

GOVT. ENGINEERING COLLEGE, AJMER

LISTS OF EXPERIMENTS

ENVIRONMENTAL ENGINEERING LAB

1. To determine the **P^H** of the given sample of sewage.
2. To determine the **total solids** of a given sewage sample.
3. To determine the **total dissolved solids** of the given sewage sample.
4. To find out the **total settle-able solids** of the given sewage sample.
5. To determine **total suspended solids** of the given sewage sample.
6. To find out the quantity of **dissolved oxygen** present in the given water sample by Winkler's method.
7. To determine the **biochemical oxygen demand** exerted by the given waste water sample.
8. To find out the **chemical oxygen demand** of the waste water sample.
9. To study various sanitary fittings.

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EXPERIMENT-1

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

PRINCIPLE: Measurement of pH is one of the most important and frequently used in water chemistry. Practically, every phase of water supply and wastewater treatment, e.g. water softening, precipitation, coagulation, disinfection, acid-base neutralization is pH dependent.

At a given temperature the intensity of acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Alkalinity and acidity are the acid- and base- neutralizing capacities of water and usually are expressed as milligrams CaCO₃ per litre.

pH as defined by the Sorenson is $-\log [H^+]$, negative logarithm of hydrogen ion concentration. It is the intensity factor of acidity. Pure water is slightly ionized and at equilibrium the ion product is –

$$\begin{aligned} [H^+] [OH^-] &= k_w \\ &= 1.01 \times 10^{-14} \text{ at } 25^\circ\text{C} \dots\dots\dots(1) \\ \text{and } [H^+] &= [OH^-] \\ &= 1.005 \times 10^{-7} \end{aligned}$$

where $[H^+]$ = activity of hydrogen ions, moles/L
 $[OH^-]$ = activity of hydroxyl ions, moles/L and,
 k_w = ion product of power.

A logarithmic scale is convenient for expressing a wide range of ionic activities. Equation 1 in logarithmic form is

$$-\log_{10} [H^+] + (-)\log_{10} [OH^-] = 14 \dots\dots\dots(2)$$

or $pH + pOH = k_w$
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 k_w is constant for a given temperature. At 25°C, pH 7.0 is neutral, the activity of the hydrogen and hydroxyl ions are equal.

SAMPLE HANDLING AND PRESERVATION

The pH value obtained in the laboratory may not be the same as that of water at the time of collection of samples due to loss or absorption of gases, reaction with sediments, hydrolysis and

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oxidation or reduction taking place within the sample bottle. Therefore, the sample should be analyzed as soon as possible, preferably in the field at the time of sampling.

The pH value may be determined either electrometrically or colorimetrically. The electrometric is more accurate but requires special apparatus. The colorimetric method is simple and requires less expensive apparatus, and is sufficiently accurate for general work.

The basic principle of electrometric pH measurement is determination of activity of the hydrogen ions by potentiometer measurements using a glass or reference electrode. Contact between the test solution and electrode is achieved by means of a liquid junction. The electromotive force is measured with a pH meter that is high impedance voltmeter calibrated in terms of pH.

APPARATUS

The apparatus consists of a pH meter with glass and reference electrode with temperature compensation.

REAGENTS

Standard pH buffer solutions from available tables or known amount of chemicals may be used for the preparation:-

- a) Dissolved 3.814 gm of Sodium Borate (Borax) in distilled water and dilute to 1 litre. This corresponds to pH value of 9.18 at 25⁰C.
- b) Dissolved 10.12 gm of Potassium Hydrogen pellets in distilled water and dilute to 1 litre. This corresponds to pH value of 4.008 at 25⁰C.

PROCEDURE

1. Switch on the instrument and allow it to warm for some period.
2. Press the standby switch.
3. Connect the electrode across the BNC Socket.
4. Clean the electrode with distilled water.
5. Standardized the instrument, by dipping the electrode in pH 4.00 buffer (or any other standard buffer).
6. Check the electrode against at least one additional buffer of different pH value.
7. Measure the temperature of water and keep the temperature knob at on that temperature and % slope knob at 100 value.
8. Press pH switch against the display to the pH value of the buffer with CAL knob.

