POORNIMA
COLLEGE OF ENGINEERING

Environmental Engg. Lab. & Design Manual

(Lab Code: 6CE4-21)
VI Semester, III Year

Department of Civil Engineering
Session – 2023-2024

ENVIRONMENTAL ENGG. LAB & DESIGN (6CE4-21)

List of experiments

1. Physical Characterization of water: (b) Turbidity, (c) Electrical Conductivity, (a) Ph

2. Analysis of solids content of water: (b) Dissolved, (d) Settle able, (c) suspended, total, volatile, inorganic etc.

3. (b) Alkalinity and (a) acidity, (c)Hardness: total hardness, calcium and magnesium hardness

4. Optimum coagulant dose

5. Chemical Oxygen Demand (COD)

6. Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD)

7. Break point Chlorination

8. Bacteriological quality measurement: MPN,

ADD-ON LAB EXPERIMENTS

1. To study various water supply Fittings.
2. Study of sampling and preservation methods and significance of characterization of water and waste water

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Experiments Procedure

EXPERIMENT NO. 1(a)

OBJECTIVE: To determine the pH value of a given sample of water & waste water.

INTRODUCTION: The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H^+ ions concentration in water and wastewater. The values of pH 0 to a little less than 7 are termed as acidic and the values of pH a little above 7 to 14 are termed as basic. When the concentration of H^+ and OH^- ions are equal then it is termed as neutral pH.

PRINCIPAL: The pH electrode used in the pH measurement is a combined glass electrode. It consists of sensing half-cell and reference half-cell, together form an electrode system. The sensing half-cell is a thin pH sensitive semi permeable membrane, separating two solutions, viz., the outer solution, the sample to be analyzed and the internal solution, enclosed inside the glass membrane and has a known pH value. An electrical potential is developed inside and another electrical potential is developed outside, the difference in the potential is measured and is given as the pH of the sample.

Pure water is slightly ionized and at equilibrium the ion product is

–

$[H^+] [OH^-]$ =

kw

$= 1.01 \times 10^{-14}$ at 25^0C (1)

and $[H^+]$ =

$[OH^-]$

$= 1.005 \times 10^{-7}$

Where $[H^+]$= activity of hydrogen ions,

moles/L $[OH^-]$ = activity of hydroxyl

ions, moles/L and,

kw = ion product of power.

A logarithmic scale is convenient for expressing a wide range of ionic activities.

Equation 1 in logarithmic form is

$-\log10\ [H+] + (-)\log10\ [OH-] = 14$

or $pH + pOH = pkw$… (2)

where,

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

$pOH = -\log [OH^{-}]$

(here p designates of –log of a number)

Equation 2 states that as pH increases, pOH decreases correspondingly and vice-versa because pkw is constant for a given temperature. At $25^{0}C$, pH 7.0 is neutral, the activity of the hydrogen and hydroxyl ions are equal.

APPARATUS:

pH meter, Standard flask, Magnetic Stirrer, Funnel, Beaker, Wash Bottle,Tissue Paper, Forceps

REAGENTS:

1. Buffers Solutions of pH 4.01, 7.0 and 9.2
2. Potassium Chloride
3. Distilled Water

CALIBRATION OF INSTRUMENT:

Using the buffer solutions, calibrate the instrument.

Step 1: In a 100 mL beaker take pH 9.2 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar

Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using the calibration knob adjust the reading to 9.2. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 2: In a 100 mL beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 7.0, using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 3: In a 100 mL beaker take pH 4.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 4.0, using the calibration knob adjust the reading to 4.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue. Now the instrument is calibrated.

PROCEDURE:

- In a clean dry 100 mL beaker take the water sample. Now place the electrode in the beaker containing the water sample and check for the reading in the pH meter.
- Wait until you get a stable reading. Note down the reading of the pH meter.
- Take the electrode from the water sample, wash it with distilled water and then wipe gently with soft tissue.

OBSERVATION TABLE:

Sample No	Name of Sample	pH
1.		
2.		
3.		
4.		
5.		

ENVIRONMENTALSIGNIFICANCE

(i) Determination of pH is one of the important objective in biological treatment of the wastewater. In anaerobic treatment if the pH goes below 5.0 due to excess accumulation of acids, the process is severely effected. Shifting of pH beyond 5 to 10 upsets the aerobic treatment of wastewaters. In these circumstances the pH can be adjusted by addition of suitable acids or alkali to optimize the treatment of the wastewater.

(ii) Dewatering of sludges, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favorable pH range.

(iii) pH value or range is of immense value for any chemical reaction. A chemical shall be highly effective at a particular pH. Chemical coagulation, disinfection, water softening and corrosion control are governed by pH adjustment.

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(ix) pH value or range is of immense value for any chemical reaction. A chemical shall be highly effective at a particular pH. Chemical coagulation, disinfection, water softening and corrosion control are governed by pH adjustment.

PRECAUTIONS:

1. We should take reading when the pH meter stops oscillating.
2. pH meter should be checked for any error.
3. We should take reading very carefully.

Result: The pH of the given water sample is……..

EXPERIMENT NO.

1(b)

OBJECTIVE: To determine the electrical conductivity of a given sample of water & waste water.

DEFINITION:

Conductivity of a substance is defined as 'the ability or power to conduct or transmit heat, electricity, or sound'. Its units are Siemens per meter [S/m] in SI and millimhos per centimeter [mmho/cm] in U.S. customary units. Its symbol is k or s.

ELECTRICAL CONDUCTIVITY (EC):

An electrical current results from the motion of electrically charged particles in response to forces that act on them from an applied electric field. Within most solid materials a current arise from the flow of electrons, which is called electronic conduction. In all conductors, semiconductors, and many insulated materials only electronic conduction exists, and the electrical conductivity is strongly dependant on the number of electrons available to participate to the conduction process. Most metals are extremely good conductors of electricity, because of the large number of free electrons that can be excited in an empty and available energy state.

In water and ionic materials or fluids a net motion of charged ions can occur. This phenomenon produce an electric current and is called ionic conduction. Electrical conductivity is defined as the ratio between the current density (J) and the electric field intensity (e) and it is the opposite of the resistivity (r, [W*m]):

$s = J/e = 1/r$

Silver has the highest conductivity of any metals: 63×10^{6} S/m.

WATER CONDUCTIVITY:

Pure water is not a good conductor of electricity. Ordinary distilled water in equilibrium with carbon dioxide of the air has a conductivity of about 10×10^{-6} $W^{-1}*m^{-1}$ (20 dS/m). Because the electrical current is transported by the ions in solution, the conductivity increases as the concentration of ions increases.

hus conductivity increases as water dissolved ionic species.

