (Garg s.k, 2015)

Turbidity: Sewage is normally turbid, resembling dirty dish water or wastewater from baths having other floating matter like fecel matter, pieces of paper, cigarette-ends, match-sticks, greases, vegetables debris, fruit skins, soaps, etc. The turbidity increases as sewage becomes stronger. The degree of turbidity can be measured and tested by **turbidity rods** or by turbidimeters, as is done for testing raw water supplies. (P.N. Modi).

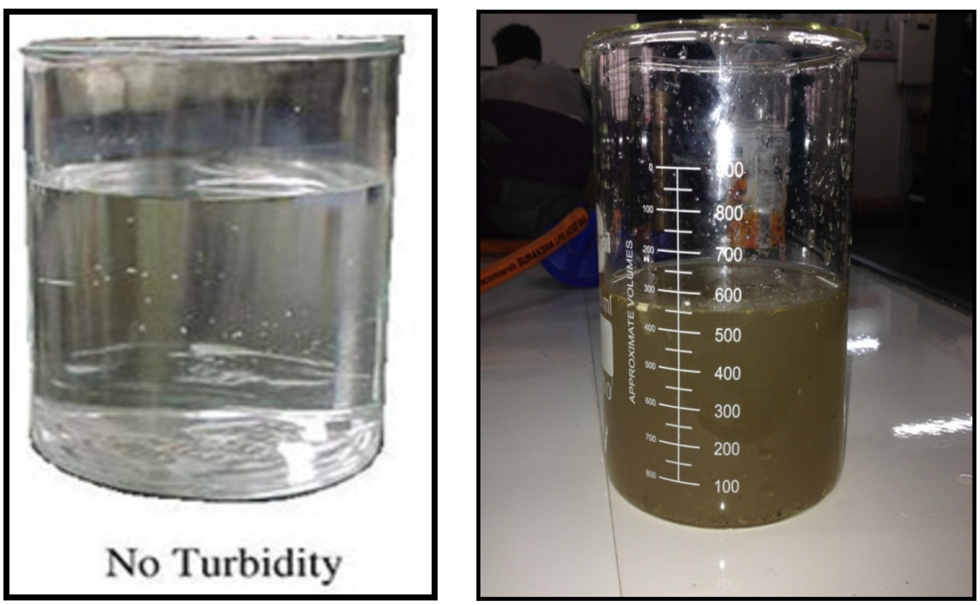


Fig. 1.01. Turbid waste water

Color: The color of sewage can normally be detected by the naked eye, and it indicates the freshness of sewage. If its color is yellowish, gray, or light brown, it indicates fresh sewage.

However, if the colors, may also be formed due to the presence of some specific industrial wastes.

<u>Temperature</u>: The temperature has an effect on the biological activity of bacteria present in sewage, and it also affects the solubility of gases in sewage. In addition, temperature also affects the viscosity of sewage. The normal temperature of sewage is generally slightly higher than the temperature of water, because of additional heat added during the utilization of water. The average temperature of sewage in India is 20°C Which is near about the ideal temperature for the biological activities. However, when the temperature is more, the dissolved oxygen content (D.O.) of sewage gets reduced.

1.1.2 Chemical characteristics of waste water:

<u>Total solids, suspended solids and settle able solids</u>: sewage normally contains very small amount of solids in relation to the huge quantity of water (99.9%).It only contains about 0.05 to 0.1 percent (i.e. 500 to 1000 mg/l) of total solids. Solids present in sewage may be in any of the four forms: suspended solids, dissolved solids, colloidal solids, and settle able solids.

Suspended solids are those solids which remain floating in sewage. Dissolved solids are those which remain dissolved in sewage just as salt in water. Colloidal solids are finely divided solids remaining either in solution or in suspension. Settle able solids are that portion of solids matter which settles out, if sewage is allowed to remain undisturbed for a period of 2 hours. The proportion of these different types of solids is generally found to be as given below:

It has been estimated that about 1000 kg of sewage contains about 0.45 kg of totals solids, out of which 0.225 kg is in solution, 0.112 kg is in suspension, and 0.112 kg is settle able.

Further, the solids in sewage comprise of both: the organic as well as inorganic solids. The organic matter works out to be about 45% of the totals solids, and the remaining about 55% is the inorganic matter.

<u>pH Value</u>: The pH value of sewage indicates the negative log of hydrogen ion concentration present in sewage.

$$pH = -\log [H^+]$$

It is thus, an indicator of the alkalinity of sewage. If the pH value is less than 7, sewage is acidic, and if the pH value is more than 7, the sewage is alkaline. The lesser pH value, the lesser is the alkalinity.

The determination of pH value of sewage is important, because of the fact that efficiency of certain treatment methods depends upon the availability of a suitable pH value. The pH value can be measured quickly and automatically with of potentiometer, which measures the electrical potential exerted by the hydrogen ions, and thus, indicating their concentration.

It may also be mentioned here that the fresh sewage is generally alkaline in nature (with pH more than 7); but as time passes, its pH tends to fall due to production of acids by bacterial action in anaerobic or nitrification processes. The pH, however, rises upon treatment of sewage.

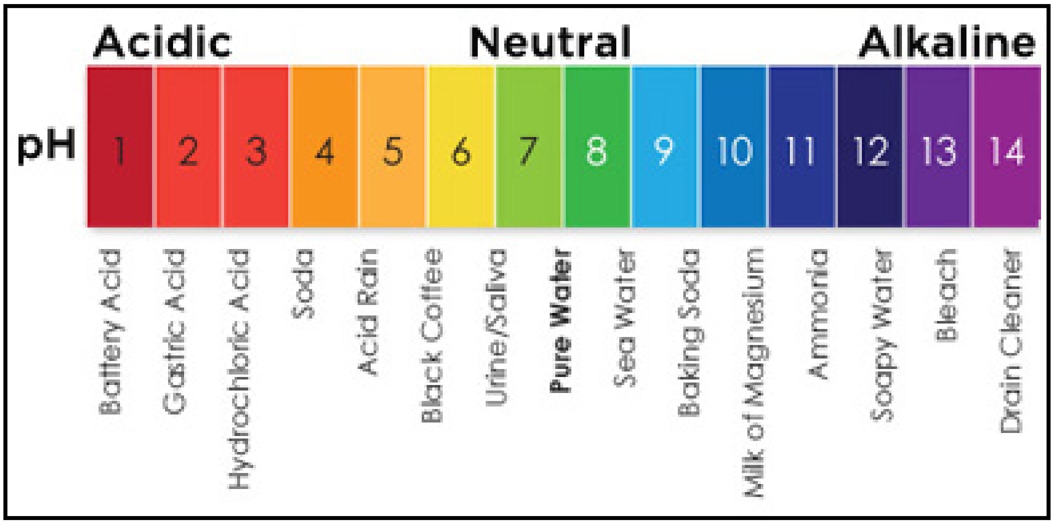


Fig. 1.02. Ph scale

Acidity and alkalinity : Acidity levels in wastewater indicate its corrosive properties and can take a leading role in regulating biological processes as well as in chemical reactions (such as chemical coagulation and flocculation). Alkalinity, too, contributes to the properties of wastewater, many of which also affect biological processes (such as nitrification) and chemical reactions.

While both acidity and alkalinity are related to pH, they should not be confused with pH, nor should the terms be used interchangeably. Acidity is a measure of a solution's capacity to react with a strong base (usually sodium hydroxide, NaOH) to a predetermined pH value. This measurement is based on the total acidic constituent of a solution (strong and weak acids, hydolyzing salts, etc.) It is possible to have highly acidic water but have moderate pH values. Likewise, the pH of a sample can be very low but have a relatively low acidity. Acidity is similar to a buffer in that the higher the acidity, the more neutralizer is needed to counteract it.

Alkalinity is the measure of a solution's capacity to react with a strong acid (usually sulfuric acid H2SO4) to a predetermined pH. The alkalinity of a solution is usually made up of carbonate, bicarbonate, and hydroxides. Similar to acidity, the higher the alkalinity is, the more neutralizing agent is needed to counteract it. In general, a treatment plant and its collection system operates better with wastewater lower in acidity and higher in alkalinity.

<u>Chloride Contents</u>: Chlorides are generally found present in municipal sewage, and are derived from the kitchen wastes, human feces, and urinary discharges etc. The normal chloride content of domestic sewage is 120 mg/l, whereas, the permissible chloride content for water supplies is 250 mg/l . However, large amounts of chlorides may enter from industries like ice cream plants, meat salting, etc., thus, increasing the chloride contents of sewage. Hence, when the chloride content of given sewage is found to be high, it indicates the presence of industrial waste or infiltration of sea water, thereby indicating the strength of sewage.

The chloride content can be measured by titrating the waste water with standard silver nitrate solution, using potassium chromate as indicator, as is done for testing water supplies.

<u>Nitrogen Contents</u>: The presence of nitrogen in sewage indicates the presence of organic matter, and may occur in one or more of the following forms:

1. Free ammonia, called ammonia nitrogen
2. Albuminoid nitrogen, called Organic nitrogen
3. Nitrites; and
4. Nitrates.

(Items 1 and 2: } Kjeldahl nitrogen)

As pointed earlier, the free ammonia indicates the very first stage of decomposition of organic matter(thus indicating recently, staled sewage); the decomposition of organic matter is started; the nitrates indicate the presence of partly decomposed (not fully oxidised) organic matter; and nitrates indicating the presence of fully oxidised organic matter.

The nitrites thus indicate the intermediate stage of conversion of organic matter of sewage into stable forms, thus indicating the progress of treatment given to sewage is still incomplete, and the sewage is stable. Whereas, the presence of nitrates indicate the most stable form of nitrogenous matter contained in swage, thus indicating the well oxidised and treated sewage.

Even though ‘nitrates’ have been defined as the non-objectionable final end product in aerobic treatment of sewage , yet its concentrations in potable waters are controlled, because larger concentrations (above 45 ppm ; say), may cause nitrate poisoning in infants.

All these different forms of nitrogen, present in sewage, can be tested and measured easily as explained below :

The amount of free ammonia present in sewage can be easily measured by simply boiling the sewage, and measuring the ammonia gas which is consequently liberated. The amount of albuminoid nitrogen can be measured by adding strong alkaline solution of potassium permanganate ($KMnO_4$) to already boiled sewage sample and again boiling the same, when ammonia gas liberated, which is measured, so as to indicate the amount of Albuminoid nitrogen present in sewage. If however an unboiled sample is used to add ($KMnO_4$) before boiling, the evolved ammonia gas will measure the sum total of ammonia nitrogen as well as organic nitrogen; and is kjeldal nitrogen.