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9. Now the instrument is calibrated and is ready for measuring the pH of unknown solutions.

In the above operation, the slope of electrode is assumed to be 100% but slope may be sometimes different and it may be adjusted as given below:

1. Calibrate the instrument for any buffer solution (say pH 4.00)
2. Now, check the value of another standard buffer solutions (say pH 9.2) when slope is 100. If the value displayed differs, it needs adjustment.
3. Adjust the display with % slope control to value displayed + half the difference between the actual and exact value.
4. Now, again check for pH 4.0. If there is any difference, adjust with CAL knob.
5. Like this, above procedure is repeated till correct values are displayed.

The calorimetric method involves the use of different indicators by visual comparison for pH determination.

REAGENTS

Prepare the universal indicator by dissolving 0.05 gm of methyl orange, 0.15gm of methyl red, 0.3 gm of Bromothymol blue and 0.35gm of phenolphthalein in one litre of alcohol.

the color changes are:

pH	Color
Upto 3	Red
4	Orange Red
5	Orange
6	Yellow
	Yellowish
7	Green
8	Greenish Blue
9	Blue
10	Violet
11	Reddish Violet

Take the sample in glass tube and a few drops of Universal indicator in it. Mix it thoroughly and note the change in color. Compare the colour produced with the standard colour strips available.

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ENVIRONMENTAL SIGNIFICANCE

Significance of pH determination in waste water:

- (i) Determination of pH is one of the important objectives in biological treatment of the waste waters. 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 waste waters. In these circumstances the pH can be adjusted by addition of suitable acids or alkali to optimize the treatment of the waste water.
- (ii) Dewatering of sludges, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favourable 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.

COMMENTS

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EXPERIMENT -2

AIM: To determine the total solids of the given sample.

PRINCIPLE: 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. Desiccators
4. Water bath

PROCEDURE:

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

CALCULATION:

$$(A - B) \times 1000$$

$$\text{Total solids (mg/l)} = \frac{\text{-----}}{V}$$

A = Final weight of the dish in mg.

B = Initial weight of the dish in mg.

V = Volume of sample taken in ml.

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OBSERVATION AND RESULTS:

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

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 may 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 extent upon the total solids present as well as the alkalinity and temperature.

COMMENTS:

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EXPERIMENT- 3

AIM- To find out *Total dissolved solids* of the given sample

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

APPARATUS:

1. Evaporating Dishes (Pyrex, porcelain or platinum)
2. Oven
3. Desiccators
4. Whatman filter paper No. 44
5. Water bath

PROCEDURE:

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

CALCULATION

$$\text{dissolved solids (mg/l)} = \frac{(A - B) \times 1000 \text{ Total}}{V}$$

A = Final weight of the dish in mg.

B = Initial weight of the dish in mg.

V = Volume of sample taken in ml.

OBSERVATION AND RESULTS:

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

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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 dissolved determination is useful for the sewage to find its suitability for agriculture purpose.

COMMENTS:

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EXPERIMENT-4

AIM- To find out *Total Settle-able Solids* of the given sample.

PRINCIPLE: 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 settle-able solids per litre of sample per hour.

CALCULATION:

$$\text{Settle-able Solids (ml/l)} = \frac{\text{ml of solids} \times 1000 \text{ Total}}{\text{ml of sample}}$$

OBSERVATION AND RESULTS:

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

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APPLICATION OF TOTAL SETTLE-ABLE SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. The settle-able 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.

COMMENTS:

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EXPERIMENT-5

AIM: To determine *Total Suspended Solids* of the given sample.

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

APPARATUS:

1. Gooch crucible / glass fibre filter
2. Suction apparatus
3. Desiccators

PROCEDURE:

1. A clean gooch crucible is ignited in a muffle furnace and after partial cooling in the air, cools in a desiccator and weigh (W_1).
2. Pour 100 ml of well mixed sample on gooch crucible or glass fibre filter which is kept on filter flask and apply suction.
3. Wash the gooch crucible with 100 ml of distilled water to remove all soluble salts.
4. Carefully remove the glass fibre filter paper or gooch crucible and dry in an oven at 105°C for one hour.
5. Cool in a desiccator and weigh (W_2).
6. Ignite gooch crucible in a muffle furnace at 600°C for 15-20 minutes.
7. Cool the crucible partially in air until most of heat has been dissipated and then in a desiccator and record final weight (W_3).

