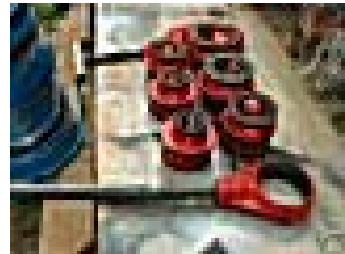


# MANUAL OF CIVIL ENGINEERING LABORATORY – I

(For First Year Intermediate Vocational Course  
in Water Supply & Sanitary Engineering)



STATE INSTITUTE OF VOCATIONAL EDUCATION &  
BOARD OF INTERMEDIATE EDUCATION

<b>Sl.No</b>	<b>TOPIC</b>	<b>Page No.</b>
1	SAMPLING	1
2	SOLUTIONS	4
3	PREPARATION OF STANDARD Na <sub>2</sub> CO <sub>3</sub> SOLUTION	5
4	ACID – BASE TITRATION	7
5	TOTAL HARDNESS	10
6	JAR TEST FOR OPTIMUM COAGULANT DOSAGE	12
7	FREE CHLORINE IN WATER	14
8	pH	16
9	CONDUCTIVITY	17
10	DISSOLVED OXYGEN	18
11	TOTAL SOLIDS	20
12	TOTAL DISSOLVED SOLIDS	21
13	CHEMICAL OXYGEN DEMAND	23
14	THEORETICAL DEMONSTRATION OF MICROBIAL TESTS	25
15	PIPE SPECIALS	27
16	LAYOUT OF TYPICAL PIPE SYSTEM	29
17	PIPE CUTTING , THREADING WITH DIE SET	31
18	ASSEMBLING OF A LENGTH OF PIPE	32
19	LINE SKETCH OF PIPE SYSTEM FOR SINGLE AND MULTI STOREYED BUILDING	34
20	PIPE CONNECTIONS TO PUMPS	37
21	TRACING LEAKAGES IN WATER SUPPLY CONNECTIONS AND THEIR REPAIRING	38
22	OPERATION OF PUMPS	40
23	PIPE CONNECTIONS TO A HAND PUMP IN A BORE WELL	41
24	INSTALLATION OF ELECTRIC HEATER	42

# SAMPLING

## WATER SAMPLING

The significance of a chemical analysis depends to a large extent on the sampling programme. An ideal sample should be done which is both valid and representative. These conditions are met by collection of samples through a process of random selection. This ensures that the composition of the sample is identical to that of the water body from which it is collected and the sample shares the same physico-chemical characteristics with the sampled water at the time and site of sampling.

The relevant factors for any sampling programme are (a) frequency of sample collection, (b) total number of samples, (c) size of each sample, (d) sites of sample collection, (e) method of sample collection, (f) data to be collected with each sample, and (g) transportation and care of samples

For analysis of natural and waste water, two principal types of sampling Procedures are employed:

**SPOT OR GRAB SAMPLES** : are discrete portions of water samples taken at a given time. A series of grab samples, collected from different depths at a given site, reflect variations in constituents over a period of time. The total number of grab samples should satisfy the requirements of the sampling programme

**COMPOSITE SAMPLES** : are essentially weighted series of grab samples, the volume of each being proportional to the rate of flow of the water stream at the time and site of sample collection. Samples may be composed over any time period, such as 4, 8 or 24 hours, on the purpose of analysis. Such composite samples are useful for determining the average condition which, when correlated with flow, can be used for computing the material balance of a stream of water body over a period of time.

It may be stated in general, that it is more meaningful to analyse a large number of separate samples taken at different times and different locations than to *compile* and analyse a *single* representative sample.

Separate samples must be collected for chemical and biological analysis, since the sampling and preservation techniques are quite different. For accurate analysis, it is desirable to allow a short-time interval between sampling and analysis. As a matter of fact temperature, pH and dissolved gases (D.O.) must be determined in the field and as quickly as possible after sampling.

Collection of truly representative sample is as important as sample preservation. A representative

*single sample is taken from a number of different locations over a long period of time.* In general, it is more significant to analyse a large number of separate samples taken at different times and different locations than it is to compile and analyse a single representative sample. It is essential to keep accurate records of the location, time and conditions of sample collection:

## PRESERVATION

It is essential to protect samples from changes in composition and deterioration with aging due to various interactions. The optimum sample holding time ranges from zero for parameters such as pH, temperature and D.O to one week for metals. The preservation techniques for various parameters are summarized in the following table. As mentioned above, these are essential for retarding biological action, hydrolysis of chemical compounds and complexes and reduction of volatility of constituents. It is desirable for accurate results, that analysis must be undertaken within 4 hours for some parameters and 24 hours for others, from the time of collection and it must be concluded within a week.

## WATER SAMPLE PRESERVATION

Parameter	Minimum Sample Size (mL)	Container	Preservation
1	2	3	4
PH	100	Polythene	Measure within 0-4 hours
DO	100	Polythene	
COD	500	Polythene	Add H <sub>2</sub> SO <sub>4</sub> to pH <sub>2</sub> ; refrigerate
Nitrogen Ammonia	500	Polythene	Analyse as soon as possible, add 0.8 mL conc. H <sub>2</sub> SO <sub>4</sub> / L
Nitrate+ Nitrite	500	Polythene	Add 40 mg HgCl <sub>2</sub> / L and refrigerate
Cyanide	500	Polythene	Add NaOH to pH 12 and 25 mL of 2% ascorbic acid and refrigerate
Sulphide	500	Polythene	Add 1 mL of 2N Zn(CH <sub>3</sub> COO) <sub>2</sub> and 2 mL of 1M NaOH Stir and refrigerate
Phosphate	500	Polythene/ Glass	Add 40 mg HgCl <sub>2</sub> / L and refrigerate
Phenol	500	Polythene/ Glass	Acidify with H <sub>3</sub> PO <sub>4</sub> to pH 4.0 and add 1g Cu <sub>2</sub> SO <sub>4</sub> · 5H <sub>2</sub> O per L to inhibit biodegradation
Tannin and Lignin	500	Polythene/ Glass	Analyse as soon as possible

Chromium , arsenic , lead , Zinc , Mercury	500	Glass /Polythene	Add 5mL conc. HNO <sub>3</sub> / L and refrigerate
E.Coli /total bacteria/ actenomycetis	100	Glass bottle	Sterilize the bottles in auto clave at 121° c at 15 lb/inch <sup>2</sup> pressure for 15 minutes, collect the sample in sterilized bottle and refrigerate immediately.
Microplankton/ algae and other biological organisms	500	Glass bottle	Add 5mL formalin per 100 mL sample and refrigerate immediately.

# SOLUTIONS

**SOLUTION** : A **solution** may be defined as a homogeneous mixture of two or more substances whose composition can be varied. Since the solution is a mixture, the composition of its component substances can be changed by dissolving one substance in to the other as per requirements. The dissolved substance may be present as individual molecules or ions throughout the other substance. Since both the components of a solution are present in the molecular or ionic state, so it forms a uniform transparent system.

The dissolved substance in solution is generally called the solute and the medium in which it is dissolved is known as the solvent,. The nature and properties of the solution, depend upon the concentration of the solution, the state of the solute and the solvent molecules.

**DEFINITION OF TRUE SOLUTION** : It has been defined already that a solution is a perfectly homogeneous mixture of two or more substances, and differs from a chemical compound in the fact that its composition can be varied continuously with in certain limits.

There is another class of solutions which appears homogeneous to the naked eye but is really heterogeneous as can be seen under a microscope or ultra microscope. Such a solution is not a true solution but is called a colloidal solution. Milk, blood, smoke, mist fog etc. are the examples of colloidal solutions

**TYPES OF SOLUTIONS:** True solutions are of seven types. These solutions and their examples are given below.

Sl.No	Type of solution	Example
1	Solutions of gases in gases	Mixture of gases i.e. air
2	Solutions of gases in liquids	Carbonated drink i.e. CO <sub>2</sub> dissolved in water.
3	Solutions of gases in solids	Adsorption of H <sub>2</sub> by palladium
4	Solutions of liquids in liquids	A mixture of alcohol and water
5	Solutions of solids in liquids	Sugar in water.
6	Solutions of solids in solids	Alloys.
7	Solutions of liquids in solids	Salt Crystals

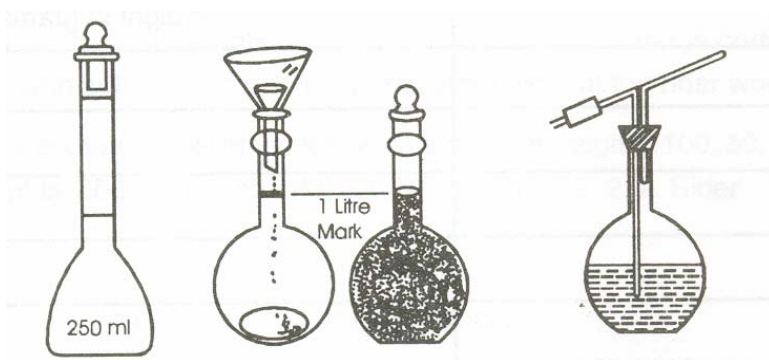
# PREPARATION OF STANDARD Na<sub>2</sub>CO<sub>3</sub> SOLUTION

**OBJECTIVE:** To prepare 0.05N Standard Sodium Carbonate Solution in 250 ml volumetric flask.

**APPARATUS :**

1. Weighing bottle	2. Analytical balance
3. Volumetric flask (250ml)	4. Glass funnel
5. Wash bottle	6. Pipette.
7. Spatula	8. Weight box

**SKETCH:**



**Volumetric Flask  
or  
Standard Flask**

**Preparation of  
Standard Solution**

**Wash Bottle**

**CHEMICALS :** Anhydrous Na<sub>2</sub>CO<sub>3</sub> salt

**PRINCIPLE :** A standard solution is one whose strength is known. Normality is defined as no. of gram equivalents of a solute present in one litre of solution.

**Normality of a solution** =  $\frac{\text{No. of gram equivalents of the substance dissolved}}{\text{Volume of the solution in liters}}$  =  $N = (n/v)$

Volume of the solution in liters

=  $\frac{\text{Weight of substance transferred}}{\text{Equivalent weight of substance} \times \text{Volume in liters}}$

To prepare any required strength of solution (say 0.05N) in 250ml Volumetric flask, the weight of the substance (say Na<sub>2</sub>CO<sub>3</sub>) to be taken can be calculated.