The amount of nitrates present in sewage sample can be measured by colour matching methods. For nitrites, the colour is developed by adding sulphonilic acid and naphthamine; whereas for nitrates, the colour is developed by adding phenol- di- sulphonic acid and potassium hydroxide. The colour developed in waste water is finally compared with the standard colors of known concentrations.

Presence of Fats, Oils and Greases: Greases, fats and oils are derived in sewage from the discharge of animals and vegetable matter, or from the industries like garages, kitchens of hotels and restaurants, etc. Such matter form scum on the top of the sedimentation tanks and clog the voids of the filtering media. They thus interfere with the normal treatment methods, and hence need proper detection and removal .

The amount of fats and greases in sewage sample is determined by making use of the fact that oils and greases are soluble in ether, and when the ether is evaporated, it leaves behind ether soluble matter, which represents the quantity of fats and oils. Hence, in order to estimate their amount, a sample of sewage is , first of all, evaporated. The residual solids left are then mixed with ether. The solution is then poured off and evaporated, leaving behind the fats and greases as residue, which can easily weighed.

Sulphides, Sulphates and Hydrogen Sulphide Gas: The determination of sulphides and sulphates in sewage is rarely called far, although their presence reflects aerobic, and/or anaerobic decomposition. Sulphides and sulphates are formed due to the decomposition of various sulphur containing substances present in sewage. This decomposition also leads to evolution of hydrogen sulphide gas, causing bad smells and odours, besides causing corrosion of concrete sewer pipes.

Hardness : Water hardness is important to fish culture and is a commonly reported aspect of water quality. It is a measure of the quantity of divalent ions (for this discussion, salts with two

Water Hardness Scale		
Grains/Gal	**mg/L & ppm**	**Classification**
Less than 1	Less than 17.1	**Soft**
1 – 3.5	17.1 - 60	**Slightly Hard**
3.5 - 7	60 - 120	**Moderately Hard**
7 - 10	120 - 180	**Hard**
Over 10	Over 180	**Very Hard**

Fig. 1.03. Hardness scale

Positive charges) such as calcium, magnesium and/or iron in water. There are many different divalent salts; however, calcium and magnesium are the most common sources of water hardness.

Hardness is traditionally measured by chemical titration. The hardness of a water sample is reported in milligrams per liter (same as parts per million, ppm) as calcium carbonate (mg/l $CaCO_3$). Calcium carbonate hardness is a general term that indicates the total quantity of divalent salts present and does not specifically identify whether calcium, magnesium and/or some other divalent salt is causing water hardness. Hardness can be a mixture of divalent salts. In theory, it is possible to have water with high hardness that contains no calcium. Calcium is the most important divalent salt in fish culture water.

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 4ppm 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. tests are performed during sewage disposal treatment processes.

The D.O. test performed on sewage before treatment, helps indicating the condition of sewage. It is well known by now by now, that only very fresh sewage contains some dissolved oxygen in fresh sewage depends upon temperature. If the temperature of sewage is more, the D.O. content will be less. The solubility of oxygen in sewage is 95% of that in distilled water.

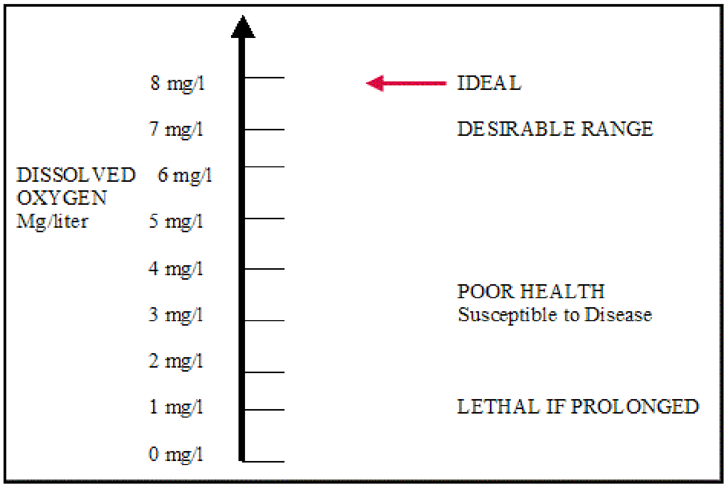


Fig. 1.04. **<u>DO scale</u>**

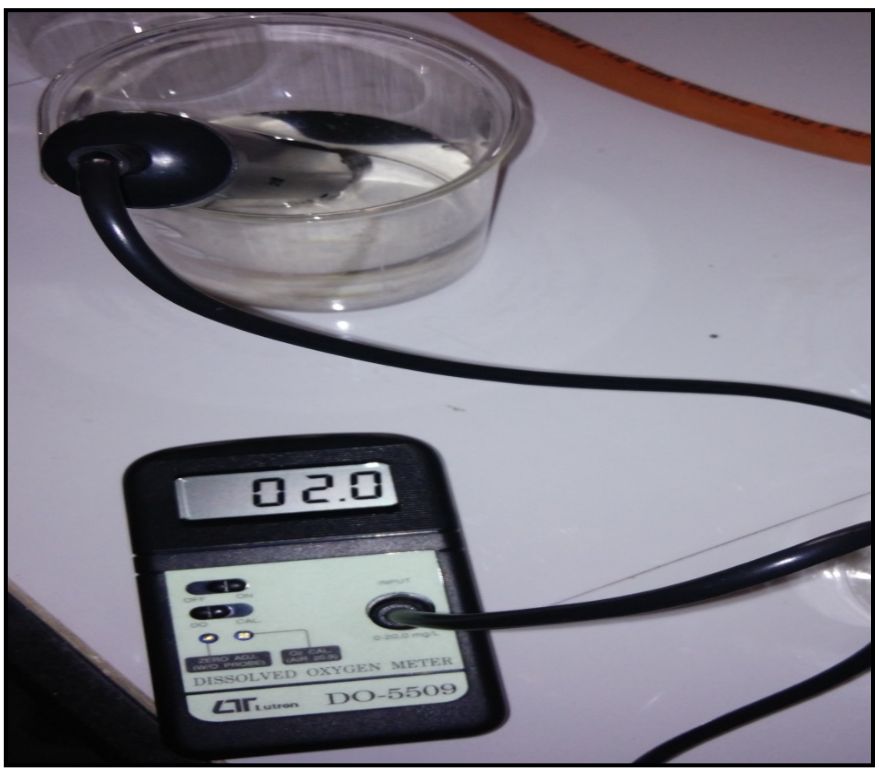


Fig. 1.05. **<u>DO METER</u>**

Chemical oxygen demand : Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes.

Chemical oxygen demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid(H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

Chemical Oxygen Demand is an important water quality parameter because, similar to BOD, it provides an index to assess the effect discharged wastewater will have on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.

1.1.3 Biological characteristic of waste water:

Bio- chemical oxygen demand: the biochemical oxygen demand determination is chemical procedure for determining the amount of dissolved oxygen needed by aerobic organisms in water body to break the organisms in water body to break the organic materials present in the given water sample at certain temperature over a specific period of time.

BOD of water or polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under standard condition at a standardized time and temperature. Usually, the time is taken as 5 days and the temperature is 20°C .

The test measures the molecular oxygen utilized during a specified incubation period for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous ion. It also may measure the amount of oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand).

ENVIRONMENTAL SIGNIFICANCE: BOD is the principle test to give an idea of the biodegradability of any sample and strength of waste. Hence the amount of pollution can be easily measured by it. Efficiency of any treatment plant can be judged by considering influent BOD and also the organic loading on the unit. Application of the test to organic waste discharges on the oxygen resources of the receiving water. Data from BOD tests are used for the development of engineering criteria for the design of waste water treatment plants. Ordinary domestic sewage may have a BOD of 200 mg/l. Any effluent to be discharged into natural bodies of water should have BOD less than 30 mg/l. This is important parameter to assess the pollution of surface waters and ground waters where contamination occurred due to disposal of domestic and industrial effluents.

Drinking water usually has BOD of less than 1mg/l. But when BOD value reaches 5 mg/l , the water is doubtful in purity. The determination of the BOD of wastes is useful in the design of treatment facilities. It is the only parameter, to give an idea of biodegradability of any sample and self purification capacity of rivers and streams. The BOD test is among the most important methods in sanitary analysis to determine the pollution power, or strength of sewage, industrial wastes or polluted water. It serves as a measure of the amount of clean diluting water required for the successful disposal of sewage by dilution.

(Table no 1.01) Physical and chemical Parameters(IS 10500 : 2012)

Sr. No	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the absence of Alternate Source
01	Colour, Hazen units, Max	5	15
02	Odour	Agreeable	Agreeable
03	pH value	6.5-8.5	No relaxation
04	Turbidity, NTU, Max	1	5
05	Total dissolved solids, mg/l, max	500	2000
06	Chloride (as Cl), mg/l, Max	250	1000
07	Nitrate (as NO3), mg/l, Max	45	No relaxation
08	Sulphide (as H2S), mg/l, Max	0.05	No relaxation
09	Total alkalinity as calcium carbonate, mg/l, Max	200	600
10	Total hardness (as CaCO3), mg/l, Max	200	600

1.02 Aim and Objectives of the study:

The principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. An environmentally-safe fluid waste stream is produced. No danger to human health or unacceptable damage to the natural environment is expected. Sewage includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage also includes liquid waste from industry and commerce.

The objectives of the study are:

1. Physical, chemical and biological characterization of domestic waste water samples from the kitchen effluent, various laboratories outlets and the bathroom waste of college area.
2. Comparison with the prescribed standard
3. Design of the sewage treatment plant.

Waste water samples from the kitchen effluent, various laboratories outlets and the bathroom waste of college area will be collected.

The following physical characteristics will be studied:

1. Odour
2. Turbidity
3. Color
4. Temperature

The following chemical characteristics will be studied:

1. Total solids, suspended solids and settleable solids
2. pH Value
3. Chloride Contents
4. Nitrogen Contents
5. Presence of Fats, Oils and Greases
6. Sulphides, Sulphates and Hydrogen Sulphide Gas
7. Dissolved Oxygen (D.O.)
8. Chemical oxygen demand.

Biological characteristic of waste water:

1. Biological oxygen demand.

1.03 Scope of project:

Traditionally sanitation work in developing countries concentrates on research on very rudimentary sanitation facilities such as treatment plant, stand alone septic tank, composite toilets etc. little is known about the viability of waste water treatment plant. Therefore this project will be design to provide a comprehensive study to establish guidelines for their application. In the context of project, these objectives mean that the project is not necessarily trying to find the best sewage disposal technology for given problem but to list the condition were waste water treatment plant represents efficient alternative to on site waste water disposal technologies.