TYPICAL CONDUCTIVITY OF WATERS:

Ultra pure water 5.5 · 10^{-6} S/m
Drinking water 0.005 – 0.05 S/m Sea
water 5 S/m

ELECTRICAL CONDUCTIVITY AND TDS:

TDS or Total Dissolved Solids is a measure of the total ions in solution. EC is actually a measure of the ionic activity of a solution in term of its capacity to transmit current. In dilute solution, TDS and EC are reasonably comparable. The TDS of a water sample based on the measured EC value can be calculated using the following equation:

TDS (mg/l) = 0.5 x EC (dS/m or mmho/cm) or = 0.5 * 1000 x EC (mS/cm)

The above relationship can also be used to check the acceptability of water chemical analyses. It does not apply to wastewater.
As the solution becomes more concentrated (TDS > 1000 mg/l, EC > 2000 ms/cm), the proximity of the solution ions to each other depresses their activity and consequently their ability to transmit current, although the physical amount of dissolved solids is not affected. At high TDS values, the ratio TDS/EC increases and the relationship tends toward TDS = 0.9 x EC.
In these cases the above-mentioned relationship should not be used and each sample should be characterized separately.
For water for agricultural and irrigation purpose the values for EC and TDS are related to each other and can be converted with an accuracy of about 10% using the following equation:

TDS (mg/l) = 640 x EC (ds/m or mmho/cm).

RESULTS:

EXPERIMENT NO. 1(c)

AIM: To determine the turbidity of the given sample water by Nephelo metric .

APPARATUS: Nephelo turbidity meter.

THEORY: Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material present in the water. Turbidity is surface waters results from the erosion of colloidal material such as clay, slit, rock fragments and metal oxides from soil, vegetable fibers and micro- organisms may also contribute to turbidity. Drinking water supplies requires special treatment by chemical coagulation and filtration before it may be used for public water supply.

This turbidity can be brought down to required level by adding coagulants. Coagulants when added to water it will form a geletaneous substance known as floc and this will arrest the fine suspended and colloidal particles. These arrested particles will settle down rapidly because of increase in their size.

RELEVANCE: Turbidity waters are aesthetically displeasant and are not accepted for domestic use. The colloidal matter associated with turbidity provides adsorption sites for chemicals and biological organisms that may be harmful or cause undesirable tastes and odour. Disinfection of the turbid waters is difficult and unsatisfactory, since the colloids partially shield organisms from the disinfectant. This IS values for drinking water is 10 to 25 NTU.

REAGENTS:

Turbidity free water:- Pass distilled water through a lower turbidity than distilled water, discard the first 200ml, collected. If filtration does not reduce turbidity use distilled water.

STOCK TURBIDITY SOLUTIONS:

i) Solution 1:- Dissolve 1.0 grams hydrazine suplate $(NH_2)_2.H_2So_4$ in distilled water and dilute it to 100 ml in a make up flask.

ii) Solution 2:- Dissolve 10.0 grams hexamethylene tetramine $(CH_2)_6N_4$ in distilled water and dilute it to 100ml.

iii) Solution 3:- In a 100ml flask, mix 5ml. each of solution 1 and 2. Allow it to stand 24 hours, then dilute it to 100ml and mix thoroughly. The turbidity of this solution is 400 NTU.

iv) Standard Turbidity Solution:- Take 10.0ml of solution 3 in a 100ml make up flask and dilute it to 100ml. with turbid free water. The turbidity of this suspension is 40 NTU.

PROCEDURE:

a) Calibration of Nephelometer:

1. Select proper range of NTU on Nephelometer.
2. By placing distilled water in Nephelometer test tube, set the Nephelometer reading to zero by using the knobs provided for zero setting.
3. Using the standard turbid solution (i.e. 40 NTU), calibrate the Nephelometer (i.e. adjust the Nephelometer reading to 40 NTU using calibration knob)

b) Determination of turbidity of sample water:

1. For samples having turbidities less than 40 NTU: Thoroughly shake the sample so as to remove any air bubbles and pour it into meter cell. Read out the turbidity of the sample from the digital display.
2. For samples having turbidities above 40 NTU:- Dilute sample with 1,2 or 3 volumes of turbidity free water and convert the value obtained as below.
3. If five volumes of turbidity free water were added to one volume of sample and the diluted sample showed a turbidity of 30 NTU, then the actual value is equal to 180 units. i.e.

c) Calibration of Nephelometer:

4. Select proper range of NTU on Nephelometer.
5. By placing distilled water in Nephelometer test tube, set the Nephelometer reading to zero by using the knobs provided for zero setting.
6. Using the standard turbid solution (i.e. 40 NTU), calibrate the Nephelemeter (i.e. adjust the Nephelemeter reading to 40 NTU using calibration knob)

d)Determination of turbidity of sample water:

7. For samples having turbidities less than 40 NTU: Thoroughly shake the sample so as to remove any air bubbles and pour it into meter cell. Read out the turbidity of the sample from the digital display.
8. For samples having turbidities above 40 NTU:- Dilute sample with 1,2 or 3 volumes of turbidity free water and convert the value obtained as below.
9. If five volumes of turbidity free water were added to one volume of sample and the diluted sample showed a turbidity of 30 NTU, then the actual value is

equal to 180 units. i.e.

RESULTS:

EXPERIMENT NO. 2(a)

OBJECTIVE: To determine the Total solids of the given sample.

PRINCIPAL: Total solids are determined as the residue left after evaporation and drying of the unfiltered sample.

APPARATUS:

1. Evaporating Dishes (pyrex, porcelain or platinum)
2. Oven
3. Desiccator

PROCEDURE:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled in a desiccator and weighed.
2. A 100 ml of well-mixed sample (graduated cylinder is rinsed to ensure transfer of all suspend matter) is placed in the dish and evaporated at 100 ^{0}C on water bath, followed by drying in oven at 103 ^{0}C for 1 hour. Dry to a constant weight at 103 ^{0}C, cool in a desiccator and weigh.

CALCULATION:

$$\text{Total solids (mg/l)} = \frac{(A-B) \times 10^{6}}{V}$$

A = Final weight of the dish in gm. B =
Initial weight of the dish in gm. V =
Volume of sample taken in ml.

OBSERVATION AND RESULTS:

Sample details	Volume of sample	Initial weight of the dish (mg)	Final weight of the dish (mg)	Total Solids

APPLICATION OF TOTAL SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. The estimation of total solids in wastewater is useful to determine its suitability for sewage farming etc.
2. Total Solids determination is used to access the suitability of potential supply of water for various uses. In cases, in which water softening is needed, the type of softening procedure used nay be dictated by the total solids content.
3. Corrosion control is frequently accomplished by the production of stabilized water through pH adjustment. The pH at stabilization depends to some extend upon the total solids present as well as the alkalinity and temperature.

PRECAUTIONS:

EXPERIMENT NO. 2(b)

OBJECTIVE: To find out Total dissolved solids of the given sample.

PRINCIPAL: Total solids are determined as the residue left after evaporation and drying of the filtered sample.

APPARATUS:

- Evaporating Dishes (pyrex, porcelain or
- platinum) Oven
- Desiccator
- Whatman filter paper No. 44

PROCEDURE:

1. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled in a desiccator and weighed.
2. A 100 ml of filtered sample is placed in the dish and evaporated at 100 ^{0}C on water bath, followed by drying in oven at 103 ^{0}C for 1 hour.
3. Dry to a constant weight at 103 ^{0}C, cool in a desiccator and weigh.

CALCULATION:

$$\text{Total solids (mg/l)} = \frac{(A - B) \times 10^6}{V}$$

A = Final weight of the dish in gm. B =
Initial weight of the dish in gm. V =
Volume of sample taken in ml.