CALCULATION:

$$\text{Total Suspended Solids (mg/l)} = \frac{(W_2 - W_1) \times 1000}{\text{ml of sample taken}}$$

$$\text{Total Volatile Solids (mg/l)} = \frac{(W_2 - W_3) \times 1000}{\text{ml of sample taken}}$$

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OBSERVATION AND RESULTS:

Sample Detail	Volume of sample taken (ml)	Empty weight of gooch (mg)	weight of crucible	Final weight of gooch crucible (mg)	Solids(mg/l)
Total Suspended Solids					
Volatile 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.

COMMENTS:

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EXPERIMENT – 6

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

PRINCIPLE: 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 $\text{Na}_2\text{S}_2\text{O}_3(0.25\text{N})$, using starch as an indicator. If oxygen absent in sample, the MnSO_4 react with the alkali to form white precipitate $\text{Mn}(\text{OH})_2$.

APPARATUS:

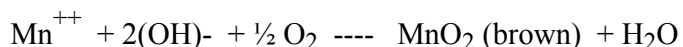
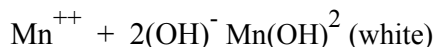
1. BOD bottles (capacity 300ml)
2. Sampling device for collection of samples
3. Burette
4. Pipettes

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. Take the BOD bottle and collect 300 ml of water sample into it.
2. Add 2 ml of manganous sulphate and 2 ml of alkali iodide-azide solution to the BOD bottle. The tip of the pipette should be below the liquid level, while adding these reagents.
3. Restopper with care to exclude air bubbles and mix by repeatedly inverting the bottle 2 to 3 times.
4. If no oxygen is present, the manganous ion reacts with hydroxide ion to form white precipitate of $\text{Mn}(\text{OH})_2$. If oxygen is present, some Mn^{++} is oxidized to M^{++} and precipitates as a brown colored manganic oxide.



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5. After shaking and allowing sufficient time for all oxygen to react, the chemical precipitates are allowed to settle leaving clear liquid with in the upper portion.
6. 2 ml of concentrated sulphuric acid is added.
7. The bottle is restoppered and mixed by inverting until yellow color is uniform throughout the bottle.



8. A volume of *203 ml is taken into the conical flask and titrate with 0.025 N sodium thiosulphate solution until yellow coloured iodine turns to a pale straw color.
9. Since it is impossible to accurately titrate the sample to a colourless liquid, 1 to 2 ml of starch solution is added.
10. Continue titration to the first disappearance of the blue color.

$$\frac{*200 \times 300}{(300 - 4)} = 203 \text{ ml.}$$

CALCULATIONS:

1 ml of 0.025N $\text{Na}_2\text{S}_2\text{O}_3$ is equivalent to 0.2 mg of O_2 ,
since the volume of the sample is 200 ml.

1 ml of sodium thiosulphate is equivalent to

$$\frac{0.2 \times 1000}{\text{ml}} = 1 \text{ mg/l.}$$

OBSERVATION AND RESULTS:

Sample details	Temp. of sample °C	Volume of sample taken ml	Initial burette reading ml	Final burette reading ml	ml. of $\text{Na}_2\text{S}_2\text{O}_3$ Solution used	D.O. in mg/l

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ENVIRONMENTAL SIGNIFICANCE:

1. Oxygen is poorly soluble in water. It's solubility is about 14.6 mg/l for pure water at 0°C under normal atmospheric pressure and it drops to 7mg/l at 35°C. Aerobic bacteria thrive when free oxygen is available in plenty. Aerobic conditions do prevail when sufficient D.O. is available within water. End products of aerobiosis are stable and not foul smelling.
2. While a minimum D.O. of 4 to 5 mg/l is desirable for the survival of aquatic life, higher value of D.O. may cause corrosion of iron and steel.
3. Higher temperature, biological impurities, ammonia, nitrates, ferrous iron, chemicals such as hydrogen sulphide and organic matter reduce D.O. value.
4. Algae growth in water may release oxygen during its photosynthesis and D.O. may even shoot up to 30 mg/l.
5. Drinking water should be rich in D.O. for good taste.