1.04 Expected outcome:

The waste water will be treated in this plant and it will become safe to drain into the natural recourses. Therefore minimize the ill effect of waste water on environment and public health. It reduces the quantity of floatables material, acidity, alkalinity, hardness and BOD of water.

1.05 STUDY AREA:

Achievement of a safe and healthful workplace is the responsibility of an organization, the people residing in the place and the workers who are given the charge to protect the environment. Waste disposal and minimization and pollution prevention should be the preferred approach. Stringent penalties for the improper disposal of wastes should be adopted. AIKTC campus is important educational institutes in the new panvel which has a large number of students studying in its campus, a number of laboratories of various department, academic blocks.

The following is the list of workplace which is the main sources of pollution generating unit in the study area:

1) College area (kitchen effluents from canteen)

Fig. 1.06. <u>Outlet of kitchen waste</u>

2) Bathroom waste and various laboratories outlets

Fig. 1.07. **<u>Outlet of bathroom w.c. and waste</u>**

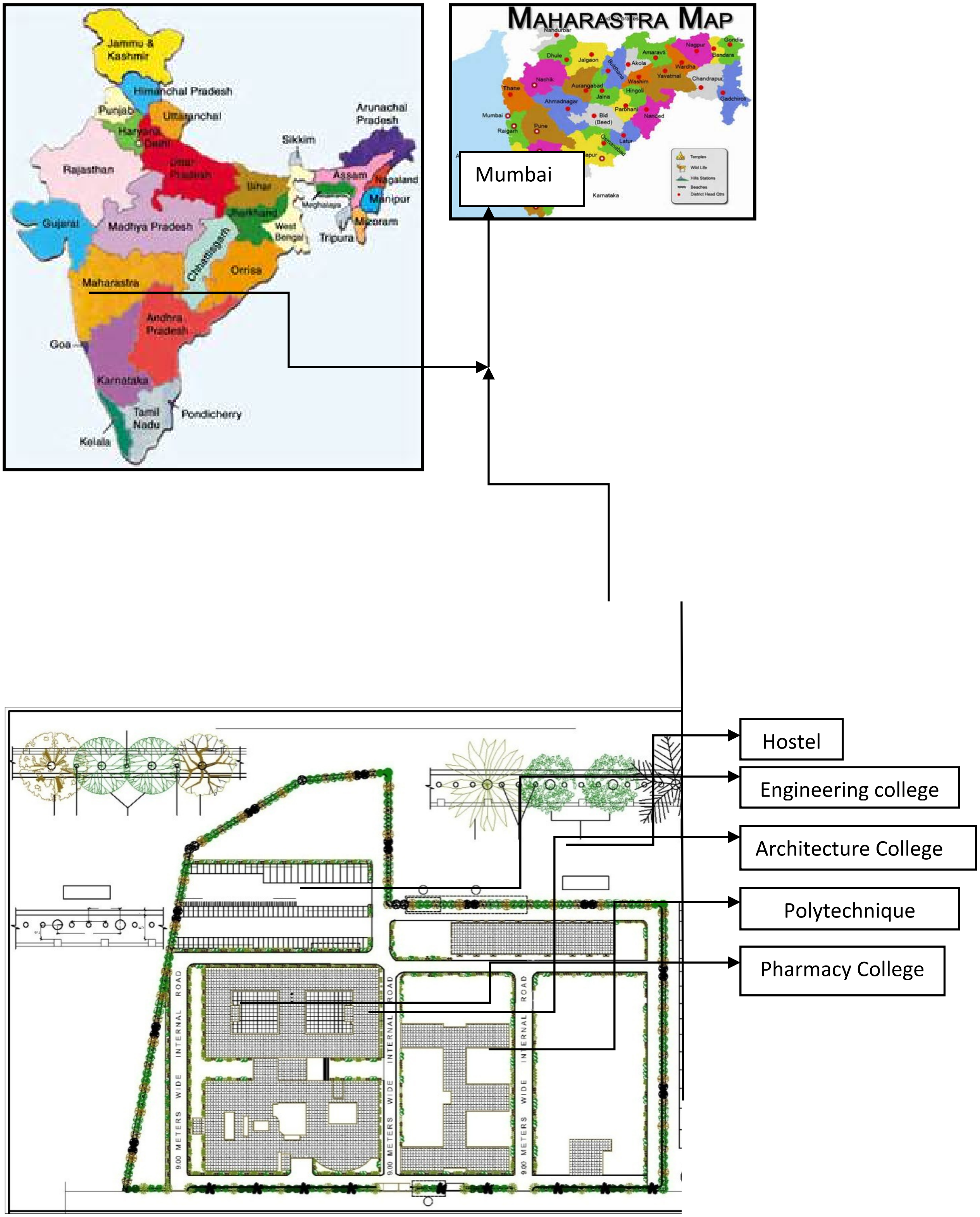
1.06 SAMPLING

TECHNIQUES:

Waste water samples will be collected in contamination free sampling bottles of 1000 ml from kitchen effluent and the bathroom waste of college and campus. The physical and chemical characteristics of sewage vary from top to bottom of sewage depth, as well as with time as from morning to evening. It therefore becomes difficult to obtain a truly representative sample. A fair comprise is, therefore, made in practice. Samples are taken at a point beneath the surface where the turbulence is thoroughly mixing up the sewage particles. This is called a grab sample. Such grab samples are collected at regular intervals during a day. These different samples are now mixed together, and the amount utilized from each specimen is proportional to the rate of flow at the time the specimen was collected. This composite sample is taken for testing, as it represents more nearly, the average true strength of the sewage.

In order to keep sample cool, so as to prevent the biological action from taking place in the sewage, preservatives, such as chloroform, formaldehyde and sulphuric acid are added in the collecting bottle.

Map of AIKTC, NEW PANVEL


Jammu & Kashmir
Himanchal Pradesh
Punjab
Uttaranchal
Haryana
Delhi
Arunachal Pradesh
Sikkim
Rajasthan
Uttar Pradesh
Bihar
Assam
Nagaland
Manipur
Meghalaya
Gujarat
Madhya Pradesh
Jharkhand
West Bengal
Tripura
Mizoram
Chhattisgarh
Orrisa
Maharastra
Andhra Pradesh
Goa
Karnataka
Tamil Nadu
Pondicherry
Kelala
MAHARASTRA MAP
Mumbai
Hostel
Engineering college
Architecture College
Polytechnique
Pharmacy College
9.00 METERS WIDE INTERNAL ROAD

1.7 METHODOLOGY

1.7.1 METHODOLOGY FOR MEASUREMENT OF pH VALUE

(ELECTROMERIC METHODS)

PRINCIPLE

The pH value is found by measurement of the electromotive force generated in a cell. It is made up of an indicator electrode which is reactive to hydrogen ions such as a glass electrode. When it is immersed in the test solution the contact between reference electrode (usually mercury/calomel electrode), and the test solution the electromotive force is measured. A pH meter, that is, a high impedance voltmeter is marked in terms of pH. Varieties of electrodes have been suggested for the determination of pH. The hydrogen gas electrode is the primary standard. Glass electrode in coordination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the theory that a change, of 1 pH unit produces an electrical change of 59.1 mV at 25°C. The membrane of the glass forms a partition between two liquids of differing hydrogen ion concentration thus a potential is produced between the two sides of the membrane which is proportional to the difference in pH between the liquids.

The apparatus used are:

1. pH meter - With glass and reference electrode (saturated calomel),
2. Preferably with temperature compensation.
3. Thermometer - With least Count of 0.5°C.

PROCEDURE:

The instrument is standardized after required warm-tip period. A buffer solution of pH near to that of the sample is used. The electrode is checked against at least one additional buffer of different pH value. The temperature of the water is found and if temperature compensation is available in the instruments it is adjusted. The electrodes are rinsed and gently wiped with solution. If necessary, the electrodes are immersed into the sample beaker or sample stream and stirred at a constant rate to provide homogeneity and suspension of solids. Rate of stirring is minimized and the air transfer rate at the air-water interface of the sample is noted. The sample pH and temperature is noted.

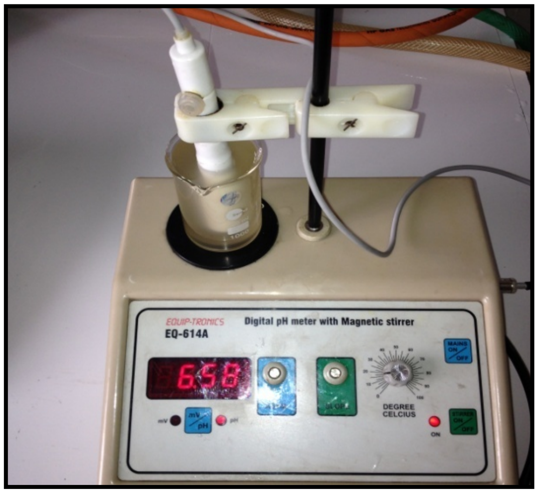


Fig. 1.08 Ph value of sample

1.7.2 METHODOLOGY FOR MEASUREMENT OF ALKALINITY

The sample liquid for analysis should be either free from turbidity or should be allowed to settle before analyzing it.

The apparatus used are:

1. pH Meter
2. Burette - 50-ml capacity.
3. Magnetic Stirrer Assembly

The reagents used are:

1. Distilled Water - pH must be greater than 6.0. In case the pH falls below 6.0, it shall be boiled for 15 minutes and cooled to room
2. Temperature.
3. Sulphuric Acid - 5.6 ml of concentrated sulphuric acid is diluted with one liter with distilled water.
4. Standard Solution of Sulphuric Acid - 0.02 N.
5. Phenolphthalein Indicator - 0.5 g of phenolphthalein in 100 ml is mixed, 1: 1 (v/v) alcohol water mixture is taken.
6. Mixed indicator Solution - Dissolve 0.02 g methyl red and 0.01 g bromocresol green in 100 ml, 35 %, ethyl or isopropyl alcohol.

PROCEDURE:

20 ml of sample is pipette into a 100-ml beaker. 2 to 3 drops of phenolphthalein indicator is added to the sample if the pH of the sample is above 8.3. It is then titrated with standard H_2SO4 solution till the pink color observed by indicator just disappears (equivalence of pH 8.3). The volume of standard H_2SO4 solution used is recorded. 2 to 3 drops of mixed indicator is put to the solution in which the phenolphthalein alkalinity has been determined. The solution is titrated with standard acid to light pink color (equivalence of pH 3-7). The volume of standard acid used after phenolphthalein alkalinity is recorded.