OBSERVATION AND RESULTS:

Sample details	Volume of sample (ml)	Initial weight of the dish	Final weight of the dish (mg)	Total Dissolved Solids

APPLICATION OF TOTAL DISSOLVED SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens.
2. The total dis purpose.solved determination is useful for the sewage to find it's suitability for agriculture

PRECAUTION:

EXPERIMENT NO. 2(c)

OBJECTIVE: To determine total suspended solids of the given sample.

PRINCIPAL: Total suspended solids are determined as the residue left on gooch crucible or a filter paper after drying in oven.

APPARATUS:

1. fibre filter no 44
2. Weight balance
3. Desiccator

PROCEDURE:

1. A clean filter paper weight (W1).
2. filter 20 ml sample by whatman filter paper no 44 .
3. Carefully remove the filter paper or and dry in an oven at 105^0C for one hour.
4. Cool in a desiccator and weigh (W2).

CALCULATION:

$$\text{Total suspended solid (mg/l)} = \frac{(W2-W1) \times 10^6}{\text{Vol of sample(ml)}}$$

OBSERVATION AND RESULTS:

Sample Detail	Volume of sample taken	Empty weight of Filter paper (gm)	Final weight of filter paper	Solids(mg/l)
Total Suspended Solids				

APPLICATION OF TOTAL SUSPENDED SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. The suspended solids parameter is used to measure the quality of the waste water influent and effluent.
2. The suspended solids determination is extremely valuable in the analysis of polluted waters.
3. It is used to evaluate strength of domestic wastewater.
4. It is used to determine the efficiency of treatment units.

PRECAUTIONS:

EXPERIMENT NO. 2(d)

OBJECTIVE: To find out Total Settleable Solids of the given sample.

PRINCIPAL: The particles in suspension whose specific gravity greater than that of water will settle under quiescent conditions.

APPARATUS:

1. Imhoff Cone
2. Holding Device

PROCEDURE:

1. Gently fill the Imhoff cone with the thoroughly well mixed sample usually one litre and allow it to settle.
2. After 45 minutes, gently rotate the cone between hands to ensure that all solids adhering to the sides are loosened.
3. Allow the solids to settle for 15 minutes more, to make up for a total period of 1 hour.
4. Read the volume of the sludge, which has settled in the apex.
5. Express the results in ml setteable solids per litre of sample per hour.

CALCULATION:

Total settleable solid (ml/l) =

OBSERVATION AND RESULTS:

Sample Detail	Volume of sample taken (ml)	Total Settleable Solids (ml/l/hou

APPLICATION OF TOTAL SETTLEABLE SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. The settleable solids determination is used extensively in the analysis of industrial waste to determine the need for and design of plain settling tanks in plants employing biological treatment processes.
2. It is also widely used in waste water treatment plant operation to determine the efficiency of sedimentation units.

PRECAUTIONS:

EXPERIMENT NO. 3(a)

OBJECTIVE: To determine the acidity of the given sample of water.

PRINCIPAL: Acidity of water is its quantitative capacity to neutralise a strong base to a designated pH. Strong minerals acids, weak acids such as carbonic and acetic and hydrolysing salts such as ferric and aluminium sulphates may contribute to the measured acidity. According to the method of determination, acidity is important because acid contributes to corrosiveness and influences certain chemical and biological processes. It is the measure of the amount of base required to neutralise a given sample to the specific pH.

Hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes are neutralised by titration with standard alkali. The acidity thus depends upon the end point pH or indicator used. Dissolved CO_2 is usually the major acidity component of unpolluted surface water. In the sample, containing only carbon dioxide-bicarbonatecarbonate, titration to pH 8.3 at 25°C corresponds to stoichiometric neutralisation of carbonic acid to carbonate. Since the colour change of phenolphthalein indicator is close to pH 8.3, this value is accepted as a standard end point for the titration of total acidity. For more complex mixture or buffered solution fixed end point of pH 3.7 and pH 8.3 are used. Thus, for standard determination of acidity of wastewater and natural water, methyl orange acidity (pH 3.7) and phenolphthalein acidity (pH 8.3) are used.

APPARATUS:

1. Burette
2. Pipette
3. flasks
4. Indicator solutions

REAGENTS:

1. CO_2 free water

2. Standard NaOH solution 0.02N

3. Methyl orange indicator solution
4. Phenolphthalein indicator solution
5. Sodium thiosulphate 0.1 N

PROCEDURE:

1. 100 mL of sample is pipette into Erlenmeyer flask.
2. If free residual chlorine is present, 0.05 mL (1 drop) of 0.1 N thiosulphate solution is added.
3. 2 drops of methyl orange indicator is added.
4. These contents are titrated against 0.02 N hydroxide solution. The end point is noted when colour change from orange red to yellow.
5. Then two drops of phenolphthalein indicator is added and titration continued till a pink colour just develops. The volumes of the titrant used are noted down.

0.02 N NaOH Sample (Methyl orange/phenolphthalein indicator)
Calculation

Acidity in mg/L as ($CaCO_3$) = $\dfrac{A \times B \times 50{,}000}{V}$

where,
A = mL of NaOH titrant
B = normality of NaOH
V = mL of the sample.

PRECAUTIONS:

RESULTS:

0.02 N NaOH Sample (Methyl orange/phenolphthalein indicator)
Calculation

Acidity in mg/L as ($CaCO_3$) = $\dfrac{A \times B \times 50{,}000}{V}$

Where,
A = mL of NaOH titrant
B = normality of NaOH
V = mL of the sample.

PRECAUTIONS:

RESULTS:

EXPERIMENT NO. 3(b)

OBJECTIVE: To determine the alkalinity of the given sample of water.

PRINCIPAL: The alkalinity of water is a measure of its capacity to neutralize acids. It is primarily due to salts of weak acids, although weak or strong bases may also contribute. Alkalinity is usually imparted by bicarbonate, carbonate and hydroxide. It is measured volumetrically by titration with 0.02 N sulphuric acid and is reported in terms of CaCO3 equivalent. For samples whose initial pH is above 8.3, the titration is conducted in two steps. In the first step, the titration is conducted until the pH is lowered to 8.2, the point at which phenolphthalein indicator turns from pink to colourless. This value corresponds to the points for conversion of carbonate to bicarbonate ion. The second phase of titration is conducted until the pH is lowered to 4.5, corresponds to methyl orange end point, which corresponds to the equivalence points for the conversion of bicarbonate ion to carbonic acid.

APPARATUS:

1. Burette
2. Pipette
3. flasks
4. Indicator solutions

REAGENTS:

1. Carbon dioxide free distilled water.
2. Phenolphthalein indicator.
3. Methyl orange indicator.
4. 0.1 N sodium thiosulphate solution
5. 0.02 N sulphuric acid.

PROCEDURE:

1. Pipette 100 mL of sample into a clean Erlenmeyer flask (V).
2. Add one drop of sodium thiosulphate solution, if residual chlorine is present.
3. Add two drops of phenolphthalein indicator; if the pH is above 8.3, colour of solution becomes pink.
4. Titrate against standard sulphuric acid in the burette, till the colour just disappears. Note down the volume (V1).
5. Then add two drops of methyl orange indicator, the colour turns yellow.
6. Again titrate against acid, until the colour turns to orange yellow. Note down the total volume (V2).