Eq. Wt of anhydrous Na<sub>2</sub>C<sub>03</sub> =Mol. Wt /Total charge on the cation or anion = 106/2

$$N = \frac{\text{Wt. of substance transferred}}{\text{Eq. wt x Vol. in liters}}$$

$$0.05 = \frac{\text{Wt.}}{53 \times 0.25}$$

Weight of substance = 0.05 X 53 X 0.25 = 0.6625 grams.

**PROCEDURE :**

1. About 0.6 -0.7 grams of anhydrous sodium carbonate is weighed in a rough balance and transferred to a clean and dry weighing bottle.
2. Using analytical balance weigh the substance with weighing bottle ( W<sub>1</sub> gm)
3. After weighing, transfer the substance in to volumetric flask using a funnel.
4. The substance kept on the funnel is washed down with a jet of distilled water. The flask is shaken well till the substance is completely dissolved in water. The water is added till the lower meniscus of the solution coincide with the mark of the flask
5. Weigh the weight of weighing bottle after transferring the substance in to volumetric flask.(W<sub>2</sub>gms).
6. Stopper the flask and shake the solution vigorously for 2-3 minutes in order to make uniform concentrated solution.
7. Calculate the correct normality of the solution using the formula

**OBSERVATIONS & CALCULATIONS :**

Weight of weighing bottle + substance = W<sub>1</sub>  
Weight of weighing bottle = W<sub>2</sub>  
Weight of the substance transferred = W<sub>1</sub> - W<sub>2</sub>

Normality of the prepared sodium Carbonate Solution

$$= \frac{\text{Weight of the substance}(W_1 - W_2)}{\text{Equivalent weight of the substance x Vol. in liters}}$$
$$= \frac{\text{-----}}{53 \times 0.25 \text{ litres}}$$

# ACID-BASE TITRATION

**OBJECTIVE:** To determine the normality of Hydrochloric acid present in given solution using 0.05N Standard solution of sodium carbonate.

**APPARATUS:** 1. Burette      2. Burette Stand      3. Pipette      4. Conical Flask  
5 Beakers      6. Glazed tile      7. Wash bottle

**CHEMICALS :** 1. Hydrochloric acid solution      2. Distilled water  
3. Standard Sodium carbonate solution      4. Methylorange indicator

**PRINCIPLE :** Hydrochloric acid reacts with Sodium carbonate solution according to the following equation . This is known as neutralization reaction

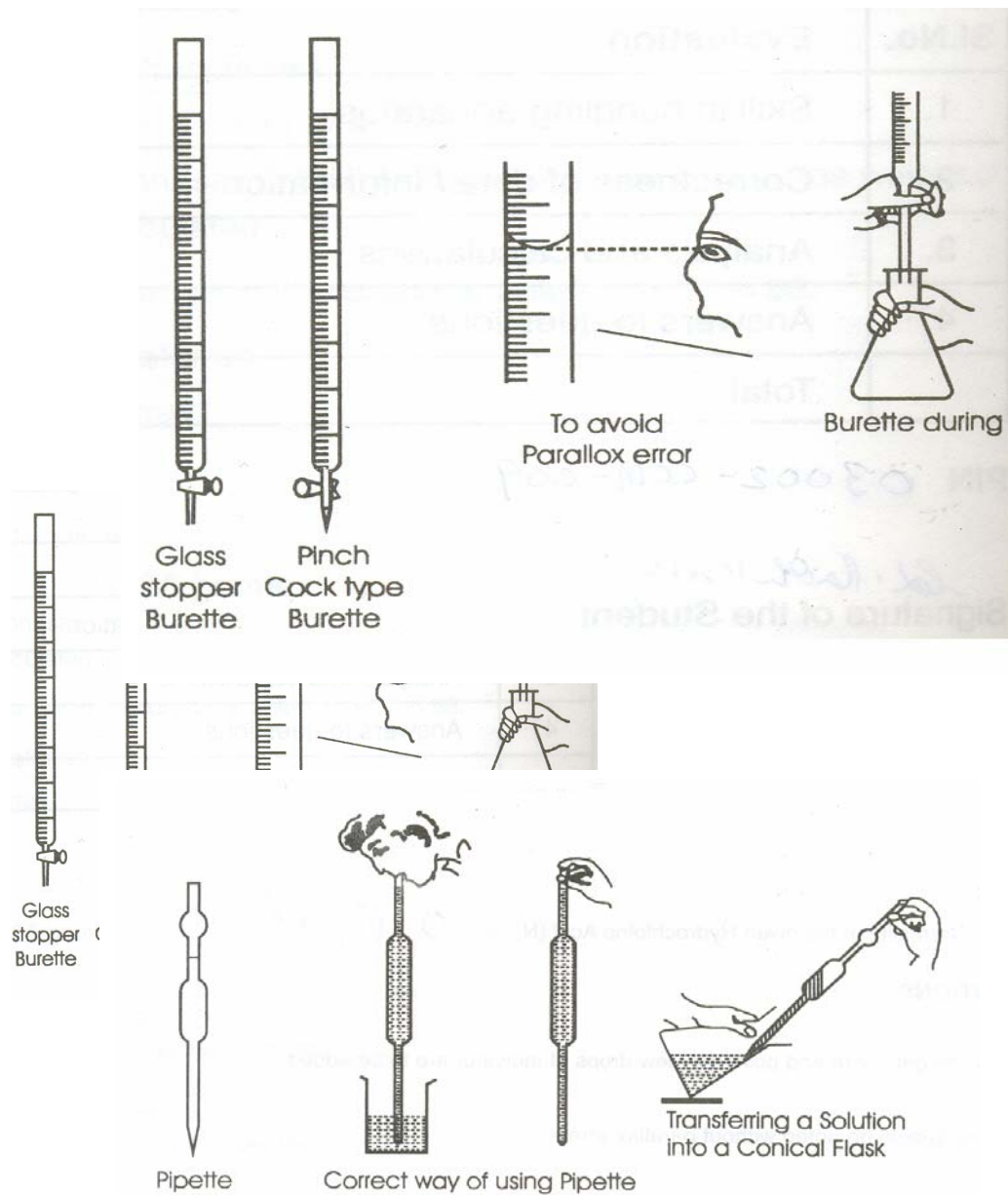


Methyl orange may be used as an indicator, since it is not affected by the liberated carbon dioxide gas.

## PROCEDURE:

1. The burette is rinsed with tap water, then with distilled water finally with the given Hydrochloric acid solution. The burette is filled with Hydrochloric acid and the nozzle portion is also completely filled with the solution with out any air bubbles in it. The initial reading of the burette is adjusted to ' 0'. The burette is clamped vertically to a burette stand.
2. A 20ml pipette is taken. It is rinsed with tap water, then with distilled water and finally with the given sodium carbonate solution. 20ml of Sodium Carbonate is transferred into a clean Conical flask by means of a Pipette.
3. 1 or 2 drops of methyl orange are added to the solution. The solution turns yellow in colour.
4. The flask is placed under the burette on a glazed tile. The HCl is added slowly while shaking the flask. The addition is continued till the colour changes from yellow to pink. It is the 'End point'. Just before the end point, any drops of the solution adhering to inner walls of the flask are washed down into the flask with a few drops of distilled water.
5. The final reading of the burette is noted. The difference between the two readings gives the volumes of Hydrochloric acid rundown. The contents of flask are thrown away.

6. Again 20 ml sodium carbonate solution is transferred to the flask and is titrated in a similar way. The titration are repeated till two consecutive readings coincide. The readings are entered in a Tabular form.



## OBSERVATIONS:

### Titration of HCl Using Standard Na<sub>2</sub>CO<sub>3</sub> Solution

Burette : HCl Solution

Conical Flask : 20 ml of Std Na<sub>2</sub>CO<sub>3</sub>+ Methylene orange 1 or 2 drops

End Point : Yellow to pink

Sl. No	Volume of Na <sub>2</sub> CO <sub>3</sub> Solution In ml 'V <sub>2</sub> '	Burette Readings		Volumes of HCl rundown.
		Initial	Final	

## CALCULATIONS :

Where: V<sub>1</sub> = Volume of Hydrochloric acid  
N<sub>1</sub> = Normality of Hydrochloric acid  
V<sub>2</sub> = Volume of sodium Carbonate solution  
N<sub>2</sub> = Normality of sodium Carbonate Solution

$$N_1 = \frac{N_2 \times V_2}{V_1}$$

## RESULT

The Normality of the given Hydrochloric Acid ( N<sub>1</sub> ) =

## PRECAUTIONS:

1. In order to get sharp end point only few drops of Indicator are to be added.
2. Reading should be noted without parallax errors.
3. The lower meniscus should be taken for colorless solution.
4. Burette should be vertically clamped to the burette stand and there should not be any air bubbles and nozzle part of the burette should also be filled with the above solution.
5. Phenolphthalein can not be used as an indicator in this titration, since it reacts with CO<sub>2</sub> liberated.

# TOTAL HARDNESS

**AIM:** To determine the hardness of given sample of water.

**GENERAL:** Hardness is the capacity of water to react with soap, hard water requiring more amount of soap to produce lather. Scaling of hot water pipes, boilers and other household appliances is due to hard water. It is caused by dissolved ions of calcium and magnesium. The degree of hardness of drinking water has been classified in terms of the equivalent  $\text{CaCO}_3$  concentration as follows:

Soft	0 - 60 mg/L.
Medium	60 - 120 mg/L.
Hard	120 -180 mg/L
Very hard	> 180 mg/L.

## PRINCIPLE:

In alkaline conduction, EDT A reacts with Ca and Mg to form a soluble chelated complex. Ca and Mg ions develop wine red colour with eriochrome black *T* under alkaline condition. When EDT A is added as a titrant, Ca and Mg divalent ions get complexed resulting in a sharp change from wine red to blue which indicates end-point of the titration.

## REAGENTS:

1. Standard EDTA solution 0.01M : Dissolve 3.723 g EDT A sodium salt and dilute to 1000 ml
2. Eriochrome black *T* indicator : Mix 0.5g dye with 100g NaCl to prepare dry powder.
3. Buffer solution : Dissolve 16.9g  $\text{NH}_4\text{Cl}$  in 143 ml Of  $\text{NH}_4\text{OH}$ .

## PROCEDURE:

1. Take 50 ml of well mixed sample in a conical flask.
2. Add 1-2 ml of buffer solution.
3. Add a pinch of Eriochrome black *T* and titrate with standard EDTA (0.01M) till wine red colour changes to blue colour. Note down the Vol. of EDTA required. (A).
4. Run a reagent blank, Note the Vol. of EDTA (B).
5. Calculate the Vol. of EDTA required by sample,  $C = (A - B)$ .