Fig. 1.09 **Chemical required for test of alkalinity**

1.7.3 METHODOLOGY FOR THE DETERMINATION OF TURBIDITY:

PRINCIPLE:

The intensity of light scattered by the sample under defined conditions is compared with the intensity of light scattered by a standard reference suspension under the same conditions, forms the basis of determination of turbidity.

Higher the intensity of scattered lights higher the value of turbidity. Formazin polymer is generally used as turbidity standard because it is more reproducible than other types of standards used previously. The turbidity of a particular concentration of Formazin suspension is defined as 40 Jackson turbidity units. The same suspension of Formazin has a turbidity of approximately 40 units when measured on Jackson candle turbidimeter. Thus turbidity units based on the Formazin preparation closely approximate those derived from Jackson candle turbidimeter but it may not always be identical to them.

The apparatus used are:

1. Sample Tubes - The sample tubes should be of clear and colorless glass.
2. Turbidimeter

The reagents used are**:**

1. Turbidity-Free Water
2. Hexamethylene Tetramine Solution
3. Hydrazine Sulphate Solution

4. Turbidity Standard Suspension I (Formazin)
5. Turbidity Standard Suspension II

PROCEDURE:

TURBIDIMETER CALIBRATION - The manufacturer's operating instructions is followed. The standards on turbidimeter covering the range of interest are measured. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of calibration.

- Turbidity less than 43 Units - The sample is shaken to disperse the solids. Air bubbles disappear gradually. Sample into turbidimeter tube is poured carefully and turbidity value is directly read from the instrument scale.
- Turbidity greater than 40 Units – If turbidity values are more than 40 units, the sample is diluted with clear distilled water to compare and bring the values within range. The readings are taken of the diluted sample. Then the turbidity is computed of the original sample from the turbidity of the diluted sample and the dilution factor.

Fig. 1.10. Turbidity value of sample

1.7.4 METHODOLOGY FOR THE DETERMINATION OF ACIDITY:

PRINCIPLE:

Acidity of water is the numerically expressible capacity to react with a strong base to a designated pH. It may be defined as equivalent concentration of hydrogen ions in mg/l. The equation in its simplest form is as follows:

$H^+ + NaOH = H_2O + Na^+$

The apparatus used are:

1. pH Meter

2. Burette - 50-ml capacity.
3. Magnetic Stirring Device

The Reagents used are:

1. Distilled Water
2. Potassium Acid Phthalate
3. Sodium Hydroxide Solution **-** 15 N.

Sodium hydroxide solution - 1 N 67 ml of 15 N NaOH solution is diluted to one liter with distilled water.

Sodium hydroxide solution - 0.02 N 20 ml of 1 N NaOH solution is diluted to one liter and is standardized using standard potassium acid phthalate

Phenolphthalein Indicator - 0.5 g of phenolphthalein is dissolved in 100 ml 1: 1 (v/v) alcohol water mixture and 0.02 N NaOH solution is added drop by drop till slight pink color is observed.

Methyl Orange Indicator – 0.5 g of methyl orange is dissolved in distilled water and made up to 100 ml in a volumetric flask.

PROCEDURE:

Indicator Method - 20 ml of a suitable amount of sample is pipetted into a 100 ml beaker. Less than 20 ml of titrant shall be required for the titration that should be the volume of sample. The pH of water is determined. If pH is less than 3.7, two drops of methyl orange indicator is added into the first sample beaker. It is titrated with standard 0.02 N NaOH solution until the colour converts to the faint orange. The volume of NaOH used is recorded. 2 to 3 drops of phenolphthalein indicator is added to the second sample beaker. It is again titrated with 0.02 N NaOH solution till the colour of solution changes to faint pink colour. The volume used is recorded.

Potentiometric Method - 20 ml of a suitable aliquot of sample is pipette into a 100 ml beaker. It is then titrated with standard NaOH solution to pH 3.7 and pH 8.3. The volume of standard NaOH used is measured. No indicator is required.

1.7.5 METHODOLOGY FOR MEASUREMENT OF CHLORIDE

PRINCIPLE:

Soluble and slightly dissociated mercuric chloride is formed when Chloride is titrated with mercuric nitrate.

Diphenyl Carbazone within the pH range of 2.3 to 2.8 signals the end point by the formation of a purple complex with extra mercuric ions.

The apparatus used are:

1. Erlenmeyer flask - 250 ml capacity.
2. Micro burette - 5 ml with 0.01 ml graduation intervals.

The reagents used are:

1. Standard sodium chloride solution
2. Nitric acid - 0. I N
3. Sodium hydroxide - 0.1 N
4. Reagents for chloride concentrations below 700 mg/l
5. Indicator-acidifier reagent - Nitric acid concentration of this reagent decides the success of the determination and it can be varied as indicated in (a) or (b) to befit the alkalinity range of the sample. Reagent (a) contains sufficient nitric acid to counteract a total alkalinity of 150 mg as $CaCO_3$/l to the proper pH in a 100 ml sample.
6. 250 mg s-diphenylcarbazone, 4-O ml. concentration nitric acid and 30 mg xylene cyanol FF in 100 ml 95 percent ethyl alcohol or isopropyl alcohol. The sample is stored in a dark bottle in a refrigerator. This reagent is not stable indefinitely. Deterioration causes a slow end point and high results.
7. Standard mercuric nitrate titrant - 2.3 g mercuric nitrate [Hg $(NO_3)_2$ or 2.5 g Hg $(NO_3).12H_2O$] is dissolved in 100 ml distilled water containing 0.25 ml concentrated nitric acid. It is diluted to just less than 1 liter. Replicates are used containing 5.00 ml standard sodium chloride solution and 10 mg sodium bicarbonate ($NaHCO_3$) diluted to 100 ml with distilled water. It is adjusted to 0.0141 N and a final standardization of 1.00 ml = 500 µg Cl^- is made. It is stored away from light in a dark bottle.
8. Mixed indicator reagent - 0.50 g diphenylcarbazone powder and 0.05
9. bromophenol blue powder is dissolved in 75 ml 95 percent ethyl or isopropyl alcohol and dilute to 100 ml with the same alcohol. 0.141 N standard mercuric nitrate is used as titrant.

PROCEDURE:

100 ml sample is taken such that the chloride content is less than 10 mg. 1.0 ml indicator acidifier reagents are put. pH is conformed to about 8 for highly alkaline or acid waters before adding indicator-acidifier reagent. 0.411 N Mercuric Nitrate is titrated with the solution to a definite purple end point. The solution turns from green blue to blue a few drops before the end point. The blank is determined by titrating 100 ml distilled water containing 10 mg of sodium bicarbonate.

Chloride, mg/l = $(V1 – V2) \times N \times 35450/V3$

Where,

V1 = volume in ml of silver nitrate used by the sample,

V2 = volume in ml of silver nitrate used in the blank titration,
V3 = volume in ml of sample taken for titration and
N = normality of silver nitrate solution.

1.7.6 METHODOLOGY FOR THE DETERMINATION OF RESIDUAL CHLORINE:

It is measured as the chlorine left in the water after the required contact period which will ensure complete killing of bacteria and oxidation of the organic matter usually a free chlorine residue is considered to be sufficient.

The reagents used are

1. O- Toluidine - 4 drops

PROCEDURE:

O- Toluidine is added to the sample and mixed thoroughly. After 15 to 20 minutes the colour is developed. The comparator was placed to match the colour of the sample. The volume of indicator used was noted down. Generally the concentration of residual chlorine must be 1 - 2 mg/l.

1.7.7 METHODOLOGY TO FIND OUT THE AMOUNT OF TOTAL SOLIDS, DISSOLVED SOLIDS, VOLATILE AND FIXED SOLIDS :

PRINCIPLE

Solids are to be determined in raw waters, industrial waste, domestic waste and sludge. The usual definition is that matter which remains as residue upon evaporation and drying out 103°C to 105°C. Solids are organic and inorganic and also dissolved and undissolved or suspended solids.

Total solids are classified as organic and inorganic in terms of volatile and fixed solids. The term settleable solids are applied to solids in suspension that will settle, under quiescent conditions, because of influence of gravity. Solids affect the specific conductance of raw water. Determination of all types of solids separately is important in design consideration of various waste treatment methods.

EQUIPMENTS: Heating Oven, Muffle Furnace.

APPARATUS: 50 ml capacity crucibles, balance with weight box and fractional weights, measuring cylinder pipette, filter paper no.40 etc. relevant is code (IS 3025-1984).

PROCEDURE:

1. Weight the empty crucibles (w). Then take 50ml of sample in the crucibles and heat in an oven kept at 103°C for about one hour till it is completely dry. Also the crucible to cool.

3. Take weight of the crucible in a with dry residue (w1).

4. Keep the same crucible in a muffle furnace and heat it as 550°C for minutes. Take out the crucible from the furnace and allow it to cool.

5. Take weight of the crucibles with residue (w2). The loss of weight indicates fixed solids.

6. For determining dissolved solids, 50ml of sample through a filter paper (no. 40) collect the filtrate in a crucible (w) and heat it on oven at 103°C for one hour, the residue is completely dry.

7. Record weight of the crucibles with dry residue (w3).

1.7.8 METHODOLOGY FOR MEASUREMENT OF DO:

PRINCIPLE:

The sample is filled in an airtight bottle and incubated at specific temperature for 5 days. The dissolved oxygen (DO) content of the sample is determined before and after five days of incubation at 20°C and the BOD is calculated from the different between initial and final DO.

APPARATUS REQUIRED

1. Burette, Burette stand
2. 300 ml glass stoppered BOD bottles
3. 500 ml conical flask
4. Pipettes with elongated tips
5. Pipette bulb
6. 250 ml graduated cylinder
7. Wash bottles

CHEMICALS REQUIRED

Manganous sulphate solution , Alkaline iodide-azide solution, Sulphuric acid concentrated, Starch indicator solution, Sodium thiosulphate, Distilled or deionized water, Potassium hydroxide ,Potassium iodide, Sodium azide.

PROCEDURE

1. Take two 300ml glass stoppered BOD bottle and fill it with sample to be tested. Avoid any kind of bubbling and trapping of air bubbles. Remember – no-bubbles!

OR

2. Take the sample collected from the field. It should be collected from the field. It should be collected in BOD bottle filled up to the rim.
3. Add 2 ml of manganese sulphate to the BOD bottle by inserting the calibrated pipette just below the surface of the liquid. Add 2 ml of alkali iodide azide reagent in the same manner.
4. Squeeze the pipette slowly so no bubbles are introduced via pipette. If oxygen is present, a brownish orange cloud of precipitate or flock will appear.
5. Allow it to settle for sufficient time in order to react completely with oxygen. Add 2 ml of concentrated sulfuric acid via a pipette held just above the surface of the sample.