APPLICATION OF DISSOLVED OXYGEN DATA IN ENVIRONMENTAL ENGINEERING:

1. It is necessary to know D.O. levels to assess quality of raw water and to keep a check on stream pollution.
2. D.O. test is the basis for BOD test which is an important parameter to evaluate organic pollution potential of waste.
3. D.O. test is necessary for all aerobic biological waste water treatment processes to control the rate of aeration.
4. Oxygen is an important factor in the corrosion of iron and steel. D.O. test is used to control oxygen in boiler feed waters.
5. D.O. test is used to evaluate the pollution strength of domestic and industrial wastes.
6. Determination of D.O. in waste water is useful to identify the nature of biochemical reactions – whether aerobic which gives out stable end products (H₂O and CO₂) and do

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not produce any foul smells or anaerobic whose end products are unstable and produce foul smells(H₂S).

COMMENTS:

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EXPERIMENT-7

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

PRINCIPLE:

The complete oxidation of organic matter takes about 2-3 months but within 10 days nearly 90% biological oxygen demand is satisfied after which the rate of depletion of oxygen is very slow. In laboratory usually 5-day BOD is tested within which 70% BOD is satisfied.

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.



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.

REAGENTS:

1. Distilled water
2. Phosphate buffer solution
3. Magnesium Sulphate solution
4. Calcium Chloride solution
5. Ferric chloride solution
6. Sodium thiosulphate solution

PROCEDURE:

1. Place the desired volume of distilled water in a 5 litre flask. Aeration is done by bubbling compressed air through water.
2. Add 1 ml of phosphate buffer, 1 ml of magnesium sulphate solution, 1 ml of calcium chloride solution and 1 ml of ferric chloride solution for every litre of distilled water (dilution water).
3. In case of the waste waters which are not expected to have sufficient bacterial population, add seed to the dilution water. Generally, 2 ml of settle sewage is sufficient for 1000 ml of

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dilution water.

- Highly acidic or alkaline samples are to be neutralized to a pH of 7.
- Add 2 or 3 ml of sodium thiosulphate solution to destroy residual chlorine if any.
- Take the sample as follows:
Strong waters : 0.1, 0.5, or 1%
Settle domestic sewage : 1, 2.5, or 5%
Treated effluents : 5, 12.5, or 25%
River water : 25% to 100%
- Dilute the sample with the distilled water and mix the contents well.
- Take dilute sample into 2 BOD bottles.
- Fill another two BOD Bottles with diluted (distilled) water alone.
- Immediately find D.O. of a diluted waste water and diluted water (distilled water).
- Incubate the other two BOD bottles at 20⁰C for 5 days. They are to be tightly stoppered to prevent any air entry into the bottles.
- Determine D.O. content in the incubated bottles at the end of 5 days (120 hours).

CALCULATIONS:

Let initial D.O. of distilled sample	= D ₀
D.O. at the end of 5 days for the diluted sample	= D ₅
Initial D.O. of distilled water (blank)	= C ₀
D.O. at the end of 5 days for the distilled water (blank)	= C ₅
D.O. depletion of dilution water	= C ₀ -C ₅
D.O. Depletion of the diluted water	= D ₀ -D ₅
D.O. depletion due to microbes	= (D ₀ -D ₅)-(C ₀ -C ₅)

OBSERVATION AND RESULTS:

Sl. No.	Volume of sample (ml)	Dilution ratio	Initial D.O. of sample mg/l	Final D.O. of sample mg/l	Initial D.O. of Blank mg/l	Final D.O. of Blank mg/l	5 days BOD at 20 ⁰ C (mg/l)

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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 influent 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 discharged into natural bodies of water should have BOD less than 30 mg/l. This is important parameter to assess the pollution of surface waters and ground waters where contamination occurred due to disposal of domestic and industrial effluents. Drinking water usually has a BOD of less than 1 mg/l and water is considered fairly upto 3 mg/l of BOD. But when the BOD value reaches 5 mg/l the water is doubtful in purity.