**CALCULATIONS:** Calculate the hardness of the sample using the relation

$$\text{Total Hardness as CaCO}_3 \text{ mg/L} = \frac{C \times D \times 1000}{\text{Volume of sample(ml)}}$$

C = Volume of EDTA required by sample (ml)

D = mg of CaCO<sub>3</sub> equivalent to 1.0 ml of EDTA titrant = 1mg of CaCO<sub>3</sub>

**OBSERVATIONS:**

S.No.	Burette reading EDT A			Hardness
	Initial	Final	Difference	

**RESULT:** Total Hardness of the water sample =----- mg/l as CaCO<sub>3</sub>

# JAR TEST FOR OPTIMUM COAGULANT DOSE

**AIM:** To determine the optimum dosage of given coagulant.

**GENERAL:** Chemical coagulation, flocculation and sedimentation together reduce suspended and colloidal solids and organic matter. Alum, ferrous and ferric salts, when used for clarification, result in producing better effluent than by the plain sedimentation. The exact doses of these coagulants can not be theoretically calculated and therefore, laboratory tests have to be carried out using the jar test procedure.

## PRINCIPLE:

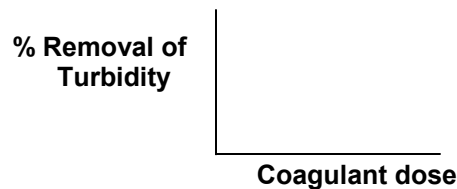
Metal salts hydrolyse in presence of the natural alkalinity to form metal hydroxides. The multivalent actions can reduce the zeta-potential. The metal hydroxides are good adsorbents and hence remove the suspended particles by enmeshing them.

## REAGENT:

Standard Alum / Ferrous / Ferric salt solution: Prepare standard chemical solution such that 1 ml of solution contains 10 mg of salt in the solution.

## PROCEDURE:

1. Measure initial turbidity of the sample.
2. Measure 1 liter quantities of the water to be tested into a series of glass jars.
3. Attach to stirring device.( Jar test apparatus).
4. Add progressive volumes of the chemical solution to each of the jars covering the range of chemical dosage expected.
5. Mix rapidly each sample for 1 minute.
6. Reduce the speed to about 10 rpm and mix for 15 minutes, (Flocculation).
7. Allow the flocs to settle for 15 minutes.
8. Measure turbidity of each settled sample.
9. Plot graph % removal of turbidity Vs. Coagulant dose and select the optimum dosage.



**PRECAUTIONS:**

1. Add coagulant doses simultaneously to all glass jars while stirring.
2. It is advisable to siphon out the settled sample from the jars so as not to disturb the settled floc.

**OBSERVATIONS:** Initial Turbidity of the sample - ---- NTU

S.No.	Coagulant dose added	Final Turbidity	% Removal	Remarks

**RESULT:** Optimum dose of coagulant = ----- mg/l

# FREE CHLORINE IN WATER

**AIM :** To determine the concentration of free chlorine available in water

**GENERAL :** The chlorination of water supplies and polluted water serves primarily to destroy or deactivate disease producing micro organisms. A secondary benefit, particularly in treating drinking water, is the overall improvement in water quality resulting from the reaction of chlorine with ammonia, iron, manganese, sulfide and some organic substances. Chlorine is widely used for disinfection of water, for deodourization since it is powerful oxidising agent and is cheaply available.

Chlorination may produce adverse effects, taste and odour characteristic of phenols and other organic compounds present in a water supply may be intensified. Combined chlorine formed on chlorination of ammonia and amine-bearing water adversely affect some aquatic life. To fulfill the primary purpose of chlorination and to minimize any adverse effects, it is essential that proper testing procedure be used with a foreknowledge of the limitations of the analytical determination.

**PRINCIPLE :** Chlorine combines with water to form hypochlorous and hypochloric acid. Hypochlorous acid dissociates to give the  $\text{OCl}^-$  ion. Quantities of  $\text{OCl}^-$  and  $\text{HOCl}$  depend on pH of the solution. Chlorine is a strong oxidising agent and liberates iodine from potassium iodide at pH = 8 or less. The liberated iodine is equivalent to the amount of chlorine present and can be titrated against sodium thiosulphate using starch as an indicator at pH 3 to 4 because the reaction is not stoichiometric at neutral pH due to partial oxidation of thiosulphate to sulphate.

## REAGENTS :

- |  |                                 |
|--|---------------------------------|
| (i) Acetic acid (glacial).                         | (ii) Potassium iodide crystals. |
| (iii) 0.1 N standard sodium thiosulphate solution. | (iv) Starch indicator           |

## APPARATUS :

Pipette (10 ml), burette, beaker, volumetric flask, conical flask, analytical balance etc.

## PROCEDURE :

1. Pipette out 25 ml of water sample in conical flask.
2. Add a pinch of KI and sufficient distilled water (100 ml).
3. Add 10 ml acetic acid and allow the reaction to complete.
4. Titrate free iodine liberated with 0.1 N thiosulphate solution. Note the volume required (A).
5. Prepare a reagent blank using distilled water. Note the volume of 0.1 N thiosulphate solution required for blank (B).

**FORMULA :**

$$\text{Available Chlorine (mg/l)} = \frac{(A - B) N \times 35450}{\text{Volume of sample}}$$

[1 g equiv. of chlorine = 35.45 x 10<sup>3</sup> mg of chlorine]

where

A = Volume of thiosulphate required by sample in ml.

B = Volume of thiosulphate required by blank in ml.

N = Normality of thiosulphate solution.

**Observations**

S. No.	Volume of Solution (ml)	Burette Reading		Vol. of thiosulphate used (ml)
		<i>Initial</i>	<i>Final</i>	
1.	10.0			
2.	10.0			
3.	10.0			
4.	10.0			
Blank without sample	10.0			

# pH

**AIM:** To determine the pH of the given sample.

**GENERAL:** pH of aqueous solutions can be defined as negative logarithm of hydrogen ion concentration. pH values ranging from 0 to 7 are acidic, and from 7 to 14 are alkaline. The effect of pH on the chemical and biological properties of liquids makes its determination very important. It is used in several calculations in analytical work. The pH determination is usually done by electrometric method which is the most accurate method and free of interference.

## **ELECTROMETRIC METHOD:**

The pH is determined by measurement of the electromotive force of a cell comprising an indicator electrode (an electrode responsive to hydrogen ions such as glass electrode) immersed in the test solution and a reference electrode or a combined electrode. The contact between the test solution and the reference electrode is usually achieved by means of a liquid junction. The emf of this cell is measured with pH meter. This is a high impedance electrometer calibrated in terms of pH.

## **REAGENTS: .**

Calibrates the electrode system against standard buffer solution of known pH. Buffer tablets having pH 4.0, 7.0 and 9.2 are available.

## **pH 4, pH7, pH 9.2 BUFFER SOLUTIONS:**

Dissolve buffer tablet of pH 4 in 100 ml of distilled water to get pH 4 buffer solution. Similarly other buffer solutions can be prepared by dissolving corresponding buffer tablets.

## **PROCEDURE:**

1. Rinse the electrode thoroughly with distilled water.
2. Dry electrode by gently blotting with a soft tissue paper and standardise instrument with electrode immersed in a buffer solution.
3. Remove the electrode from buffer, rinse thoroughly and blot. dry.
4. Immerse in a second buffer below pH 10, approximately 3 pH units different from the first, the reading should be within 0.1 unit for the pH of the second buffer.
5. Rinse the electrode thoroughly, blot and dry and determine the pH of unknown sample.

Sample No.	pH	Remarks

# CONDUCTIVITY

**AIM:** To determine the Conductivity of the given sample

**GENERAL :** Conductivity is the capacity of water to carry an electrical current and varies both with number and types of ions the solution contains, which in turn is related to the concentration of ionized substances in the water. Most dissolved inorganic substances in water are in the ionized form and hence contribute to conductance. Conductivity measurement gives rapid and practical estimate of the variations in the dissolved contents of a water.

## REAGENTS:

**0.01 N, KCL solution:**

Dissolve 0.746 grams of potassium chloride in 1 liter of distilled water.

## PROCEDURE:

1. Rinse the electrode thoroughly blot and dry.
2. Immerse the electrode in 0.01 N KCL solution and the conductivity should be 1413 micro mhos at 25°C Temperature.
3. Now the instrument is calibrated.
4. Remove the cell from KCL solution and wash it thoroughly with distilled water.
5. Immerse the electrode/cell in the unknown sample whose conductivity is to be determined. The conductivity of the sample can be calculated by multiplying the observed conductance with the cell constant.

**Conductivity of the sample** = observed conductance x cell constant (in micro mhos)

**Tabulation:**

Sample No (1)	Observed conductance (2)	Cell constant (3)	Conductivity (4) = (2) x (3)

# DISSOLVED OXYGEN

**AIM:** To determine the dissolved oxygen content in given sample.

**THEORY:** The solubility of atmospheric oxygen in fresh water ranges from 14.4 mg/l at 0° C to about 7.0 mg/L at 35°C at one atmospheric pressure. Since it is poorly soluble gas, its solubility directly varies with the atmospheric pressure at any given temperature. Analysis of DO is important in sanitary engineering practice. It is necessary to know DO levels to keep a check on stream pollution, and also to assess raw water quality. DO is necessary for all aerobic biological treatment processes. DO is the basis for BOD test which is an important parameter to evaluate pollution potential of wastes.

**PRINCIPLE:** (WINKLER METHOD WITH AZIDE MODIFICATION)

Oxygen present in a sample rapidly oxidizes the dispersed divalent manganese hydroxide 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 the original DO content. The liberated iodine is titrated against  $\text{Na}_2\text{S}_2\text{O}_3$  (N/80) using starch as an indicator.

**APPARATUS:**

1. BOD bottles of capacity 300 ml.
2. Sampling device for collection of samples.

**REAGENTS:**

1. **Manganous sulphate:** Dissolve 480g tetrahydrate manganous sulphate and dilute to 1000 ml. Filter if necessary. This solution should not give colour starch when added to an acidified solution of KI.
2. **Alkali iodide-azide reagent:** Dissolve 500g NaOH and 150 g KI or 135 g. NI dilute to 1000 ml. Add 10 g  $\text{NaNO}_3$  dissolved in 40 ml distilled water. This solution should not give colour with starch solution when diluted and acidified.
3. **Concentrate sulphuric acid:**
4. **Starch indicator:** Prepare paste or solution of 2.0 g L.R. grade soluble starch powder and 0.2 g salicylic acid as preservative in distilled water. Pour this solution in 100 ml boiling water. Allow to boil for few minutes, cool and then use.
5. **Stock sodium thiosulphate 0.1N:** Dissolve 24.82 g  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  in boiled distilled water and dilute to 1000 ml. Preserve by adding 5 ml of chloroform per litre.
6. **Standard sodium thiosulphate 0.025 N:** Dilute 250 ml stock  $\text{Na}_2\text{S}_2\text{O}_3$  solution to 1000 ml with freshly boiled and cooled distilled water. Preserve by adding 5 ml chloroform per litre.