Fig. 1.11. <u>BOD sample in incubator</u>

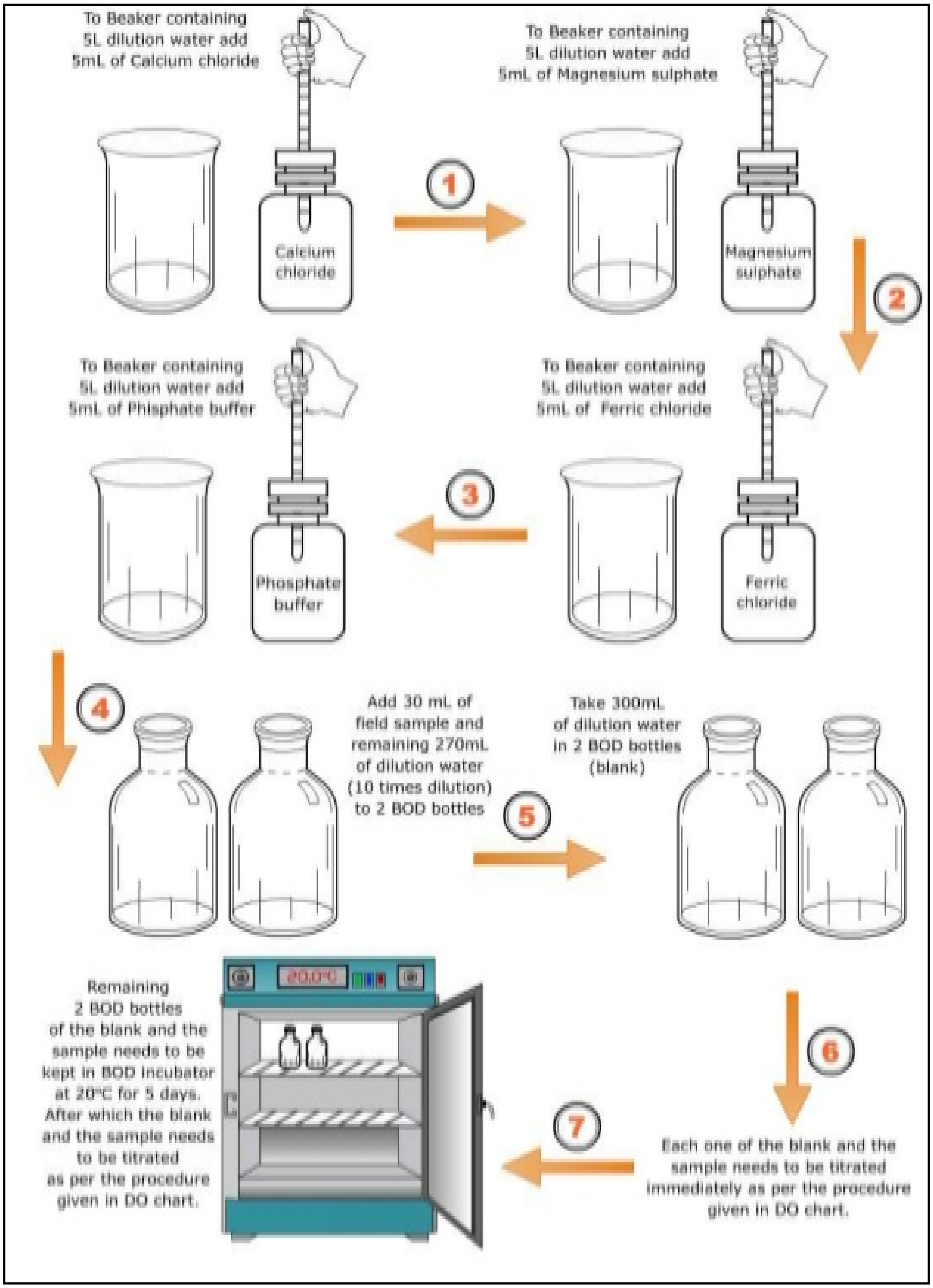


Fig. 1.12. Procedure chart for DO test

1.7.9 METHODOLOGY FOR MEASUREMENT OF BOD:

PRINCIPLE:

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:

1. 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.
2. 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.

1.7.10 METHODOLOGY FOR THE DETERMINATION OF HARDNESS:

Principle:

This method is contingent upon the power of ethylenediamine tetraacetic acid (C10H14O8N2) or its disodium salt to form stable complexes with calcium and magnesium ions. When the dye eriochrome black T (EBT) is added to a solution containing calcium and magnesium ions at pH 10.0 a wine red complex is formed. This solution is titrated with standard solution of disodium salt of EDTA, which extracts calcium and magnesium from the dye complex and the dye is changed back to its original blue colour. Eriochrome black T is used to indicate the end-point for the titration of calcium and magnesium together.

PROCEDURE:

25.0 ml of standard calcium solution is pipetted in a porcelain basin. The volume is adjusted to 50 ml with distilled water. 1 ml buffer solution is used. 1 to 2 drops of indicator is put. After continuous stirring until the reddish tinge disappears, it isn't titrated. Few drops of sample at 3 to 5 second interval are added. At the end point the colour is sky blue. For drinking, surface and saline waters - An aliquot of water sample is pipetted, in a porcelain dish or 150-ml beaker. The volume is tuned to approximately 50 ml. 1 ml hydroxylamine hydrochloride (NH4OH.HCl) is added to the solution. 2 ml of buffer solution is mixed so as to achieve pH of 10.0 to 10.1. 2 ml sodium cyanide or sodium sulphide inhibitor solution is put if the end point isn't sharp. If Cu, Zn, Pb, Co and Ni are absent and if 25 the sample contains less than 0.25 mg of Fe and 0.025 mg of Mn the addition of NaCN or Na2S may be omitted. 2 ml of Eriochrome black T indicator solution is added and titrated with standard EDTA solution stirring rapidly in the beginning. It is stirred slowly towards the end when all the traces of red and purple colour disappear and solution is clear sky blue in colour. For waste waters and highly polluted waters - An aliquot of the sample is

digested with 3 ml of distilled conc. HNO3 in a beaker on a hot plate. It is evaporated to near dryness while ensuring that the sample does not boil. Digestion with nitric acid is repeated till the digestate is light in colour. It is evaporated to near dryness and cooled. Little amount of 1: 1 hydrochloric acid (5 ml) is added and warmed on a steam-bath to dissolve the residue.

Note 1 - For water with very low hardness (less than 5 mg/l) micro buretteis used.

Note 2 - Sample size may be selected such that the result lies between 200 to 300 mg/l of hardness (as CaCO3).

CHAPTER 2

LITERATURE REVIEW

Ramprasad. C,

The waste water generated from the quarters, school hostel and college hostels in BSA crescent engineering campus were collected and analyzed. Conventional treatment method and the method of purification using Reed bed for the treatment of effluent were compared. The plant used for this purpose was Phragmitis australis which is locally known as NANAL.The experiment was conducted with the Primary treated sewage taken from the Sewage Treatment Plant (STP) of our campus. From the experiment it is found that the one with Reed Bed system gives a better quality treated water vis-à-vis the campus STP treated water. Hence, the filter bed of STP is planted with Phragmitis australis as a trial run. The project presentsthe method of construction of root zone bed and the effectiveness of removal of various contaminants using this root zone treatment process. The results for raw water and treated water samples were compared and discussed.

The results show the concentrations of five parameters for wastewater treated by conventional treatment plant, root zone system and simple filter bed system. It is clear that the use of Reed bed system is best for the treatment of all parameters when compared to the other two. There is a remarkable reduction in pH, B.O.D, C.O.D by Reed bed treatment and the treated water has become fit enough to be let out directly into a receiving water body as the concentrations are below allowable limits. Thus the root zone treatment can be used independently or as an addition to conventional treatment so as to make the final output fit enough for discharge into a natural water body.

N. Abdel-Raouf,

Organic and inorganic substances which were released into the environment as a result of domestic, agricultural and industrial water activities lead to organic and inorganic pollution. The normal primary and secondary treatment processes of these wastewaters have been introduced in a growing number of places, in order to eliminate the easily settled materials and to oxidize the organic material present in wastewater. The final result is a clear, apparently clean effluent which is discharged into natural water bodies. This secondary effluent is, however, loaded with inorganic nitrogen and phosphorus and causes eutrophication and more long-term problems because of refractory organics and heavy metals that are discharged. Microalgae culture offers an interesting step for wastewater treatments, because they provide a tertiary biotreatment coupled with the production of potentially valuable biomass, which can be used for several purposes. Microalgae cultures offer an elegant solution to tertiary and quandary treatments due to the ability of microalgae to use inorganic nitrogen and phosphorus for their growth. And also, for their capacity to remove heavy metals, as well as some toxic organic compounds, therefore, it does not lead to secondary pollution.

Algae can be used in wastewater treatment for a range of purposes, including the reduction of BOD, removal of N and/or P, inhibition of coliforms and removal of heavy metals. The high concentration of N and P in most wastewaters also means these wastewaters may possibly be used as cheap nutrient sources for algal biomass production. This algal biomass could be used for the methane production, composting, production of liquid fuels ((pseudo-vegetable fuels), as animal feed or in aquaculture and production of fine chemicals etc. Waste-grown microalgae are a potentially important biomass for biofuel production.

Deepika Sandhu,

About 90 per cent of sewage and 70 per cent of waste water including industrial and domestic domains in developing countries are discharged without treatment, often polluting the usable water supply and also causes massive harm to the marine life as well, for the very fact that the ultimate destination for all the water sources and streams is ultimately the sea. Although the sewage is 99% pure water, still the approximate 1% is harmful to a very large extent. While talking about the economics, a major part is dedicated to the machinery and installation costs, while a considerable portion is also inclined towards the energy costs. In a conventional waste water treatment plant, working on conventional activated sludge process, a portion of energy is spent in operation of the primary clarifiers. If the Extended Aeration process is followed, the energy spent in the operation of primary clarifiers will not be required and thus, without affecting much of the plant operation, for small establishments. A similar waste water treatment plant working on activated sludge process is in operation at an educational institution, namely Educational Institution in Jabalpur. Originally, the plant is working on Activated Sludge Process. Process modification has been suggested in the research work. Also, an aspect of environmental modeling has been highlighted. Basically, when the process modification has been done, by eliminating the primary clarifier skimmer mechanism, an advantage has been that approximately 10% of the total energy that is being used up by the waste water treatment plant has been saved. For 22 consecutive days, the Influent and Effluent Biochemical Oxygen Demand was tested for and it was found from the Equation 1, that, For Activated Sludge Process the average Biochemical Oxygen Demand Removal efficiency = 95.22% For Extended Aeration Process the average Biochemical Oxygen Demand Removal efficiency = 94.64% Which are nearly the same, wherein the Extended Aeration Process consuming about 10% lesser energy than the conventional Activated Sludge Process.