CALCULATIONS:

1. Phenolphthalein alkalinity (P) as mg/L CaCO3 = $\dfrac{A\text{x } B\text{x } 50000}{V}$

Where,

A = mL of H_2SO_4 titrant

B = normality of H_2SO_4 (0.02N) V
= mL of the sample.

2. Total alkalinity (T) as mg/L CaCO3 = $\dfrac{A\text{x } B\text{x } 50000}{V}$

Where,

A = mL of H_2SO_4 titrant

B = normality of H_2SO_4 (0.02N) V
= mL of the sample.

RESULTS:

EXPERIMENT NO. 3(c)

OBJECTIVE: To determination the hardness of water by EDTA.

PRINCIPAL: Originally, the hardness of water was understood to be a measure of the capacity of water for precipitating soap. Soap is precipitated chiefly by the calcium and magnesium ions commonly present in water, but may also be precipitated by ions of other polyvalent metals, such as aluminium, iron, manganese, strontium and zinc, and by hydrogen ions. Because, all but the first two are usually present in insignificant concentrations in natural waters, hardness is defined as a characteristic of water, which represents the total concentration of just the calcium and the magnesium ions expressed as calcium carbonate. However, if present in significant amounts, other hardness producing metallic ions should be included.

APPARATUS:

1. Burette
2. Pipette
3. flask
4. Bottle etc.

REAGENTS:

1. Standard EDTA titrant (0.02 N)
2. Eriochrome black T indicator
3. Ammonia buffer solution

PROCEDURE:

1. Take 20ml sample in a volumetric flask.
2. Add 2 mL of buffer solution.
3. Add two drops of indicator (EDTA) solution. The solution turns wine red in

colour.

4. Fill the burette by EDTA and titrate till steel blue coloue.
5. Note down the volume of EDTA added (V_1).

CALCULATIONS:

$$\text{Total hardness}(caco_3) = \frac{\text{Vol of EDTA x N x 50 x 1000}}{\text{Vol of samle taken}}$$

OBSERVATION:

Sample No	Volume of Sample (mL)	Burette Reading (mL)		Volume of EDTA (mL)
		Initial	Final	
1.				
2.				

PRECAUTIONS:

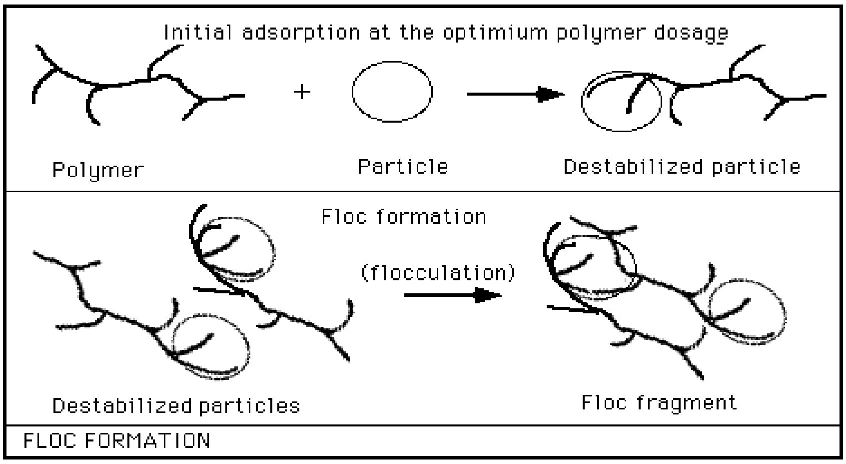
RESULTS:

EXPERIMENT NO. 4

OBJECTIVE: To determine the optimum dose of alum in the given sample of water.

PRINCIPAL: The Coagulation/Flocculation process is necessary in water treatment primarily because of NONSETTLEABLE SOLIDS, particles too small to be effectively removed by other treatment processes such as sedimentation and filtration. These nonsettleable solids can be changed into larger and heavier settable solids by physical and chemical changes brought about by adding and mixing chemical coagulants in the raw water. These larger and heavier particles can now be removed by sedimentation and filtration processes.

Nonsettleable solids (colloidal suspensions) consist of particles with an electric charge, usually negative. This characteristic prevents the collision and the aggregation of the particles. The addition of certain chemicals to colloidal suspensions can enhance destabilization and aggregation processes, leading to the formation of flocs of considerable dimensions. These flocs can then be further, removed by sedimentation or filtration.



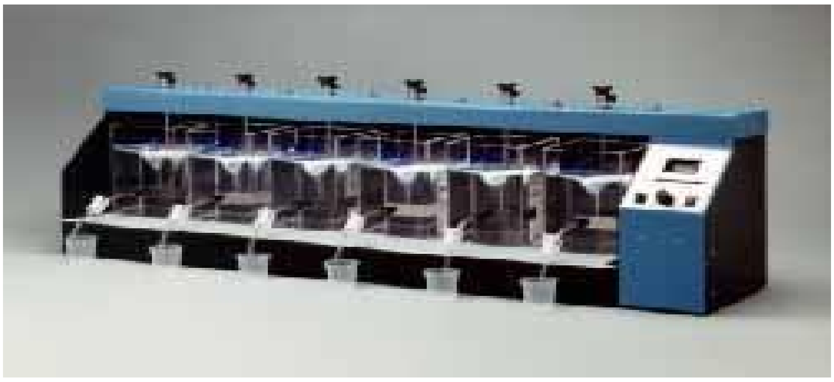
Typical Flocculation Process

COAGULANTS AND FLOCULANTS:

The common coagulants in water treatment are the trivalent salts of Iron and Aluminum. Organic polymers, such as polyacrilamides, are usually used as flocculants, in addition to the metallic salts, to improve floc formation.

THE JAR TEST:

Jar tests are used in water treatment plants to determine the optimum dose of a coagulant. Results of the test are dependent on current raw water quality, which may vary day-to-day. The apparatus is operated to stimulate a mixing, flocculation and settling cycle. Varying amounts of coagulants are added at the same time to the jars that contain water to be treated. The jars are then mixed at high speed for one minute. This rapid mix is followed by a 20-40 minute period of gentle mixing to promote floc growth. The suspension is allowed to settle for a period of 15-60 minutes. The turbidity in each jar is measured and plotted against the coagulant dose. The optimum dose is determined from this plot.



Jar Testing Apparatus

INEERING OBJECTIVES:

1. To visualize the coagulation-flocculation process in the laboratory.
2. To determine the optimum dose of Alum [Al2(S04)3 • 18H20] to reduce the turbidity of Rowan Pond Water.
3. To use basic chemical reaction stoichiometry in engineering calculations.