## PROCEDURE:

1. Collect sample in a BOD bottle using DO sampler.
2. Add 2 ml  $\text{MgSO}_4$  followed by 2 ml of alkali-iodide-azide reagent. The tip of the pipette should be below the liquid level while adding these reagents. Stopper immediately.
3. Mix well by inverting the bottle 2-3 times and allow the precipitate to settle leaving 150 ml clear supernatant.
4. At this stage, add 2 ml conc.  $\text{H}_2\text{SO}_4$ . Mix well till precipitate goes into solution.
5. Allow the solution to stand at least 5 minutes.
6. Withdraw 100 ml. of the solution into an conical flask and immediately add 0.025 N sodium thiosulfate drop by drop from a burette until the yellow color almost disappears.
7. Add about 1 ml. of starch solution and continue the addition of the thiosulfate until the blue color just disappears. Record the ml. of thiosulfate used.

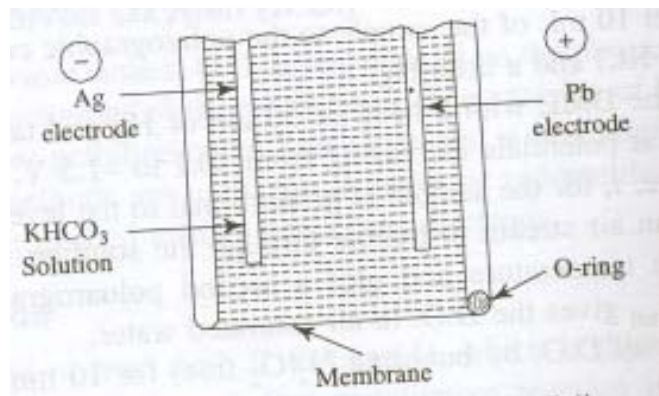
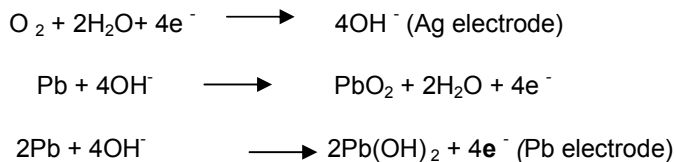
**CALCULATION:** Dissolved oxygen mg/L = ML of 0.025 N sodium thiosulphats used x 2

## RESULT:

Dissolved oxygen = ----- mg/l.

## MEMBRANE ELECTRODE METHOD (MACKERETH OXYGEN CELL)

Two metal electrodes, one of Ag and the other of Pb, are immersed in a saturated  $\text{KHCO}_2$  solution separated from the test solution by a poly ethylene membrane, around 0.06 mm thick.. Thus, a galvanic cell can be plugged to a pH meter to give a direct reading of D.O. in  $\text{mg L}^{-1}$  (the scale of 0 to 14 pH becomes 0 to 14  $\text{mg L}^{-1}$  D.O.). The current is measured for sample, for a standard (sample after air saturation) and for a blank (sample after treatment with a little  $\text{Na}_2\text{S}_3$  to expel  $\text{O}_2$ )



**The Mackereth Oxygen cell**

# TOTAL SOLIDS

**AIM:** To determine the total solids present in water sample.

**GENERAL:** The term solid refers to the matter either filterable or infilterable that remains as residue after evaporation and subsequent drying at a defined temperature. Different forms of solids are defined on the basis of method applied for their determination.

Residue after the evaporation and subsequent drying in oven at specific temperature, 103-105°C of a known volume of a sample are total solids. The loss in weight on ignition of the same sample at 550°C (in which organic matter is converted to CO<sub>2</sub> and H<sub>2</sub>O) gives organic solids present in the sample.

## PROCEDURE:

1. Take empty weight of beaker. (W<sub>1</sub>)
2. Take a known volume of a well mixed sample in the above beaker.
3. Evaporate the sample to dryness at 103°C for 24 hours.
4. Cool and weigh and record the reading (W<sub>2</sub>)
5. Keep the beaker for 15-20 min. in a muffle furnace maintained at 550 ± 50°C.
6. Cool the beaker and record the final weight (W<sub>3</sub>).

**CALCULATIONS:** Total solids mg/L. =  $\frac{(W_2 - W_1) \times 1000}{\text{ml of sample}}$

Organic solids mg/L. =  $\frac{(W_2 - W_3) \times 1000}{\text{ml of sample}}$

## OBSERVATIONS:

Weight of empty beaker	W <sub>1</sub> = ----- mg
Weight of beaker after evaporation at 103°C	W <sub>2</sub> = ----- mg
Weight of beaker after evaporation in muffle furnace	W <sub>3</sub> = ----- mg

## RESULT:

Total Solids =            mg/l

# TOTAL DISSOLVED SOLIDS

**AIM :** To determine the concentration of total dissolved solids in given water sample.

**GENERAL :** Solids refer to matter suspended or dissolved in water or waste water. Solids may affect water or effluent quality adversely in a number of ways. Water with high dissolved solids generally are of inferior potability and may induce an unfavourable physiological reaction in the transient consumer. For this reason, a limit of 500 mg dissolved solids/litre is desirable for drinking water. Highly mineralized water is also unsuitable for many industrial applications. Solid analyses are important in the control of biological and physical assessing compliance with regulating agency.

**PRINCIPLE :** A well mixed sample is filtered through a standard glass fiber filter, and the filtrate is evaporated to dish and dried to dryness in a weighed constant weight around 140°C. The increase in the weight of dish represents the total dissolved solids.

## APPARATUS :

Evaporating dish, dessicator, funnel, oven, analytical balance and filter paper.

## PROCEDURE :

1. Take an evaporating dish of suitable size, weigh it and store in dessicator until needed.
2. Evaporate 250-500 ml filtered sample in the evaporating dish in a oven by heating around 140°C. .
3. Dry the residual sample for atleast 1 hour in an oven around 140°C, cool in dessicator to balance temperature and weigh it.
4. Repeat drying cycle of drying, cooling and dessicating until constant weight is obtained or until weight loss is less than 4% of the previous weight or 0.5 mg, whichever is less.

## FORMULA :

$$\text{Total dissolved solids (mg/ litre of sample)} = \frac{(A - B) \times 1000 \text{ mg}}{\text{Volume of sample (ml)}}$$

Where A = mass of dried residue and dish in g.

B = mass of dish in g.

## OBSERVATIONS :

Temperature of measurement =

Mass of Evaporating Dish (*B*) =            g

Volume of sample =            ml

### Observation Table

Sl. No.	Sample	Mass of Dish + dried residue (g)	Mass of dried residue (mg)	Total dissolved solids (mg/litre)
1.				
2.				
3.				
4.				

## CALCULATION :

Mass of Dish + dried residue (*A*) =            g

Mass of Dish (*B*)                                =            g

Mass of dried residue (*A-B*)                =            mg

Total Dissolved Solids                        =  $\frac{\text{Mass of dried residue} \times 100}{\text{Volume of sample}}$

## RESULT :

Total dissolved solids present in water sample =            mg/litre

Total Suspended solids present in water sample =

( Total Solids present in water sample ) - ( Total dissolved solids present in water sample )

# CHEMICAL OXYGEN DEMAND

**AIM:** To determine the chemical oxygen demand of given sample.

**THEORY:** Chemical oxygen demand (COD) test determines the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The limitation of COD test is that it can not differentiate between the biologically oxidizable and biologically inert material. COD determination has an advantage over BOD determination in that the result can be obtained in about 3-4 hours as compared to 5 days required for BOD test.

**PRINCIPLE:** The organic matter gets oxidized completely by  $K_2Cr_2O_7$  in the presence of  $H_2SO_4$  to produce  $CO_2 + H_2O$ . The excess  $K_2Cr_2O_7$  remaining after the reaction is titrated with  $Fe(NH_4)_2(SO_4)_2$ . The dichromate consumed gives the  $O_2$  required for oxidation of organic matter.

## APPARATUS:

1. Reflux apparatus consisting of a flat bottom 250 to 500 ml capacity flask
2. Burner or hot plate with temperature regulator .

## REAGENTS:

1. **Standard potassium dichromate 0.250 N:** Dissolve 12.259g of  $K_2Cr_2O_7$  dried at  $103^\circ C$  for 24 hours in distilled water and dilute to 1000 ml. Add about 120 mg sulphamic acid to take care of 6 mg/L  $NO_2-N$ .
2. **Sulphuric Acid reagent:** Add 10 g of  $Ag_2SO_4$  to 1000 ml conc.  $H_2SO_4$  and keep over night for dissolution.
3. **Standard ferrous ammonium sulphate 0.1 N:** Dissolve 39 g  $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$  in about 400 ml distilled water. Add 20 ml conc.  $H_2SO_4$  and dilute to 1000 ml.
4. **Ferriin indicator:** Dissolve 1.485 g of 1, 10 phenanthroline monohydrate and 695 mg  $FeSO_4 \cdot 7H_2O$  and dilute to 100 ml with distilled water.
5. **Mercuric Sulphate:**  $HgSO_4$  crystals, analytical grade.

## PROCEDURE:

1. Place 0.4 g  $HgSO_4$  in a reflux flask.
2. Add 20 ml sample and mix well.
3. Add pumice stone or glass beads followed by 10 ml of standard  $K_2Cr_2O_7$ .
4. Add slowly 30 ml  $H_2SO_4$  containing  $Ag_2SO_4$  mixing thoroughly. This slow addition along with swirling prevents fatty acids to escape out due to high temperature.
5. Connect the flask to condenser: Mix the contents before heating.
6. Reflux for a minimum of 2 hours cool and then wash down the condenser with distilled water.

7. Dilute for minimum of 150 ml, cool and titrate excess  $K_2Cr_2O_7$  with 0.1 N Ferr. Amm. Sulphate using ferroin indicator. Sharp colour change from blue green to wine red indicates end-point.
8. Reflux blank: in the same manner using distilled water instead of sample.
9. Calculate COD from the following formula:

$$\text{COD mg/L} = \frac{(a-b) \times N \times 8000}{\text{ml of sample}}$$

where a = ml of Ferr. Amm. Sulphate for blank.

b = ml of Ferr. Amm. Sulphate for sample.