Mohan Singh Negi and Vaishali Sahu,

Sewage treatment plant under study has 9 MLD capacity and is located in Gurgaon. It receives sewage from the surrounding residential areas and after three stage treatment, treated effluent is supplied back to meet water requirement for various purposes. This has certainly reduced dependency on the precious underground water and thereby reducing the burden and saving environment. For performance evaluation of the sewage treatment plant samples were collected at various stages i.e., at inlet raw sewage, after

primary treatment, secondary treatment and after tertiary treatment. Samples were tested to measure various parameters like pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Total Suspended Solids (TSS), Total Kjedahl Nitrogen (TKN), Total Coliform, Phosphorous and Oil & Grease. Data on above parameters were observed and collected for three months November, 2014 to January, 2015. All these treatment are adding a huge cost to the recycled water. Hence the present study is aimed to provide alternatives to reduce the cost input. Also studies were made to find out ways by minimizing processes and stages of treatment. From this study it is concluded that to meet the increasing water demand the waste water should be recycled. Tertiary treatment of waste water is required to reuse it for various applications. Also the appropriate technology should be judiciously being chosen for a particular degree of treatment. The treated water based on its final quality can be further decided for different applications. The tertiary process should not be an economic burden on the society. Hence effective selection of the methods and full utilization is required.

Prof. Dr. Mohammed,

This research is concerned with study and check the suitability of waste stabilization ponds (WSPs) for treating wastewater in Al-Dewaniyah province by taking a sample of community of 10000 population.

Experimental work had three cases depending on many considerations such as economical and specification of final effluent. A model of two ponds (facultative and aerobic) in series was used as first case of experimental work. Then third pond with aeration process to aerobic pond were added to the series as second case to improve the effluent. At last, sand filter was used to polish the final effluent from aerobic pond.

The three ponds had the same surface area (5.75m*2m) but with different depths, where it was 2m for anaerobic pond, 1.5m for facultative pond and 0.75m for aerobic pond. From the tests taken for the three cases, the results obtained for the last two cases were much better when compared with first case. Sand filter contributed in improving final effluent by decreasing total suspended solid (TSS) also in increasing removal efficiency of biochemical oxygen demand (BOD) and chemical oxygen demand (COD). At the end, the results of this work could be an invitation to use waste stabilization pond for wastewater treatment in rural areas or even small communities but it may need more examinations to get best results.

According to the results from the the experimental work on the model of ponds which contained anaerobic, facultative, and aerobic process, the following conclusions may be listed below:-

1- The WWTP in Al-Diwaniyah province designed to receive 12000 m3/day while actually receives 26000 m3/day in winter and reaches to 34000 m3/day in summer. This would affect the performance of bar screen and grit chamber that result in variations and raising of TSS, BOD, COD and most of the other characterstics of influent raw wastewater because of the continuous operation.

2- The WWTP started working in 1983 which means that most of the mechanical parts of the treatment plant units including bar screen and grit chamber that affects the characterstics of influent raw wastewater have lost propal efficiency.

As proceeded, the value of wastewater parameters, especially TSS,enters the model is higher than the design parameters most of the period of the field work of the search which affects the effluent results.

4- The BOD removal in the three cases were 61%, 82%, 87% respectively, which shows the effect of the aeration process in the final two cases and the some influence of the sand filter on the BOD removal in the third case which may be caused by removing some of remaining organic components.

5- Aeration process and sand filter contributed in decreasing of COD concentrations in the effluent wastewater.

6- Sand filter contributes in decreasing the concentrations of TSS in the effluent wastewater beside the effect in changing effluent color.

7- The anaerobic pond acts as shock resistance for the influent wastewater as shown in the results which show the difference between the zero point (influent point) and point (No1) in the front of anaerobic pond.

8- For the nitrate and nitrite concentrations, it is clearly noticed that nitrification process occurs in the oxidation pond model which approves that there is a sufficient quantity of DO in the treated wastewater.

9- Regarding the phosphate concentrations, it is clearly noticed that there is no eutrophication actions in the treating process which indicates to a moderate aerating in the model.

R Kaur, S P Wani,

Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river basins in India and elsewhere are closing or closed and experiencing moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus, wastewater/low quality water is emerging as potential source for demand management after essential treatment. An estimated 38354 million litres per day (MLD) sewage is generated in major cities of India, but the sewage treatment capacity is only of 11786 MLD. Similarly, only 60% of industrial waste water, mostly large scale industries, is treated. Performance of state owned sewage treatment plants, for treating municipal waste water, and common effluent treatment plants, for treating effluent from small scale industries, is also not complying with prescribed standards. Thus, effluent from the treatment plants, often, not suitable for household purpose and reuse of the waste water is mostly restricted to agricultural and industrial purposes. Wastewater- irrigated fields generate great employment opportunity for female and male agricultural labourers to cultivate crops, vegetables, flowers, fodders that can be sold in nearby markets or for use by their livestock. However, there are higher risk associated to human health and the environment on use of wastewater especially in developing countries, where rarely the wastewater is treated and large volumes of untreated wastewater are being used in agriculture.

In developing countries like India, the problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources. The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to the conventional treatment systems, constructed wetlands need lesser material and energy, are easily operated, have no sludge disposal problems and can be maintained by untrained personnel. Further these systems have lower construction, maintenance and operation costs as these are driven by natural energies of sun, wind, soil, microorganisms, plants and animals.

Hence, for planned, strategic, safe and sustainable use of wastewaters there seems to be a need for policy decisions and coherent programs encompassing low-cost decentralized waste water treatment technologies, bio-filters, efficient microbial strains, and organic / inorganic amendments, appropriate crops/ cropping systems, cultivation of remunerative non-edible crops and modern sewage water application methods.

Figure 2.01 & 2.02: Sewage generation and treatment capacity in 498 Class I cities and 410 class II towns in India. (CPCB, 2009)

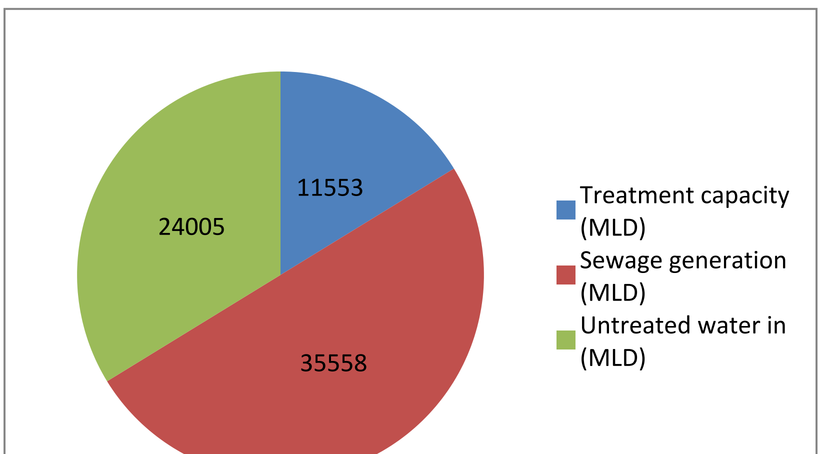


Figure.2.01

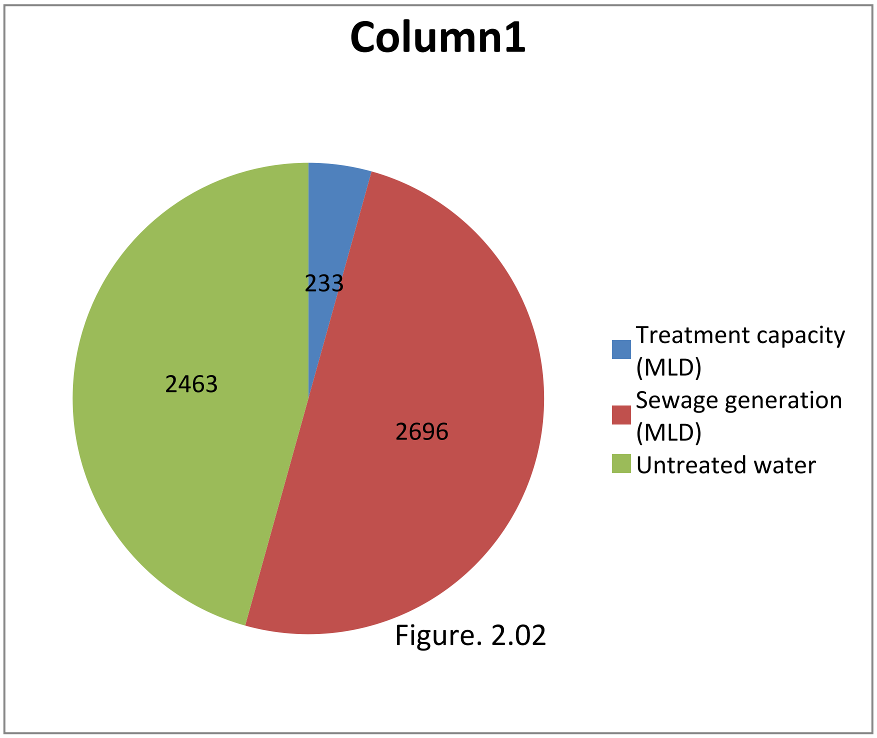

Column1
233
2463
2696
Treatment capacity (MLD)
Sewage generation (MLD)
Untreated water

Figure. 2.02

CHAPTER 3

RESULTS

3.1 Tabulations:

Table 3.01: The presence of non-metallic constituents from the waste water sample was determined.