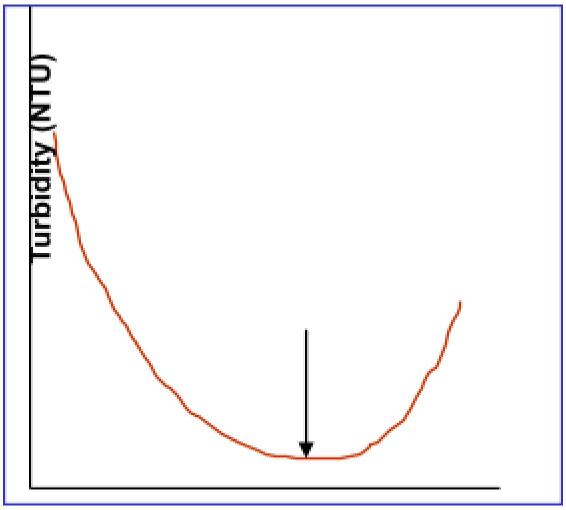
PROCEDURE:

1. Analyze the raw water for turbidity.
2. Place 900 ml of Rowan Pond water into the beakers provided with the apparatus.
3. Calculate the alum dosage required for each jar and the volume of alum solution to be added.
4. Set paddles at 30 rpm and, using a pipette, measure the appropriate volume of stock alum solution into the beakers. Rapid mix for 1-2 minutes.
5. After the 1 - 2 minute coagulation (rapid mixing) step, adjust the mixing speed to about 10 rpm and flocculate for 5 minutes.
6. After the flocculation period, remove the paddles and allow solids to settle for 30 minutes.
7. Transfer the supernatant (the very top portion of sample) from each jar to a turbidity sample cell, taking care not to disturb the sediment during sampling. Measure and record the turbidity.
8. Plot Turbidity versus Alum dose.
9. Determine the optimum alum dose.

OBSERVATION:

Jar #	Alum added (mL)	Alum Concentration (mg/L)	Turbidity (NTU)
1			
2			
3			
4			
5			
6			

Plot turbidity versus alum concentration as shown below and determine the optimum alum dose.



PRECAUTIONS:

OBJECTIVE: To find out Chemical Oxygen Demand (COD) of given waste water sample.

PRINCIPAL: The organic matter present in a sample gets oxidized completely by K2Cr2O7 in the presence of H2SO4 to produce CO2 and H2O. The excess K2Cr2O7 remaining after the reaction is titrated with Fe(NH4)2(SO4)2. The dicromate consumed gives the O2 required to oxidation of the organic matter.

APPARATUS:

1. Reflux appratus
2. Hot plate/heating mantle
3. Burette
4. Pipette
5. volumetric flask

REAGENTS:

1. Standard potassium dichromate 0.25 N
2. Sulphuric acid with reagent (Conc. H2SO4+Ag2SO4)
3. Standard ferrous ammonium sulphate 0.1 N
4. Ferroin indicator
5. Mercuric sulphate

PROCEDURE:

1. Place 0.4 gm of HgSO4 in the reflux flask.
2. Add 20 ml of sample (or an aliquot dilute to 20 ml).
3. 10 ml of more concentrated dichromate solution are placed into flask together with glass beeds.
4. Add slowly 30 ml of H2SO4 containing Ag2SO4 and mix thoroughly.

5. Connect the flask to condenser. Mix the contents thoroughly before heating. Improper mixing results in bumping and the sample may be blown out.
6 . Reflux for a minimum period of 2 hours. Cool and wash down the condenser with distilled water.
7. Dilute the sample to make up 150 ml and cool.
8. Titrate excess K2Cr2O7 with 0.1 Fe(NH4)2SO4 using ferroin indicator. Sharp color change from blue green to wine-red indicates the end point.
9. Reflux the blank in the same manner using distilled water instead of sample.

CALCULATIONS:

$$\text{COD} = \frac{(A-B)*N*8*1000}{\text{Vol of sample}}$$

Where

A = volume of ferrous ammonium sulphate for blank (ml)

B = volume of ferrous ammonium sulphate for sample (ml) N =

normality of ferrous ammonium sulphate (0.01N)

OBSERVATION AND RESULTS:

Sl. No.	Sample details	Vol. Of Sampl e taken	Initial burette reading ml	Final burette reading ml	Vol. Of $Fe(NH_4)_2(SO_4)_2$ ml	COD of the sample mg/l

PRECAUTIONS:

EXPERIMENT NO. 6(a)

OBJECTIVE: To find out the quantity of Dissolved Oxygen (DO) present in the given sample.

PRINCIPAL: Oxygen present in sample oxidizes the divalent manganous to its higher valency which precipitates as a brown hydrated oxide after addition of NaOH and KI. Upon acidification, manganese reverts to divalent state and liberates iodine from KI equivalent to D.O. content in the sample. The liberated iodine is titrated against Na_2S2O_3(0.25N), using starch as an indicator. If oxygen absent in sample, the $MnSO_4$ react with the alkali to form white precipitate $Mn(OH)_2$.

APPRATUS:

1. BOD bottles (capacity 300ml)
2. Sampling device for collection of samples
3. Burette
4. Pipettes

REAGENTS:

1. Manganous sulphate
2. Alkali iodide-azide reagent
3. Starch Indicator
4. Standard sodium thiosulphate (0.25 N)
5. Concentrated Sulphuric acid

PROCEDURE (Winkler method):

1. Fill the field sample in bod bottle(no air bubbles).
2. Add 2ml of manganese sulphate (the pipette should be dipped inside the sample).
3. Add 2ml of alkali iodide azide (the pipette should be dipped inside the sample).
4. Mix the contents thoroughly.
5. Allow the precipitate to settle down.
6. Add 2ml of concentrated sulfuric acid via a pipette (just above the surface of sample).
7. Invert the bottle to mix the contents.
8. Measure exactly 203ml to 500ml conical flask.
9. Titrate the contents against the sodium thiosulphate to straw yellow colour.
10. Add 2ml of starch to the conical flask the colour turn blue.
11. Continue the titration until the sample colourless.
12. Calculate the DO concentration.

CALCULATIONS:

$$\text{DO} = \frac{\text{volume of sodium thiosulphate} * 0.25 * 1000}{\text{Volume of sample taken}}$$

OBSERVATION AND RESULTS:

Sample details	**Temp. of sample °C**	**Volume of sample taken ml**	**Initial burette reading ml**	**Final burette reading ml**	**ml. of $Na_2S_2O_3$ Solution used**	**D.O. in mg/l**

PRECAUTIONS:

EXPERIMENT NO. 6(b)

OBJECTIVE: To determine Biochemical Oxygen Demand (BOD) exerted by the given waste water sample.

PRINCIPAL: The BOD is an empirical biological test. This BOD test may be considered as wet oxidation procedure in which the living organisms serve as the medium for oxidation of the organic matter to carbon-dioxide and water.

CnHaObNc + [n+a/4-b/2-3c/4]O2 Bacteria nCO2 + [a/2-3c/2] H2O +cNH3 On the basis of the above relationship, it is possible to interpret BOD data in terms of organic matter as well as the amount of oxygen used during its oxidation.