N = normality of Ferr. Amm. Sulphate.

**OBSERVATIONS:**

S.No.	Burette Reading of Ferr. Amm. Sulphate			Remarks
	Initial	Final	Difference	

**RESULT:**

COD of the given sample = ----- mg/l.

# THEORETICAL DEMONSTRATION OF MICROBIAL TESTS

## **BIOLOGICAL WATER-QUALITY PARAMETERS :**

Water may serve as a medium in which literally thousands of biological species spend part, if not all, of their life cycles. Aquatic organisms range in size and complexity from the smallest single-cell microorganism to the largest fish. All members of the biological community are, to some extent, water-quality parameters, because their presence or absence may indicate in general terms the characteristics of a given body of water. As an example, the general quality of water in a trout stream would be expected to exceed that of a stream in which the predominant species of fish is carp. Similarly, abundant algal populations are associated with a water rich in nutrients. Certain organisms can be used as indicators of the presence of pollutants.

## **PATHOGENS :**

From the perspective of human use and consumption, the most important biological organisms in water are pathogens, those organisms capable of infecting, or of transmitting diseases to, humans. These organisms are not native to aquatic systems and usually require an animal host for growth and reproduction. They can, however, be transported by natural water systems, thus becoming a temporary member of the aquatic community. Many species of pathogens are able to survive in water and maintain their infectious capabilities for significant periods of time. These waterborne pathogens include species of bacteria, viruses, protozoa, and helminths (parasitic worms).

Analysis of water for all the known pathogens would be a very time-consuming and expensive proposition. Tests for specific pathogens are usually made only when there is a reason to suspect that those particular organisms are present. At other times, the purity of water is checked using indicator organisms.

Most of the waterborne pathogens are introduced through fecal contamination of water. Thus, any organism native to the intestinal tract of humans and meeting the above criteria would be a good indicator organism. The organisms most nearly meeting these requirements belong to the fecal coliform group. Composed of several strains of bacteria, principal of which is *Escherichia coli*, these organisms are found exclusively in the intestinal tract of warm-blooded animals and are excreted in large numbers with feces. Fecal coliform organisms are nonpathogenic and are believed to have a longer survival time outside the animal body than do most pathogens. Because the die-off rate of fecal coliforms is logarithmic, the number of surviving organisms may be an indication of the time lapse since contamination.

There are other coliform groups which flourish outside the intestinal tract of animals. These organisms are native to the soil and decaying vegetation and are often found in water that was in recent contact with these materials. Because the life cycles of some pathogens (particularly helminths) may include periods in the soil, this group of coliform organisms also serves as an indicator of pathogens.

It is the usual practice to use the total coliform group (those of both fecal and nonfecal origin) as indicators of the sanitary quality of drinking water, while the indicator of choice for wastewater effluents is the fecal coliform group. Relatively simple tests have been devised to determine the presence of coliform bacteria in water and to enumerate the quantity. The tests for total coliform organisms employ slightly

different culture media and lower incubation temperatures than those used to identify fecal coliform organisms.

### **MEMBRANE –FILTER TECHNIQUE :**

The membrane-filter technique, a technique popular with environmental engineers, gives a direct count of coliform bacteria. In this test, a portion of the sample is filtered through a membrane, the pores of which do not exceed  $0.45 \mu\text{m}$ . Bacteria are retained on the filter that is then placed on selective media to promote growth of coliform bacteria while inhibiting growth of other species. The membrane and media are incubated at the appropriate temperature for 24 h, allowing coliform bacteria to grow into visible colonies that are then counted. The results are reported in number of organisms per 100 mL of water.

### **MPN TEST :**

An alternative method often preferred by microbiologists is the multiple tube fermentation test. Coliform organisms are known to ferment lactose, with one of the end products being a gas. A broth containing lactose and other sub. stances which inhibit noncoliform organisms is placed in a series of test tubes which are then inoculated with a decimal fraction of 1 mL (100, 10, 1.0, 0.1, 0.01, etc.). These tubes are incubated at the appropriate temperature and inspected for development of gas. This first stage of the procedure is called the *presumptive test*, and tubes with gas development are presumed to have coliforms present. A similar test, called the *confirmed test*, is then set up to confirm the presence of coliform organisms. A statistical method is used in to determine the most probable number (MPN) of coliform bacteria in 100 mL of the water sample.

# PIPE SPECIALS

**AIM :** To study Pipe specials

**THEORY :** In a fluid carrying system the fluid is transmitted through a pipe from one point to the other in one or different directions. Some times branch lines are taken off from main lines. Under these circumstances suitable devices are to be used in the pipe line . This necessitates the use of different pipe specials such as couplings , reducers, tees etc.,. The study of pipe specials enables us to select the appropriate pipe special for a given situation.

## PIPE SPECIALS :

**1. COUPLER:** For making-up the length, in general, wrought iron and steel pipes are joined by means of a socket or coupler. It is a small pipe with internal threads throughout, used to connect the pipes having external threads at their ends

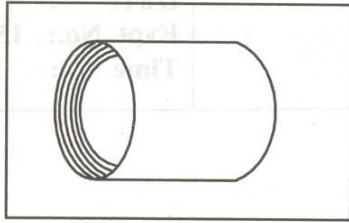
**2. NIPPLE:** A nipple is a small pipe, threaded throughout on the outside. For making-up the length, the nipple is screwed inside the internally threaded ends of other pipes or pipe fittings. This type of joint, causes restriction to the fluid passage.

**3. BENDS, ELBOWS, TEES AND CROSSES:** These fittings are used either to connect or branch off the pipes at right angles

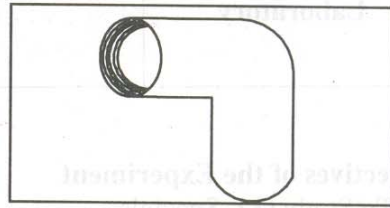
**4. REDUCING SOCKET:** It is used to connect two pipes of different diameters

**5. PLUG:** It is used to close the end of a pipe with internal threads. For the same purpose, a plug with internal threads can also be used to close a pipe end with external threads.