Sr	DATE ⇨ prperty ⇩	SOURCES	25/01/16	28/01/16	29/01/16	04/02/16	05/02/16	06/02/16
01	Turbidity (NTU)	W.c / bath room	13	14	14.5	14	13.5	13.6
		Kitchen	65.6	70	104.9	80	80.5	85
		Tap water	1	0.8	1	1	0.9	1
02	pH	W.c / bath room	7.25	7.3	7.136	7.4	7.38	7.35
		Kitchen	6.35	6.1	6.7	6.17	6.20	6.58
		Tap water	7	7.01	7.02	7	6.99	7
03	Acidity (mg/lit)	W.c / bath room	3.5	3.45	3.6	3.5	3.55	3.56
		Kitchen	4	4.5	4.7	4.2	4.3	4.5
		Tap water	2	2.1	2.3	2	2.1	2.09
04	Alkalinity (mg/lit)	W.c / bath room	78	76	80	80.5	79.5	79.6
		Kitchen	71	74	75	76	75	72.5
		Tap water	35	34	32	34	33	32
05	Chloride (mg/lit)	W.c / bath room	55	57	58	58.5	57.5	56.7
		Kitchen	110	113	110	112.5	110.6	111
		Tap water	3.35	3.4	3.5	3.45	3.5	3.4
06	Residual chlorine (mg/lit)	W.c / bath room	Nil	Nil	Nil	Nil	Nil	Nil
		Kitchen	Nil	Nil	Nil	Nil	Nil	Nil
		Tap water	0.1	0.1	0.1	0.1	0.1	0.1
07	Hardness (mg/lit)	W.c / bath room	125	120	135	128	130	135
		Kitchen	110	115	100	105	110	112
		Tap water	90	95	85	80	85	90
08	Total solids (mg/lit)	W.c / bath room	780	800	750	725	760	700
		Kitchen	375	420	400	380	410	415
		Tap water	5	4	5	5.5	4.1	4.5
09	BOD (mg/lit)	W.c / bath room	110	90	105	100	100	105
		Kitchen	25	26	30	27.5	25.6	28
		Tap water	Nil	Nil	Nil	Nil	Nil	Nil
10	DO (mg/lit)	W.c / bath room	7	6.8	7.1	6.7	7.1	7.05
		Kitchen	7.1	7.8	7.4	7.5	7.2	7.4
		Tap water	8	8.01	8.01	8	8.02	8

3.02 Tabulation for physical and chemical characteristics in different Time for w.c and bath room waste sample

Sr no.	Time Characteristics	8 a.m Grab sample	11 a.m Grab sample	1-2 pm Grab sample	4-5 p.m Grab sample	Composite sample
01	Turbidity (NTU)	13	14	14.5	13.5	13.8
02	ph	7.25	7.34	7.36	7.31	7.3
03	Acidity (mg/lit)	3.45	3.55	3.6	3.5	3.56
04	Alkalinity (mg/lit)	78	80	80.5	79	80
05	Chloride (mg/lit)	57	58	57.9	57.3	57.8
06	Residual chlorine (mg/lit)	Nil	Nil	Nil	Nil	Nil
07	Hardness (mg/lit)	125	120	123	128	127
08	Total solids (mg/lit)	700	750	800	770	725
09	BOD (mg/lit)	100	110	90	100	105
10	DO (mg/lit)	7	6.8	7.1	6.9	7.05

3.03 Tabulation for physical and chemical characteristics in different Time for kitchen waste sample

Sr no.	Time Characteristics	8 a.m Grab sample	11 a.m Grab sample	1-2 pm Grab sample	4-5 p.m Grab sample	Composite sample
01	Turbidity (NTU)	70	80	104	77	78
02	ph	6.35	6.1	6.2	6.5	6.37
03	Acidity (mg/lit)	4	4.5	4.7	4.6	4.7
04	Alkalinity (mg/lit)	70	75	76	74	75
05	Chloride (mg/lit)	110	113	111	110	112
06	Residual chlorine (mg/lit)	Nil	Nil	Nil	Nil	Nil
07	Hardness (mg/lit)	110	95	100	101	98
08	Total solids (mg/lit)	375	400	410	380	425
09	BOD (mg/lit)	25	27	30	25.5	27
10	DO (mg/lit)	7.1	7.8	7.4	6.7	7.2

3.04 Tabulation for physical and chemical characteristics in different Time for tap water

Sr no.	Time Characteristics	8 a.m Grab sample	11 a.m Grab sample	1-2 pm Grab sample	4-5 p.m Grab sample	Composite sample
01	Turbidity (NTU)	5	3	4	5	5
02	ph	7	7.01	6.99	7	7.01
03	Acidity (mg/lit)	2.3	2.4	2.39	2.38	2.4
04	Alkalinity (mg/lit)	14.9	15	15	14.99	15
05	Chloride (mg/lit)	3.5	3.5	3.4	3.5	3.5
06	Residual chlorine (mg/lit)	0.1	0.1	0.1	0.1	0.1
07	Hardness (mg/lit)	90	85	95	80	90
08	Total solids (mg/lit)	5	6	4	4.5	4.7
09	BOD (mg/lit)	Nil	Nil	Nil	Nil	Nil
10	DO (mg/lit)	8	8.01	8.1	8	8

Water consumption of AIKTC campus in year

3.05 Per month water consumption

Month	Water quantity (cu.m)
Dec – jan (2015-2016)	7000
Feb – march (2015)	7400
April – may(2015)	6100
June – july(2015)	6100
Aug – sep(2015)	7200
Oct – nov (2015)	7673

3.06 Student details of AIKTC campus

Sr no.	Details	Present status	Future
1.	No. of students	2267	5000
2.	No. of faculty and staff	261	375
3.	hostel	NA	500

Average water consumed = 3456.5 m^3/ month

= 115.216 m^3/ day

= 116 m^3/ day

=116000 lit /day

Hostel building will construct of capacity = 500 students

Water required per day per student = 180 lit

Water quantity per day =90000 lit /day

Total water required for college per day = 116000*2

(Including future intake) = 232000 lit / day

Total water required for college campus = 232000 + 90000

= 322000 lit / day

CHAPTER 4

DESIGN OF SEWAGE TREATMENT PLANT

Plant capacity:

Average water supply per day = 322000 lit = 0.322MLD
Average sewage generated per day = 85% of supplied water
= 0.85*0.322
=0.2737 MLD
= 273.7 KLD
Average sewage generated per hour =273.7 /24
=11.40 m^3/hr
= 0.00317 m^3/ sec
Peak factor = 3
Design flow capacity (maximum) = 273.7* 3
= 821.1 KLD
= 821.3/24
=34.2 m^3/hr
= 0.0095 m^3/ sec

Sizing calculation for collection pit:

Retention time required = 4 h
Average design flow = 11.40 m^3/h
Capacity of collection sump = 4 x 11.40
=45.6 m^3
Assume liquid depth =4 m
Area required for collection pits = 45.6/4
= 11.4 m^2
Let it is a circular tank,
r = 1.905 m
= 2 m
Volume of the pit provide = π*r*r*h
= π*2*2*4
= 50.27 m^3
Thus Area of the pit provided = 12.57 m^2

Sizing calculation of bar screen:

Peak discharge =34.2 m^3/h
Q_{max} = 0.0095 m^3/ sec
Average velocity @ average flow isn't allowed to exceed 0.8 m/sec
Assume velocity of flow =0.3 m^3/sec
Q max = A*V
0.0095 = A*0.3

A = 0.0095 /0.3

=0.03167 m^2

Keeping 100% as excess opening

A =2*0.0317

=0.0633 m^2

Assume diameter of screen =10 mm

Spacing=20 mm

Length of screen =800 mm

Effective width of the screen = 0.0633 /0.8

=0.0791 m

But practically we can't provide 0.0791 m width

For easy cleaning and maintenance

Provide width = 0.5 m

Size of opening = 20 mm

No of openings = 0.5/0.02 =25

No of bars =24

Let the angle thickness of both ends be 20 mm

Total width of screen = (25*0.02) + (24*0.01) + (2*0.02)

= 0.78 m

= 0.8 m

Sizing calculation of aeration tank:

BOD in the feed sewage = 100 ppm

No. of aeration tank = 2

Average flow = 34.2/2

= 17.1 m^3/hr

Total BOD load to the aeration tank = 34.2*24*100

= 82.08 kgs

Assuming that negligible BOD is removed in screening, the BOD of sewage coming to aeration tank.

Y_0 = 100 mg/lit

BOD left in the influent = Y_E =20 mg /lit

BOD removed in activated plant =100-20 = 80 mg

Minimum efficiency required in the activated plant =80/100*100 =80%

Since the adopted extended aeration process can remove BOD up to 85 to 92 % (s.k.garg)

Volume of aeration tank can be designed by assuming a suitable value of MLSS and F/M ratio.

Let, MLSS = 2000 mg/l, (between 1500 to 3000)

F/M=0.35 (between 0.3 to 0.4)

by using equation,

F/M = Q/V * Y_0/X_T

Q= 410.55 m^3 /day

0.35 =410.5*100/v*2000

$V = 58.65\ m^3$

Aeration tank dimensions.

Let us assume

Liquid depth of tank =2m

Width = 4m

The length of the tank =58.65/2*4

=7.33 m

=7.5 m

So, Volume of tank =7.5*4*2

$= 60\ m^3$

(i)Check for aeration period or H.R.T (t)

t = V *24h/Q

=60*24/410.55

=3.5 hrs

=4 hrs

Hence, okay

Since it lies between 4 to 6 hrs

(ii) check for volumetric loading

$= Q * Y_0 / V$

=410.55*100/7.5*4*2

$= 0.68\ gm/m^3$

O.K.

Since it should lie between 0.3 to 0.7 gm / m^3

(iii) Check for return sludge ratio

(For SVI ranging between 50 – 150 ml/gm)

Using equation

$Q_R/Q = X_T / ((10^6/SVI) - X_T)$

Using, SVI =100 ml/ gm

$X_T = 2000$ mg / lit

$Q_R/Q = 2000 / ((10^6/100) - 2000)$

=0.25

Q_R/Q lies between 0.25 to 0.5

O.K.

(iv) check for S.R.T

$V * X_T = \alpha_y * Q * (Y_0 - Y_E) *_{c} / 1 + K_e *_{c}$

$\alpha_y = 1.0$ (constant for municipal sewage w.r.t MLSS)

$K_e = 0.06$ (constant for municipal sewage)

$Y_0 == 100$ mg/lit

$Y_E = 20$ mg /lit

$V = 60\ m^3$

$X_T = 2000$ mg / lit

Q = 410.55 m^3 / day

60*2000 = 1*410.55 (100-20) * $_c$/ (1+0.06 $_c$)

120000 (1+0.06 c) =32844 $_c$

$_c$ =12000/25644

$_c$ = 4.6 days

= 5 days

O.K.

Since it is between 5 to 8 days

Provide 0.5 m free board

Overall depth =2+0.5 =2.5 m

The adopted tank size is thus O.K.

Hence, adopt an aeration tank having an overall size of (7.5m x 4m x 2m)

The outlet weir shall be of adjustable type.

The effluent from the aeration tank will be taken to the final secondary clarifier. The inflow to the secondary clarifier shall be by means of 150 mm C.I pipes, which will give a velocity of 0.3 m / sec at peak flow.