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APPRATUS:

1. BOD bottles (capacity 300ml)
2. Sampling device for collection of samples
3. Burette
4. Pipettes

REAGENTS:

1. Manganous sulphate
2. Alkali iodide-azide reagent
3. Starch Indicator
4. Standard sodium thiosulphate (0.25 N)
5. Concentrated Sulphuric acid
6. Phosphate buffer solution

7. Calcium Chloride solution
8. Ferric chloride solution
9. Sodium thiosulphate solution

PROCEDURE:

1. Take a beaker containing 1L dilution water.
2. Add 1ml of calcium chloride.
3. Add 1ml of magnesium sulphate.
4. Add 1ml of ferric chloride.
5. Add 1ml of phosphate buffer.
6. Take 4 bottle (300ml).
7. Add 30ml of field sample and remaining 270ml of dilution water.
8. Take 300ml of dilution water in 2 BOD bottle (blank).
9. Each one of the blank and the sample titrated at same day.
10. Remaining 2 BOD bottle (1sample+1blanke) need to be kept in a bod incubator for 5 days.

ENVIRONMENTAL SIGNIFICANCE:

1. BOD is the principle test to give an idea of the biodegradability of any wastewater sample and strength of the waste. Hence the amount of pollution can be easily measured by it. It is the basic criteria for the control of stream pollution.
2. Efficiency of any treatment plant can be judged by considering BOD and effluent BOD so also the organic loading on the unit.
3. If any industrial waste is to be let off into a public sewer municipal cess depend upon the volume and BOD of the wastewater.
4. Ordinary domestic sewage may have a BOD of 200 mg/l. Any effluent to be

5. 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

CALCULATIONS:

$$\text{BOD} = \frac{(D_0-D_5-BC)*\text{Vol Of Diluted Sample}}{\text{Vol Of Sample Taken}}$$

Where

D_0 = initial do of diluted sample

D_5 = do at the end of 5 days for diluted sample C_0 =

initial do of the blank

C_5 = do at the end of 5 days for blank

BC = blank correction (C_0-C_5)

Vol of diluted sample = 200ml

Vol of sample taken = 30 ml

OBSERVATION AND RESULTS:

Sl. No.	Volume of sample (ml)	Dilution ratio	Initial D.O. of sampl	Final D.O. of sample	Initial D.O. of Blan	Final D.O. of Blan	5 days BOD at 20 ^{0}C

PRECAUTIONS:

EXPERIMENT NO. 7

DEFINITION: Breakpoint chlorination is defined as the point where enough chlorine has been added to a quantity of water to satisfy its disinfecting demand. In other words, it is the point where all undesirable contaminants have been removed from the water. At breakpoint chlorination, all the added chlorine is consumed by chemical reactions with the contaminants, resulting in no free available chlorine (FAC) in the water.

WHAT IS BREAK POINT CHLORINATION IN WASTE WATER ?

In wastewater treatment, breakpoint chlorination is a means of eliminating ammonia, which is converted to an oxidized volatile form. The addition of chlorine to a water that contains ammonia or nitrogen-containing organic matter produces an increased combined chlorine residual.

WHAT IS THE PROCESS OF CHLORINATION ?

Chlorination is the process of adding chlorine to drinking water to disinfect it and kill germs. Different processes can be used to achieve safe levels of chlorine in drinking water. Chlorine is available as compressed elemental gas, sodium hypochlorite solution (NaOCl) or solid calcium hypochlorite ($Ca(OCl)_2$.

WHAT ARE THE TYPES OF CHLORINATION ?

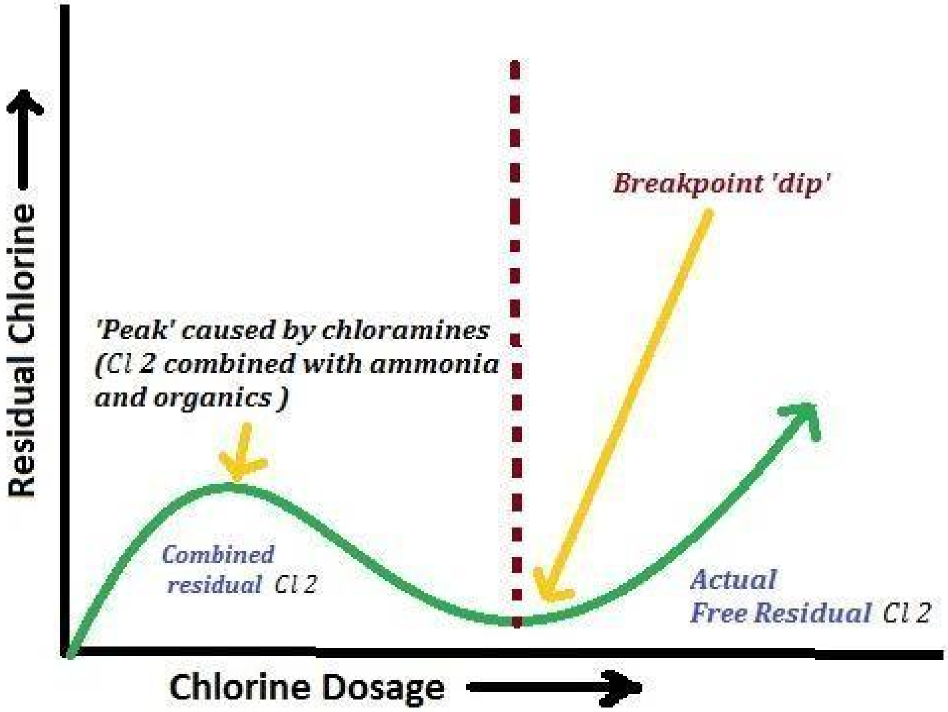
The three most common types of chlorine used in water treatment are: chlorine gas, sodium hypochlorite, and calcium hypochlorite.

HOW ARE CHLORAMINES FORMED ?

Chloramines are formed during a reaction between chlorine) and ammonia (NH_3). Chloramines are amines which contain at least one chlorine atom, which is directly bond to nitrogen atoms (N). Inorganic chloramines are formed when dissolved chlorine and ammonia react.

WHAT IS POST CHLORINATION ?

Postchlorination is the final step in the treatment of water. It is a method of adding a minimum level of chlorine into the water mainstream down to distribution.



EXPERIMENT NO. 8

DEFINITION: Bacteriological water analysis is a method of analysing water to estimate the numbers of bacteria present and, if needed, to find out what sort of bacteria they are. It represents one aspect of water quality. It is then possible to draw inferences about the suitability of the water for use from these concentrations.

WHAT IS MPN INDEX ?

Most Probable Number (MPN) is a method used to estimate the concentration of viable microorganisms in a sample by means of replicate liquid broth growth in ten-fold dilutions.MPN is most commonly applied for quality testing of water i.e to ensure whether the water is safe or not in terms of bacteria present in it.

ADVANTAGES OF MPN :

- Ease of interpretation, either by observation or gas emission
- Sample toxins are diluted
- Effective method of analyzing highly turbid samples such as sediments, sludge, mud, etc.
- that cannot be analysed by membrane filtration.

DISADVANTAGES OF MPN:

- It takes a long time to get the results
- Results are not very accurate
- Requires more hardware (glassware) and media
- Probability of false positives

WHAT IS THE DIFFERENCE BETWEEN MPN AND CFU ?

They are equivalent- one MPN is equal to one CFU(colony forming unit). Both units measure the estimated number of bacteria in a water sample.

HOW IS MPN CALCULATED ?