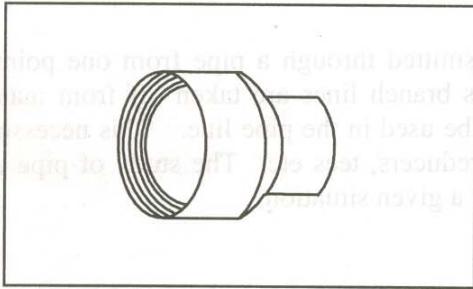
## G.I. PIPE SPECIALS



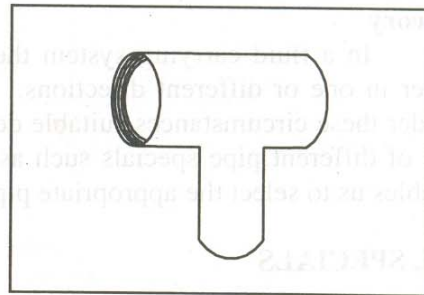
**COUPLING**



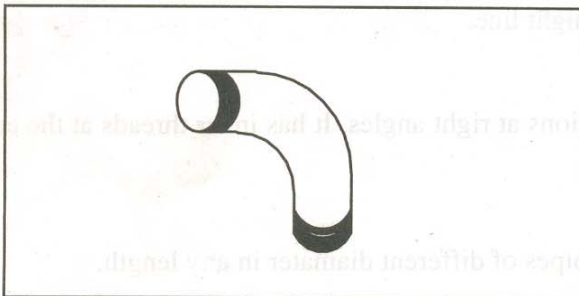
**ELBOW**



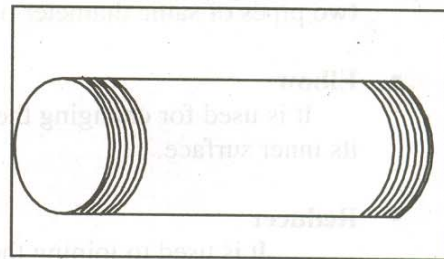
**REDUCER**



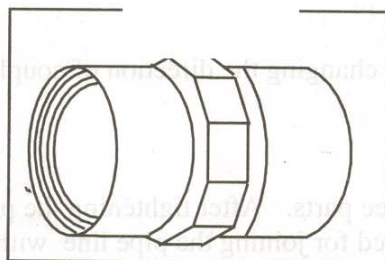
**TEE**



**BEND**

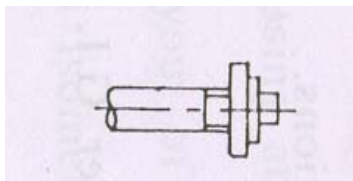


**NIPPLE**



**UNION**

**PLUG**

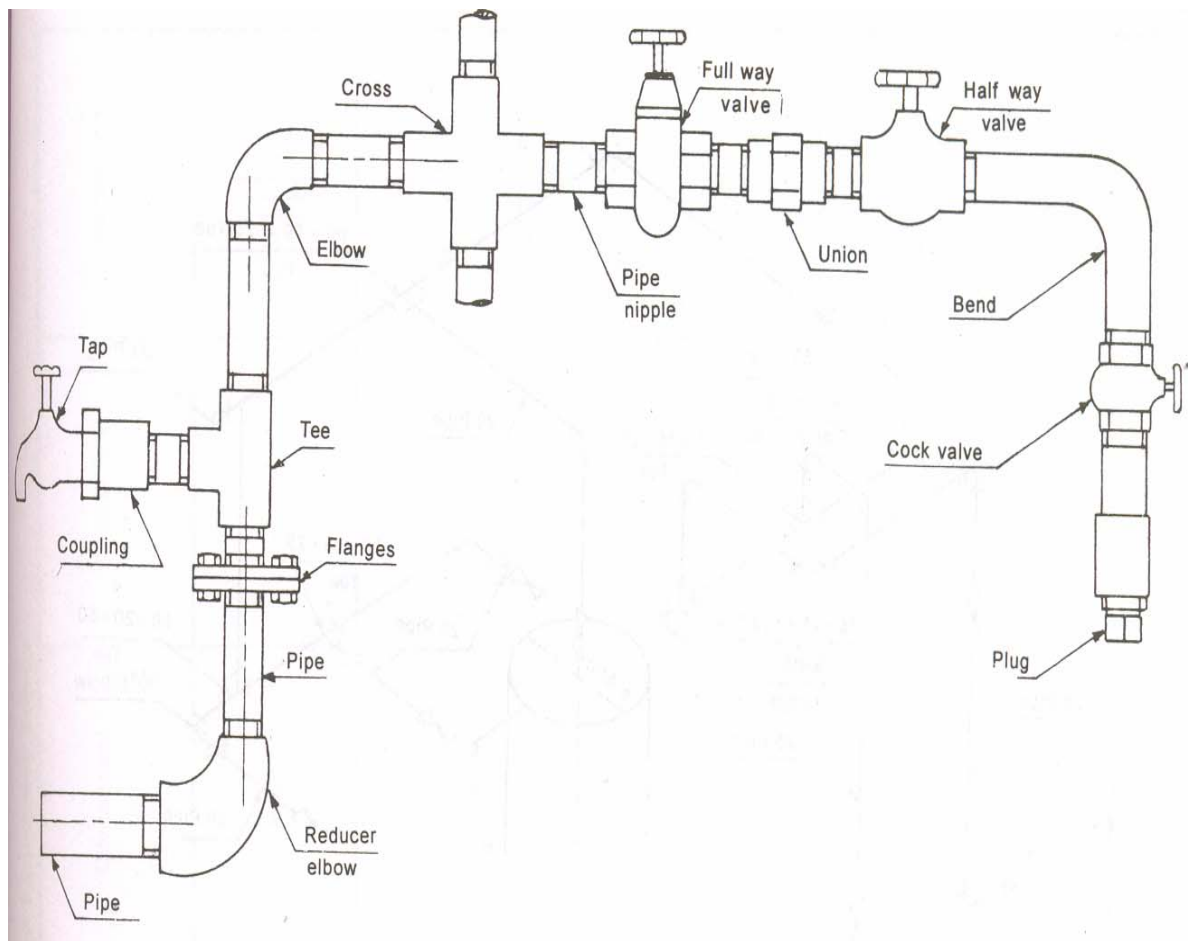


# LAYOUT OF TYPICAL PIPE SYSTEM

## OBJECTIVES :

To know various pipe fittings and valves used in the layout with their specifications.

To estimate the material required for a given pipe layout.



**PIPE LAYOUT**

## **IMPORTANT PIPE FITTINGS AND SPECIALS :**

**FLANGED JOINT:** It is used where fluid under high pressures are to be conveyed. It is also used in water pipe lines over 75 mm dia.

**UNION JOINT:** This is special joint used on small pipes where a socket joint can not be used due to  
i) difficult to fix in position ii) too long to rotate. The advantage of union joint is that it facilitates making or breaking of the joint without disturbing the pipe layout.

**SOCKET:** It is also termed as coupler. It is a small pipe with internal threads throughout and is used to connect the pipes leaving external threads at their ends.

**VALVES:** Valves are used to control the flow of fluid through the pipes. Globe valve and gate valve are commonly used.

**TAP:** Taps are small valves with their outlet open to atmosphere.

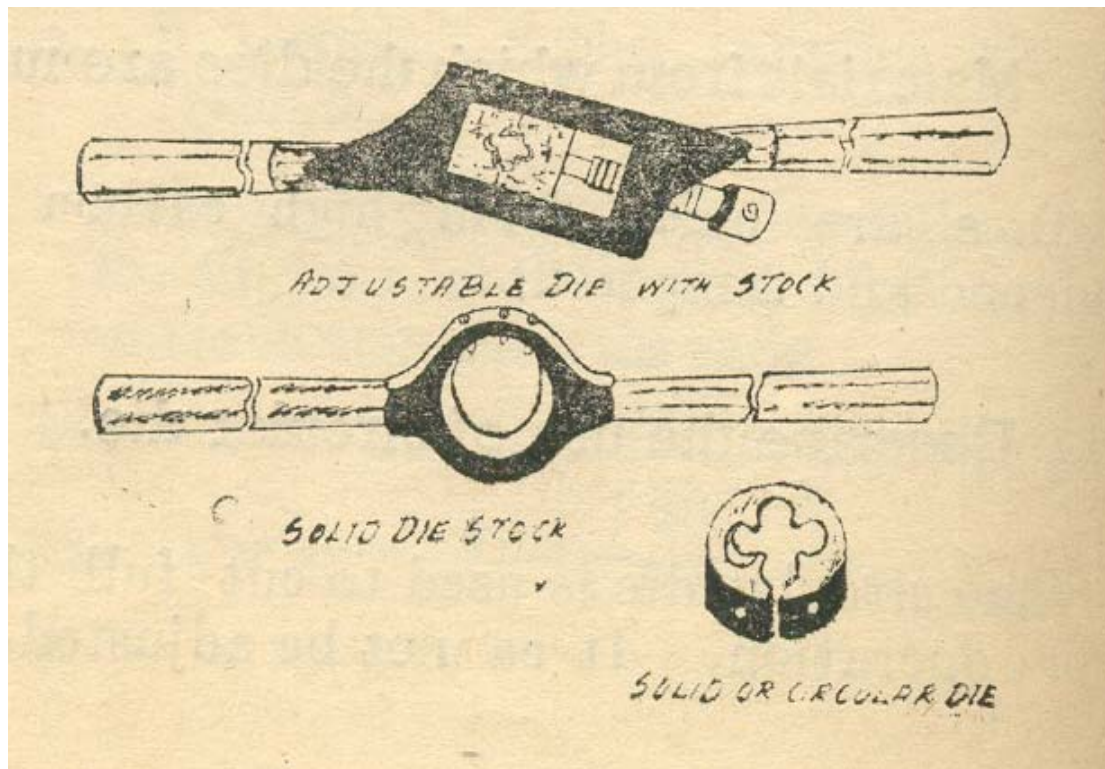
# PIPE CUTTING , THREADING WITH DIE SET

**AIM :** To know about pipe cutting and threading tools

**PIPE DIE :** Pipe Die is used with stocks for cutting external threads on the pipes. The stock can be adjusted to cut the threads step by step , the dies are available in variable sizes. The British Standard pipe threads are generally used on pipes. The included angle of the B.S.P thread on pipes is 55°. The following table shows the various bore sizes of the pipes and number of threads per inch.

Bore size of the pipes and Tubes in inches	Number of threads per inch
1 / 8	28
( 1 / 4 ) to ( 3 / 8 )	19
( 1 / 2 ) , ( 5 / 8 ) , ( 3 / 4 ) , ( 7 / 8 )	14
1 to 6	11
7 to 10	10
11 to 18	8

**PIPE CUTTER :** Pipe cutters of various sizes are used for cutting the pipes into different lengths . Pipe Cutter consists of three sharp edged steel rollers and two of them can be adjusted according to the size of pipes.



# ASSEMBLING OF A LENGTH OF PIPE (WITH TWO JOINTS / ONE TURN / TWO TURNS)

**AIM :** To prepare pipe lines with joints & turns and to understand pipe line system details.

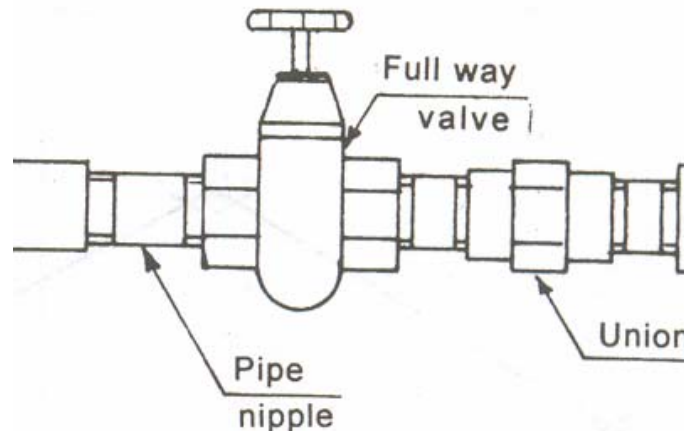
## TOOLS REQUIRED:

**PIPE VICE :** It consists of handle, screw fixed and movable jaw frame. The frame may be fixed or movable. It is used for holding the pipe in position rigidly for cutting and threading. The vices used by the plumber are in stand or without stand. The frame and the body is made of cast iron, its handle is made of M.S.

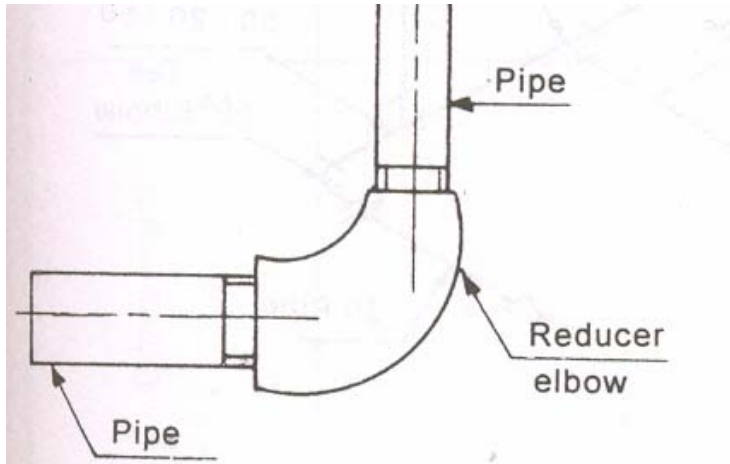
**ADJUSTABLE PIPE WRENCH :** It is used for screwing and unscrewing small pipes .It also used for tightening of nuts, bolts , fixing of small taps ,valves ,etc ,in pipelines.

**HACK SAW:** It consists of frame, handle, prongs, tightening screw and nut. The frame may be fixed type or adjustable type. Blade is fixed in position by means of tightening screw. The direction of the cutting teeth of the blade is to be in the forward direction. It is used for cutting pipes and metals.