Aerator sizing:

BOD_5 applied to each tank = 100 mg/lit

Average flow in each tank =410.55 m^3/ day

BOD_5 to be removed in each tank = 410.55*0.100

= 1.71 kg /hr

Oxygen required = 1.2 kg / kg BOD applied

Peak oxygen demand =125 %

Oxygen transfer capacity of aerator in standard conditions = 1.9 kg / kWh

=1.41 kg/HP/hr

Oxygen transfer capacity of aerator at field conditions = 0.7 *1.41

=0.98 kg/HP/hr

Oxygen applied in each tank = 1.2*1.71*1.25

=2.565 kg /hr

H.P. of aerator required = 2.565 HP/0.98

=2.617

=3 HP

Provide only 1 generator, of 3 HP.

Check for mixing consideration

As per practice, power required for mixing =0.02 kW/ m^3

SHP required = 0.02*60

=1.2 kW

Providing 1 aerators and considering gear efficiency as 97%

H.P. of each aerator required =

= 1.24 HP

Considering a power margin of 25% on motor rating

Motor H.P. required =1.24*1.25

= 1.5 HP

Provide 1.5 H.P. motor/aerator in each tank.

Design of secondary clarifier:

No of secondary clarifier =1 no

Average flow = 273.7 m^3 /day

Provide hydraulic detention tank = 2 hrs

Volume of tank =

=31.212 m^3

Assume liquid depth = 2.5m

Area of tank (superficial) =

=12.485 m^2

=12.5m^2

Surface loading rate of average flow = 15 m^3 /m^2/day

Surface area provided = 273.7/15 =18.25 m^2

(Provide area greater of two i.e. 12.5 m^2)

Diameter of circular tank (d)

D =

=3.989 m

=4m

Actual area = xD^2

= 16 m^2

(i)Check for weir loading:

Average flow = 273.7 m^3/day

Weir loading =

= 21.78 m^3/day /m

O.K. as it is less than 185 m^3/day /m

Provide a peripheral launder.

(ii) Check for solids loading :

Recirculated flow= 136.85 m3/day

Average flow =273.7 m^3/day

MLSS in tank = 20 mg/lit

Total solids in flow = (273.7+136.85)*3

= 1231.65 kg/day/ m^2

Solid loading =

= 76.98 kg/day/m^2

Provide clarifier having diameter 4m and liquid depth = 2.5m

Hopper slope shall be 1 in 12

Free board will be 0.3m

Sludge will be withdrawn from clarifier through C.I pipe. The sludge will be taken to the return sludge pump house. The treated effluent from the secondary clarifier can be disposed of in nearby nallah valley.

Return sludge pump house

Total return flow = 136.85 m^3/day

=

=0.0950 m^3/min

Detention time = 15 min

Volume of wet well = 0.095 x 15

=1.425 m^3

=1.5 m^3

Provide wet well = 1.5m x 1.5m x 0.8m

Provide dry well = 1.5m x 1.5 m

Size of annex control room = 2.5m x 2.5m

Provide 2 no of pumps, each of 0.136 MLD capacities in the dry well for returning the sludge to the aeration tank.

The return sludge pipe line shall be 150 mm

Design of sludge drying bed

Maximum design flow rate = 34.21 m^3/hr

Total free suspended solids = 250 ppm

Total outlet suspended solid = 50 mg /lit

Load to the clarifier = 250-50

=200 mg/lit

Sludge generated per day = average flow x

= 273.7 x

= 54.74 kg/day

Sp. Gravity = 1.015

Solid contents = 1.5%

Volume of sludge =

= x 1000 X 1.015

= 3.595 m^3/day

Considering monsoon etc. total no. of cycle in one year = 33

Period of each cycle =

= 11 days

Volume of sludge / cycle = 3.595 x 11

= 39.54 m^3

Spreading a layer of 1m / cycle

Area of bed required =

=39.54 m^2

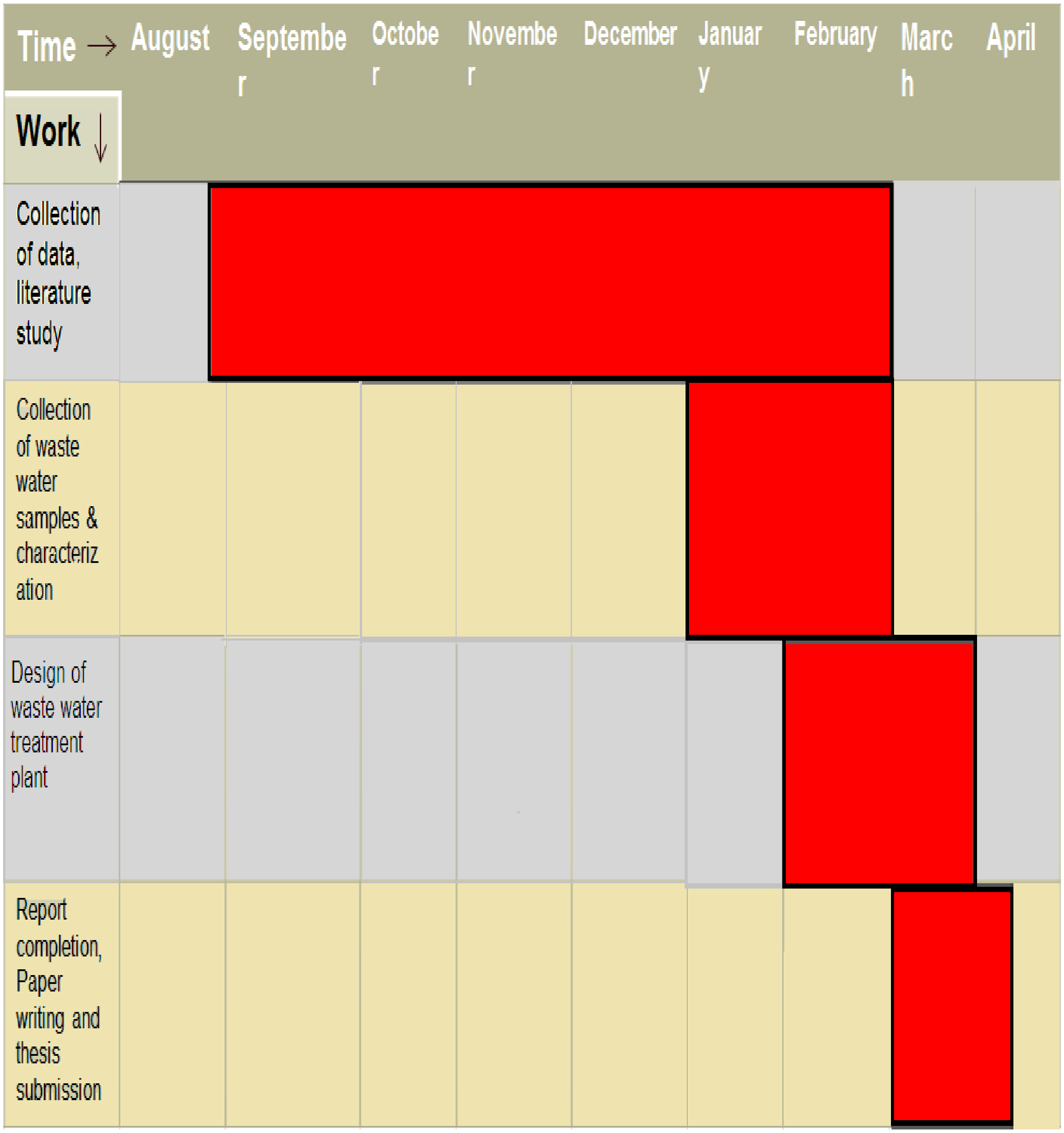
Sludge drying bed = 3m x 3m x 1.5m

Provide 3 beds of 3m x 3m x1.5m.

4.01 LAYOUT TREATMENT PLANT :

CHAPTER 5

Timeline (Milestones) of the project:


Time →
Work ↓
August
Septembe
r
Octobe
r
Novembe
r
December
Januar
y
February
Marc
h
April
Collection of data, literature study
Collection of waste water samples & characteriz ation
Design of waste water treatment plant
Report completion, Paper writing and thesis submission

CHAPTER 6

CONCLUSION

The average ranges of physical, chemical and biological characteristics of waste water quality are experimented and found out.

The pH ranges from 6.5 to 7.5. The Turbidity ranged from 10 to 120 NTU. The value of Turbidity was found to be within the permissible limit.

The Chloride and Alkalinity were in the range of 50 to 120 mg/l and 50 to 100 mg/l respectively.

The parameters studied resemble the waste water quality.

Total amount of waste water treated = 0.322 mld.

Dimension of the collection pit is calculated to be 2m in diameter and 4 m depth of the cylindrical tank.

A bar screen of width 0.8 m is provided.

Dimension of the aeration tank is 7.5m x 4 m x 2m

Dimensions of Sludge Drying Bed are 3 m x 3 m x 1.5 m of three numbers.

APPENDIX

Table5.01 characteristics and design parameters of different activated sludge systems

Process type	Flow regime	MLSS mg/lit (X_T)		F/M	HRT hrs	Volumetric loading kg BOD_5 per m^3	SRT (days) $_c$	Q_R/Q Return sludge ratio	BOD removal percent or efficiency	Kg of O_2 required per day
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
conventional	plug	1500 to 3000	0.8	0.4 to 0.3	4 to 6	0.3 to 0.7	5 to 8	0.25 to 0.5	85 to 92	0.8 to 1
Tapered aeration	Plug	1500 to 3000	0.8	0.4 to 0.3	4 to 6	0.3 to 0.8	5 to 8	0.25 to 0.5	85 to 92	0.7 to 1
Step aeration	Plug	2000 to 3000	0.8	0.4 to 0.3	3 to 6	0.7 to 1	5 to 8	0.25 to 0.75	85 to 92	0.7 to 1
Contact stabilization	plug	1000 to 3000	0.8	0.5 to 0.3	3 to 6	1 to 1.2	5 to 8	0.25 to 0.1	85 to 92	0.7 to 1
Complete mix	Complete mix	3000 to 4000	0.8	0.5 to 0.3	4 to 5	0.8 to 2	5 to 8	0.25 to 0.8	85 to 92	0.8 to 1
Modified aeration	plug	300 to 800	0.8	3 to 1.5	1.5 to 3	1.2 to 2.4	0.2 to 0.5	0.05 to 0.15	60 to 75	0.4 to 0.6
Extended aeration	Complete mix	3000 to 5000	0.5 to 0.6	0.18 to 0.1	12 to 24	0.2 to 0.4	10 to 25	0.5 to 1	95 to 98	1 to 1.2

CHAPTER 7

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