The MPN value is expressed as 2.2 per 100 ml. These numbers are given by Maccardy based on the laws of statistics.

HOW DO YOU CALCULATE CFU ?

Calculate the number of bacteria (CFU) per milliliter or gram of sample by dividing the number of colonies by the dilution factor The number of colonies per ml reported should reflect the precision of the method and should not include more than two significant figures.

ADD-ON LAB EXPERIMENTS

EXPERIMENT-1

STUDY OF PIPE FITTING

Adapters

Brass flare x MIPS adapter

Brass Flare x MIPS Adapter Adapters are used to extend runs, or to simply change the connection type at the end of a pipe. This allows dissimilar pipes to be connected, without the need for a more involved setup.
Adapters are available in most all standard materials: ABS, brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.

Bushings

Stainless steel hex bushing

Stainless Steel Bushing Bushings are used to join pipes of different sizes, usually by reducing a larger fitting down to a smaller pipe. Bushings are usually - not always - threaded both inside and out, and take up very little space compared to a coupling or union, which accomplish the same goal. Offered in: ABS, brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.
Note: Some fitting types, like bushings, have limitations placed on their use (or are not allowed at all) by some plumbing codes. Remember to check local plumbing codes prior to purchasing.

Caps & Plugs

PVC pipe cap

PVC Cap Caps are, surprisingly enough, used to cap a pipe end. Plugs do pretty much the same thing, but usually fit inside the fitting, and are threaded to allow for future use of the pipe. Caps can be threaded, glued, or soldered onto pipe (depending on its material)
Both are available in: ABS, brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.

Couplings

Chrome-plated brass bell reducer coupling

Chrome Coupler A coupling is used to extend the run of a pipe, or change pipe sizes (in the case of a reducing coupling, also sometimes called a "bell" reducer due to its shape). Available with female threads, or unthreaded for either plastic gluing (solvent welding) or copper soldering, these are among the most-used of fittings.

Offered in: ABS, brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.

Elbows

Copper 90° elbow

Copper 90° Elbow If you need to change the direction of flow, elbows are likely your best bet. Produced primarily in 90 and 45 degree angles (unique sizes like 22.5 and 60 are also available), elbows can be threaded or sweated, and are one of the most crucial fittings used in plumbing. Street elbows feature male and female threaded ends to easily connect differing pipes or fittings. Some unique elbows also feature a side outlet, making it act more like a tee with a bend.

Available in: ABS, brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.

Flanges

Black iron floor flange

Black Iron Floor Flange Flanges are used to connect pipes. Pipe is threaded or welded to the flanges, which are then sealed together (usually with bolts). Flange connections are used extensively in industrial applications handling high pressures. They can also be found connecting residential pump systems. "Closet" (or toilet) flanges are found in the home mounting the toilet to the floor and drain beneath.

Offered in: brass, copper, malleable (galvanized and black), and PVC (for closet/toilet flanges).

Nipple

Chrome pipe nipple

Chrome Pipe Nipple Nipples are a short stub of pipe, male-threaded at each end, that are used to connect straight pipe runs. Close nipples are threaded from each end along their whole length for particularly tight connections.

Available in: brass, chrome-plated brass, copper, malleable (galvanized and black), PVC, and stainless steel.

Tees

Brass IPS tee

Brass IPS Tee When more than one branch is required of a water supply, tees are the way to go. Essentially a long coupling with an outlet on the side, these fittings feature their outlets at 90° from the inlet, and are sized according to their "run" (the horizontal, or straight-through dimension of the fitting), and the side outlet (the "top" of the fitting, 90 degrees off the run). When the run of a tee is smaller than the side outlet, it's often referred to as a "bull head" fitting.

Tees are offered in ABS, brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black), PVC, and stainless steel.

Crosses

Galvanized steel cross

Galvanized Cross "Cross" fittings are 4-way fittings that are essentially the combination of two tees. Many opt to use two tees instead.

Crosses are available in brass, malleable (galvanized and black), and PVC.

Saddle Tees

PVC saddle tee

PVC Saddle Tee These fittings are used to quickly add a tee to an existing length of pipe, without having to cut and re-solder what's there. Most often, this takes place with irrigation systems to add a new sprinkler line. Also referred to as snap-tees, saddles are glued to the pipe, and after setting, the new hole is drilled.

Saddle tees are offered only in PVC.

Unions

CPVC union

CPVC Union Unions are an alternative to couplings, when the latter are impractical or inconvenient. Whereas couplings (when not soldered) need to have pipe threaded into them, unions rely upon their own nut to create a seal between the pipe ends. This makes them the perfect choice for connecting two fixed pipes (that are unable to be threaded into a regular coupling), and make future repairs that much easier. Dielectric unions are used to join pipes of different metals by providing a barrier against galvanic corrosion. For all their benefits, unions do have drawbacks: they are not to be used with natural and LP gas.

They are available in in brass, chrome-plated brass, copper, CPVC, malleable (galvanized and black) PVC, and stainless steel.

Wyes

ABS Wye

ABS Wye Wyes are primarily drainage fittings, and feature a 45° branch line designed to keep flow smooth. While sanitary tees are used with vertical drain connections, they can cause problems when used flat on a horizontal connection: those situations call for a wye.

These are available in brass, ABS, and PVC.

Common Fitting Materials

ABS

ABS elbow

ABS 60° Elbow Acrylonitrile Butadiene Styrene, a black plastic used in drainage, sewer, waste and vents. ABS pipe/fittings as well as PVC have replaced much of the cast iron, lead, and steel pipes formerly used for DWV. Important to note is that no solvent cement (or primer) can totally "glue" (solvent weld) ABS to PVC plastic.Purchase ABS plastic fittingsPurchase ABS tubular drain parts

Brass

Brass fittings adapter

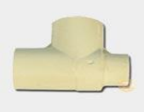
Brass Fitting Extender Made with a mixture of metal alloys: mostly copper and zinc, as well as small amounts of lead, tin, manganese, nickel, aluminum or iron. Brass fittings used for potable water usually have approximately 62-65% copper, 30-35% zinc and very small percentages of tin and lead. Brass works particularly well in hot water applications, and is highly resistant to corrosion.Purchase standard brass IPS fittings - Purchase brass IPS fittings for potable waterPurchase chrome-plated brass fittings - Purchase chrome-plated brass fittings for potable water

Copper

Copper bushing

Copper Bushing Reddish-brown, non-ferrous metal widely used for household plumbing pipes. Copper is a relatively soft and often thin material, making threading difficult. As a result, most copper fittings are not threaded, and must be soldered to copper pipe.Purchase copper fittingsPurchase copper tubing - Purchase rigid copper pipe

CPVC



CPVC reducing tee

CPVC Reducing Tee Chlorinated Polyvinyl Chloride is a plastic product designed for drinking water at temperatures up to 180 degrees (where code permits), and can generally withstand higher temperatures than standard PVC. The CPVC fittings we offer will not glue on PVC schedule 40 pipe.Purchase CPVC plastic fittings

Malleable (Galvanized or Black)