25 mm; 20 mm; 15 mm pipe threading die set (Hand operated)



**PIPE LINE WITH TWO JOINTS**

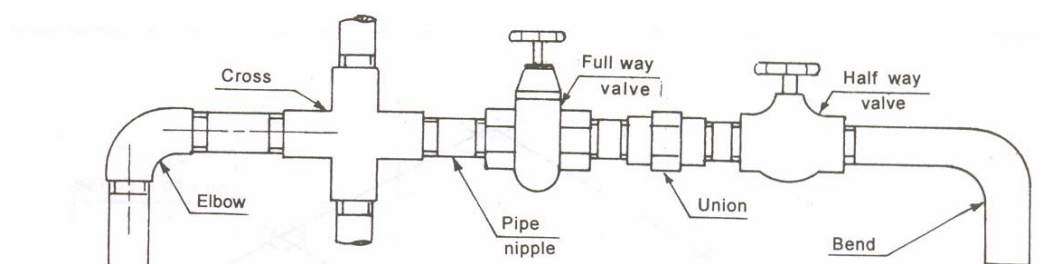
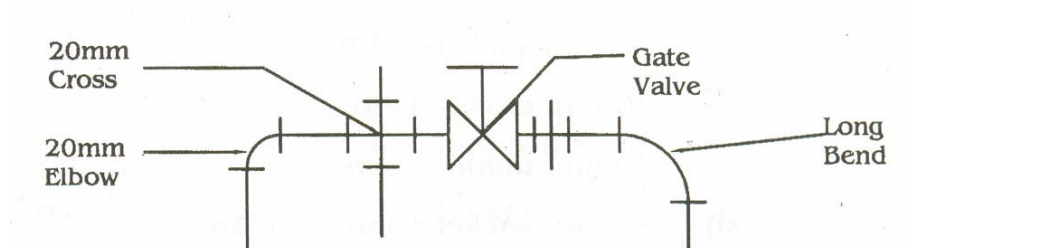


### PIPE LINE WITH ONE TURN

**SEQUENCE OF OPERATIONS:** Marking – Cutting – Threading – Fitting – Testing

#### PROCEDURE :

1. Mark the pipe to the required length as per given drawing
2. Hold the pipe by using pipe vice to do threading operation
3. Do the threading operation by using die stock
4. Fit the reduce , elbow and coupling as per given drawing
5. Test the pipe for any leakage by sending water.



### PIPE LINE WITH TWO TURNS

# LINE SKETCH OF PIPE SYSTEM FOR SINGLE STOREYED & MULTI STOREYED BUILDING

**AIM:** To know about the pipe system to be arranged in a single storeyed building and Multi storeyed building

**(I) WATER MAIN:** This is also called “street main” . This is a water supply pipe for public or community use and maintained by local or administrative authority.

**(II) SUPPLY PIPE:** The pipe which extends from the stop cock upto the boll cock or entrance of the storage tank if any , and subjected to water- pressure from the water main is called the supply pipe. This pipe is under control of the consumer.

**(III) SERVICE PIPE:** Any pipe used for conveying water from a water main to any building or premises and is subjected to water pressure from the water main is called service pipe.

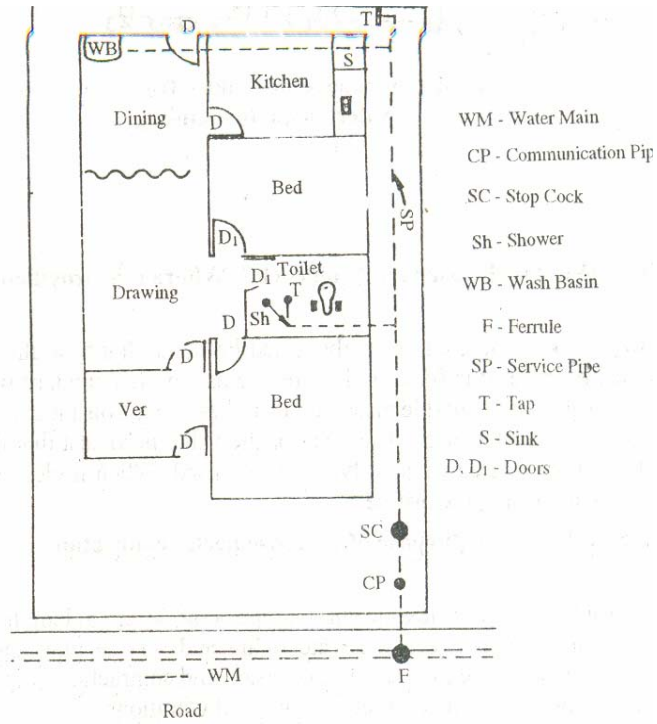
**(IV) DISTRIBUTION PIPE:** It is a pipe connecting the storage tank to the various sanitary fixtures , taps etc., for the purpose of distribution of water inside the building.

**(V) COMMUNICATION PIPE:** The part of the service pipe, extending from the water main up to and including the stop cork, which is under control of the authority is called communication pipe.

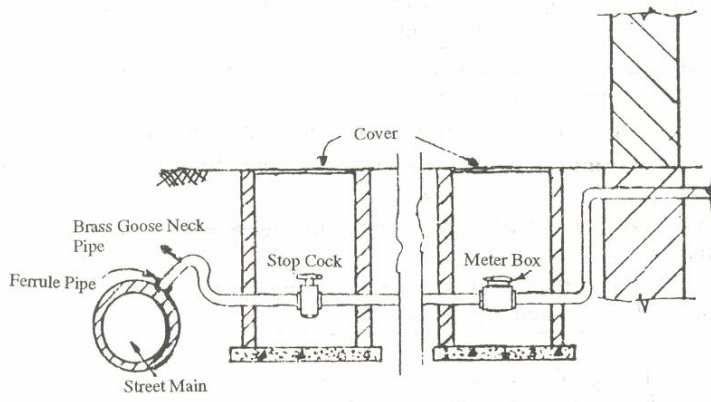
**(VI) STOP COCK:** It is a control valve fixed by the authority at the end of communication pipe. It is fixed in the street, close to the boundary wall in an accessible position in a suitable masonry chamber. It controls the supply to the building from the water main. The body of the valve is so cast that the water passes through an orifice when valve stem is raised. When it is closed, it rests against the seat, closing the orifice.

**(VII) FERRULE:** Ferrule is a right angled sleeve made of brass or gun metal. It is jointed to an opening drilled in the water main to which it is screwed down with a plug and then connected to a goose neck or communication pipe. The ferrule is usually of size varying from 10 to 50 mm diameter. For connections more than 50 mm bore, a tee-branch connection from the water main is adopted.

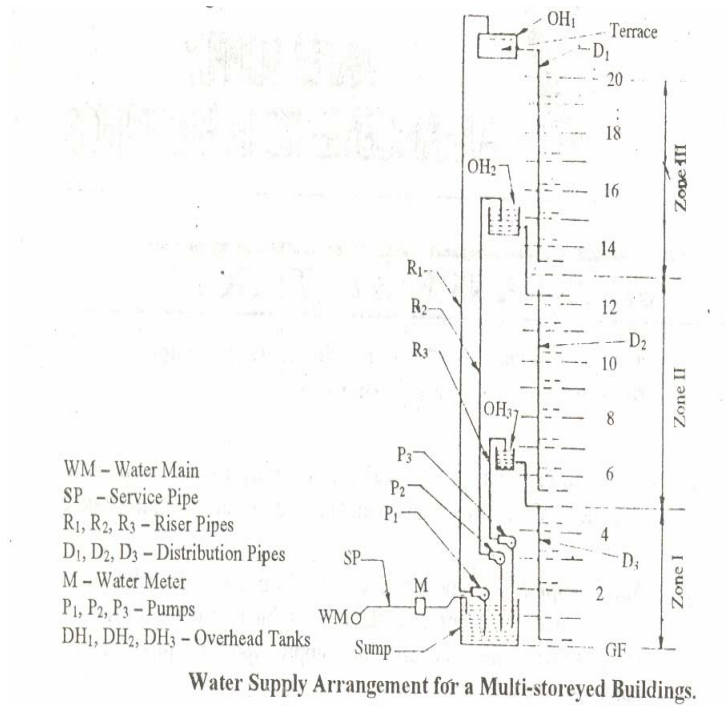
**(VIII) GOOSE NECK :** It is a flexible curved pipe about 75cm in length. It forms a flexible connection between the water main and service pipe and avoids stresses and strains on the joint due to expansion and contraction of the service pipes and also due to small earth movements and vibrations.



**LAYOUT OF A WATER SUPPLY IN A SINGLE STOREYED BUILDING**

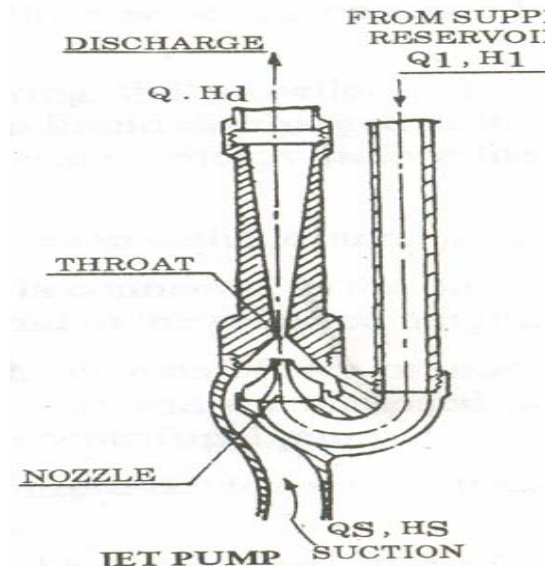
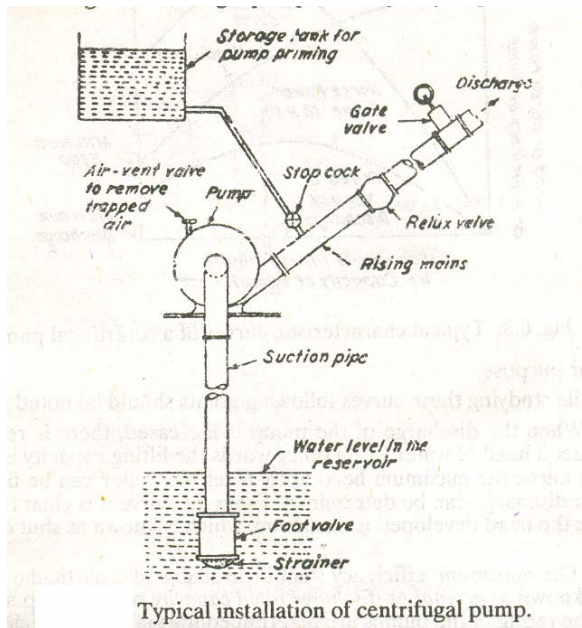


**Water connection taken from the water main to building**



# PIPE CONNECTIONS TO PUMPS

**AIM :** To know the different pipe connections to Centrifugal Pump and Jet Pump.



**SUCTION AND DELIVERY PIPES:** The pipe which connects the water sump or any under ground water source and the inlet of the pump is called the suction pipe because the negative pressure exist in it.

In order to avoid Cavitations , the negative pressure at the inlet to the pump is kept within limits. This restriction , limits the height of the suction pipe above the liquid level and keeps the losses as small as possible. For this purpose, suction pipe is often kept larger in diameter than the delivery pipe and bends should be avoided as for as possible.

The pipe which conveys the liquid from the outlet of the casing and discharges to the desired point is known as delivery pipe.

**FOOT-VALVE AND STRAINER:** The lower end of the suction pipe is provided with a foot valve and strainer which is immersed in the liquid and serves to prevent the liquid from flowing back into the sump when the pump is not working. A foot valve is a non-return valve which opens only in the upward direction. Strainer is provided to prevent large size impurities and debris to reach impeller of the pump which cause damage to it.

# TRACING LEAKAGES IN WATER SUPPLY CONNECTIONS AND THEIR REPAIRING

**AIM :** To know the methods of tracing leakages and repairing of leakages

## **DETECTION OF LEAKAGE :**

The leakages can be detected by the following methods.

### **1. DIRECT OBSERVATION :**

A wet soft spot, or green grass patch during drought, or formation of spring at odd places is an indication of Leakage.

### **2. SOUNDING ROD:**

The rod is kept touching the pipe and the ear is placed on top of rod to hear the sound produced by leakage. The sounds can be magnified by aqua phone or sonoscope . The rod is pulled up and observed whether the point is dry or moist or muddy. If it is moist or muddy, it indicates leakage.

### **3. BY PLOTTING HYDRAULIC GRADIENT:**

The pressure at various points of a suspected line are measured and plotted. Any kink or change of slope in hydraulic gradient indicates leakage.

### **4. BY WASTE DETECTING METERS:**

Generally Deacon's waste meter is used for this purpose. The rate of flow of water is automatically recorded on graph paper. Test is conducted during nights.

The supply of all other parts except that of suspected area is closed and water is allowed to flow into the above area. After this, all sub mains , branches etc. are shut-off gradually. At each shut-off the recorded flow through the meter will drop. The pipe having leakage will indicate a large and disproportionate drop in the recorded flow.

## **REPAIRS :**

Leaky taps and other fixtures should be rectified.

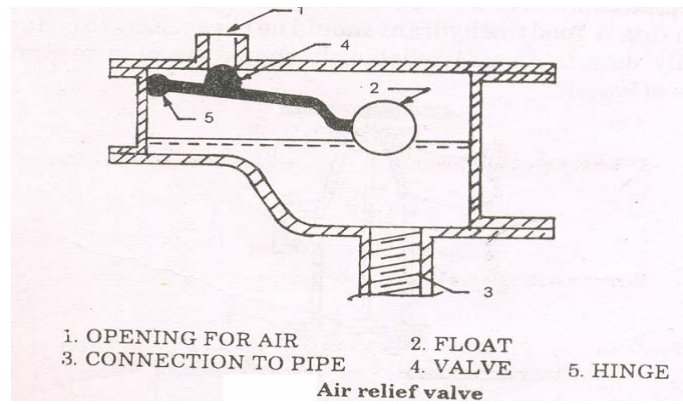
All the leaky joints should be repaired or reconstructed.

All the damaged pipes, and other fittings should be replaced.

## AIR RELIEF VALVES:

Sometimes air is accumulated at the summits of pipelines and blocks the flow of water due to air lock. In such cases the accumulated air has to be removed from the pipelines. This is done automatically by means of air relief valves.

This valve consists of a chamber in which one or two floats are placed and is connected to the pipeline. When there is flow under pressure in the pipeline, water occupies the float chamber and makes the float to close the outlet. But when there is accumulation of air in the pipeline, air enters the chamber, makes the float to come down thus opening the outlet. All the air thus accumulated is driven out through the outlet.



# OPERATION OF PUMPS

**AIM :** To know about operation of Centrifugal Pump and Jet Pump.

## **CENTRIFUGAL PUMP**

Before starting the centrifugal pumps usually they require priming. Priming is the process, of removing the trapped air from the pump and filling it completely with water. The centrifugal pumps which are installed below the water level do not require priming. While doing the priming of these pumps, the water from an outside tank (which is kept for this purpose only) is filled in the suction pipe and the pump fully. The trapped air is allowed to escape through the air-vent made for this purpose in these pumps. When the air has been removed completely water will start coming through the air-vent. Now the air-vent screw is tightened and the pump started.

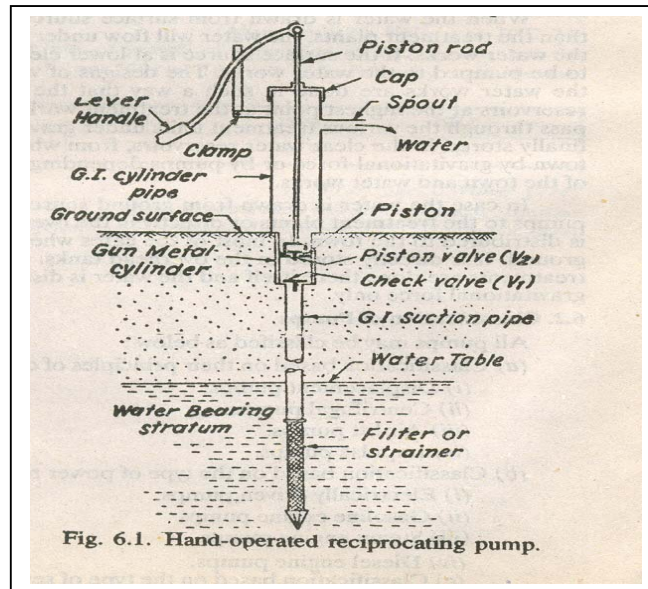
Sometimes just after starting the pump, air may enter through leaky joint or trapped inside the pump which could not be removed during priming comes in between and the flow of water is interrupted. Under such Conditions the pump is stopped and the priming is done again.

## **JET PUMP**

A jet pump is a simple device which uses high pressure water. Jet pump consists of a pipe having throat at its bottom. The upper end of the pipe leads to the required height. When the high pressure water is forced through the nozzle at the throat, it creates a suction pressure in the main pipe. Because of the pressure difference between the throat and the sump level, the water is lifted up. The lifted water after coming in contact with the high pressure jet is carried into the delivery pipe. The pumping continues till the supply of the high pressure water is maintained.

# PIPE CONNECTIONS TO A HAND PUMP IN A BORE WELL

**AIM :** To know about the different components of a Hand Pump



**GENERAL :** This is the simplest and cheapest type of pump which is widely used in the towns and villages of India., where the first water bearing stratum is within reasonable depth from the ground surface. In cities also these are provided in private houses and on roads for general public use., in case of failure of the water works supply.

It essentially consists of a strainer, suction pipe, gun metal cylinder, G.I. cylinder pipe, piston, piston rod and set of valves. In ordinary pumps instead of gunmetal cylinder, G.I. cylinder is used. But for longer life and more quantity of water, it is recommended to use the gunmetal cylinder.

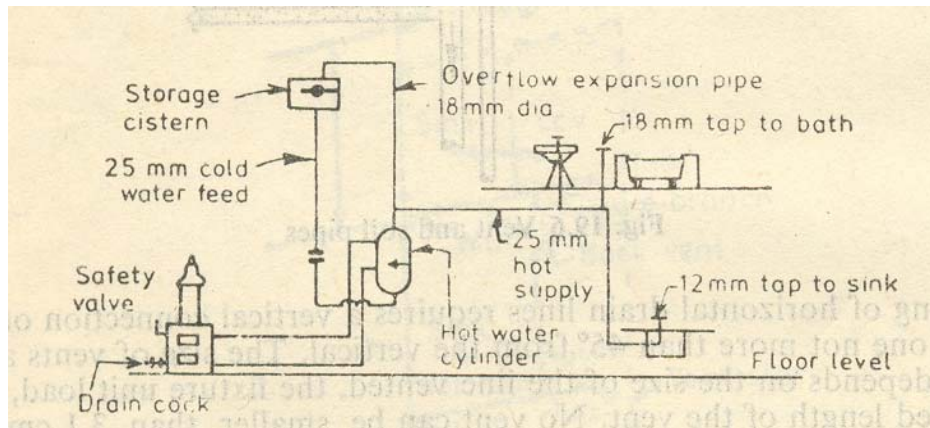
The piston or plunger moves up and down by means of handle as shown in figure. When the piston is raised up, vacuum gets created in cylinder below the piston, thereby opening the check valve  $V_1$  automatically closes up, valve  $V_2$  (piston valve) is opened and the water enters in the space above the piston. In this way with each upward stroke it moves up and starts flowing through the spout fixed for this purpose. This pump can give continuous supply of water which is sucked from the ground through strainer, which removes sand, clay and other impurities up to reasonable limit. These pumps are usually used when the water table is 6.0 m or so from the ground level.

# INSTALLATION OF ELECTRIC HEATERS

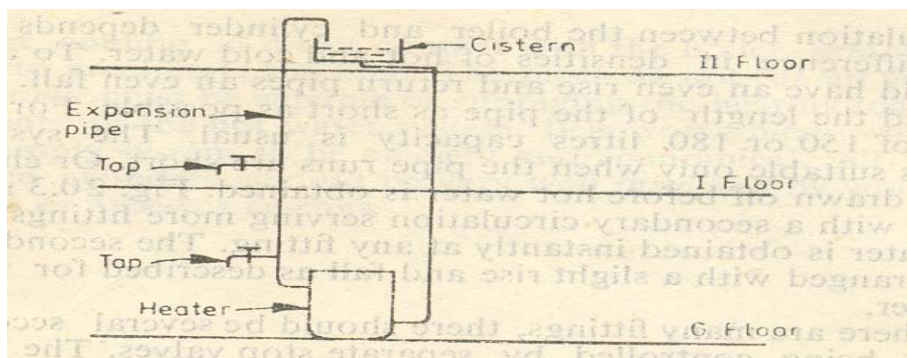
**AIM:** To know about the pipe connections to Electric Heaters

**GENERAL :** In a tropical country like India the requirement for hot water supply is not much. Hot water supply is required for hospitals, certain types of industries and lodging houses in hill stations. Water can be heated by gas, oil, electricity or solid fuel. Supply of gas through service pipes is not- widely available in our country. Hence, the heating of water by electricity and solid fuel is most common. A heater serving only one fitting is called a single point heater and that serving several fittings is called a multipoint heater .

An electric water heater usually consists of a well insulated storage tank or cylinder with an electric immersion heater placed in it and controlled by a thermostat. The immersion heater usually consists of a metal rod which is heated by an electric element and around which water circulates. It is necessary to insulate the storage tank carefully and prevent circulation in any associated pipe work. Such storage heaters are available either as single point heaters directly over the sink or wash basin, or as multipoint heaters to provide the whole hot water system for the house or as cistern type heaters which are especially useful in blocks of flats. When a large quantity of hot water is required, it is not economical to use electricity and it is preferable to use a solid fuel boiler system.



**HOT WATER SUPPLY**



**MULTI POINT ELECTRIC HEATER**