Black iron side outlet tee

Black Iron Side Outlet Tee Made from steel. Black iron is mostly used in gas and oil applications, and is often coated with black paint or lacquer. Galvanized fittings are coated with zinc to protect against rust and corrosion. Galvanized piping was widely used for home plumbing in the past, but no longer, due to leak issues over time. Galvanized fittings today are most often used for non-potable outdoor applications, and to repair existing galvanized systems.Purchase black fittings - Purchase galvanized IPS fittingsPurchase galvanized compression fittings

PVC

PVC coupler fitting

PVC Coupling A rigid, generally white plastic pipe. Used for waste and vent systems as well as cold water (underground) supplies outside of the house as well as used for sprinkler and irrigation pipes, sewers, drains, wastes and venting pipes and fittings. PVC in the plumbing business is generally white (Sch 40) but sometimes comes in other colors (in our industry gray is the second most popular, and is typically used for Sch 80 PVC). Another color you may see more frequently as water conservation efforts grow is purple, which is used to differentiate reclaimed or grey water systems from potable drinking water systems.Purchase PVC fittings

Stainless Steel

Stainless lock nut

Stainless Steel Lock Nut A combination of iron alloys and chromium, stainless steel is durable and offers excellent rust and corrosion resistance. Stainless steel comes in many types, with 304 and 316 being the most used in plumbing. Both are rated to pressures of 150 psi, with type 316 steel providing greater protection against chemical corrosion.

ADD ON LAB EXPERIMENT-2

Aim- To study the sampling and preservation methods in water and waste water characterization and to learn the significance of characterizations of water and waste water Sampling Programmer and Procedures The collection of a representative sample is the most important function of an environmentalist

The interpretation of results and recommendation for prevention and corrective treatment are all based on the analysis report. Scrupulous care in the collection of samples is therefore necessary to ensure that the sample is representative of the body of water under examination and to avoid spoilage and accidental contamination of the sample during collection and transport. Methods of sampling Three types of samples are often collected depending on situations a. Grab Samples Grab samples are samples collected at a designated place at a particular time. They represent the composition at the time and space. When a source is known to vary in time, as in the case of waste effluents, grab samples collected at various time intervals and analyses separately can be of greater value. b. Composite samples Composite samples are a mixture of grab samples collected at one sampling point at different times. Individual samples are collected in wide mouth bottles every hour and mixed in volume proportional to the flow. The composite values are useful for observing average values. c. Integrated samples integrated samples are a mixture of grab samples collected from different points simultaneously and mixed in equal volumes. Individual samples are collected from both banks of a river and at varying depths to represent available situations. Sampling and preservation Requirements: 1. Physical and Chemical Requirements: For general physical and chenica1 examination, the sample should be collected in a chemically clean bottle made of good quality glass fitted with a ground glass stopper or a chemically inert polyethylene container. The volume of sample to be collected would depend on the selection of tests; however, for general examination 3.0 litre sample would be sufficient, The following precautions must be taken while collecting the sample

i) The sampling location is representative of the water body

ii) The place is devoid of floating material Where ever possible the sample should be collected 15cm, below the surface or as the situation warrants No physical activity is permitted upstream of sampling point Shorter the time between collection and examination, the reliable will be the analytical results. For certain constituents and physical values, immediate analysis in the field is required, because, the composition of water may change before it arrives at the laboratory. The maximum limits of storage are: Unpolluted water: 72 hours slightly polluted. : 48 hours grossly polluted: 1 2hours some determinations are more likely to be affected by storage than others. Temperature may change, pH may change significantly, and dissolved gases may be evolved and lost (O2, CO2. and H2S) Frequency of sampling: Frequency depends on objectives. Yet, collection of samples of both raw and treated waters should be carried out as frequently as possible and at least once in every three months. Some waters undergo more pronounced seasonal variation and therefore require more frequent testing. Samples from treatment units should be collected and analyses frequently, at least one from each unit daily. 2. Bacteriological requirements: The samples for bacteriological examination are collected in sterilized. Neutral glass, glass-stopper 80z, and 300 ml bottles. The stopper and the neck should be protected by paper or parchment cover. If the sample is likely to contain traces of residual chlorine, an amount equal to 3.0 mg of sodium thiosul1ite (Na2s203, 51120) to neutralize chlorine is added to the bottle before sterilization. The sterilization is done at 15 psi (121°C) for 20-30 minutes in an autoclave. The sterilized sample bottle should be kept unopened until the time of collection. The stopper should be removed with care to eliminate chances of spoiling and contamination and should never the rinsed. After filling, the stopper should be replaced immediately. The place of collection should be predetermined and procedure of collection conditioned depending on the source. The standard procedure in sampling from a water faucet or tap is as follows:

a) Flame the tap briefly to kill clinging bacteria. This can be done with a piece of burning paper.

b) Turn on the water and allow it to run for 1 mm.

c) Remove the stopper from the bottle, being careful not to touch the inner portions o the stopper or bottle neck.

d) Fill bottle carefully, allowing no water to enter that has come in contact with hands. It is sometimes necessary to collect a sample from a reservoir or basin. If the water can be reached, remove the stopper, plunge the bottle below the surface and move the bottle while it is filling, so that no water will enter that has been in contact with hand. If the water is out of reach, as in a dug well, the bottle can be lowered with a cord. The sample after collection should be examined immediately, preferably within one hour. If the conditions do not permit immediate examination, the sample should be stored at low temperatures. This period should in case be more than 24 hours. If storage or transportation is necessary, they should be got at a temperature between 0°C and 10°C. Frequency of sampling: The frequency of sampling should be fixed depending on the magnitude of the problem involved. The number of samples to be examined from drinking water supply distribution system is normally decided on the basis of population served as given in the tabulation: Population Treated / untreated water entering distribution system Max.interval between successive sampling Max.no.of samples to be examined. Upto 20,000 1 month One sample for every 5000 population 20,001 – 50000 15 days 50,001 – 1,00,000 4 days More than 100,000 1 day One sample for every 10,000 population The raw water should be examined as frequently as the situation demands. The frequency is also determined based on objectives of study. 3. Biological Requirements: In general the samples for biological examination are collected in wide mouth, clean glass bottles of 2.0 litre capacity. They are never filled completely. This method is employed when total microscopic count is the aim. In some specific cases the concentrate of a sample may be collected through plankton nets made of bolting silk cloth, or the. Sample filtered through Sedge wick Rafter funnels. In general the sample must be examined microscopically within one hour of collections. If the facilities do not permit an immediate examination, it should be preserved after collection by addition of 2 ml neutralized (pH 7.0) formaline to each 100 ml of the sample. There is no practice about the frequency of sampling but the examination should be made regularly, or else as the situation demands. Benthos study is complex, Collection through cages placed at proper preselected sites for a defined period of time is recommended. Preservation Methods for Characterisation of samples: Determination Containers Minimum sample size ml Preservation Max.storage recommended pH P,G - Analyse immediately preferably in field 0.5 h Solids P,G 300 Refrigeration 7 d Sulfates P,G 100 Refrigerate 28 d D.o G,BOD Bottle 300 Titration may be delayed after fixation (1 ml Alk.KI and 1 ml $MnSO_4$) and acidification 8 h Turbidity P,G - Analyse same day store in dark, refrigerate 24 h Hardness P,G 100 Add HNO_3 to Ph

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