APPLICATION OF BOD DATA IN ENVIRONMENTAL PRACTICE:

1. To determine strength of domestic and industrial sewage.
2. The determination of BOD is used in studies to measure the self purification capacity of streams and serves regulatory authorities as a means of checking on the quality of effluents discharged to such waters.
3. BOD of wastes is useful in the design of treatment facilities.
4. It is a factor in the choice of treatment method and is used to determine the size of certain units, particularly trickling filters and activated sludge units.

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5. It is useful to estimate population equivalent of any industrial wastes which is useful to collect cess from industrialists for purification of industrial wastes in municipal sewage treatment plant.
6. It is used to evaluate the efficiency of various treatment units.
7. It is only the parameter to give an idea of the biodegradability of any sample and self purification capacity of rivers and streams.

COMMENTS:

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EXPERIMENT-8

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

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

APPARATUS:

1. Reflux apparatus
2. Hot plate/heating mantle
3. Burette

REAGENTS:

1. Standard potassium dichromate 0.25 N
2. Sulphuric acid with reagent (Conc. $H_2SO_4 + Ag_2SO_4$)
3. Standard ferrous ammonium sulphate 0.1 N
4. Ferroin indicator
5. Mercuric sulphate

PROCEDURE:

1. Place 0.4 gm of $HgSO_4$ 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 beads.
4. Add slowly 30 ml of H_2SO_4 containing Ag_2SO_4 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 $K_2Cr_2O_7$ with 0.1 $Fe(NH_4)_2SO_4$ using ferroin indicator. Sharp color change from

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blue green to wine-red indicates the end point.

9. Reflux the blank in the same manner using distilled water instead of sample.

CALCULATIONS:

Quantity of $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)$ added for blank = A ml.

Quantity of $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)$ added for the sample = B ml.

$$\text{COD} = \frac{(\text{A}-\text{B}) \times \text{Normality } \text{Fe}(\text{NH}_4)_2(\text{SO}_4) \times 8 \times 1000}{\text{quantity of sample (ml)}}$$

OBSERVATION AND RESULTS:

Sl. No.	Sample details	Vol. Of Sample taken ml	Initial burette reading ml	Final burette reading ml	Vol. Of $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$ added ml	COD of the sample mg/l

ENVIRONMENTAL SIGNIFICANCE:

BOD test has the following disadvantages:

- 1 BOD can not be determined accurately when toxins are present and conditions are unfavorable for the growth of microbes.
- 2 BOD test consumes more time i.e. a minimum of 5 days, whereas COD test is relatively faster test taking only 3 hours for completion

Drawbacks of COD test are:

1. It is going to oxidize all the organic matter i.e. both readily degradable and which is relatively biological resistant organic matter as lignin and detergents. Also it includes the oxygen consumed by inorganic matter as nitrites and sulphides. Hence to differentiate biodegradable organic matter from biologically resistant compounds is difficult.

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2. Rate of biological oxidation can not be determined by COD test. Thus COD for any waste shall be higher than its corresponding BOD value. A BOD value close to COD indicates that the waste is highly biodegradable.

APPLICATION OF COD DATA IN ENVIRONMENTAL PRACTICE:

1. The COD test is used extensively in the analysis of industrial waste
2. It is particularly valuable in surveys designed to determine and control losses to sewer systems.
3. The test is widely used in the place of BOD in the operation of treatment facilities because of the speed with which the results can be obtained.
4. It is useful to assess strength of wastes which contains toxins and biologically resistant organic substances.
5. The ratio of BOD to COD is useful to assess the amenability of waste for biological treatment. Ratio of BOD to COD greater than or equal to 0.8 indicates that waste waters are highly amenable to the biological treatment.

COMMENTS :

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EXPERIMENT – 9

AIM : To study different types of *water supply and Sanitary Fittings*.

1. TRAP:

Trap may be defined as a fitting placed at the ends of the soil pipes or the sullage pipe to prevent the passes of foul gases from the pipes to the outside.

Depending upon their shapes, the traps may be:

- (i) P-trap
- (ii) Q-trap
- (iii) S-trap
- (iv) Intercepting trap
- (v) Nahani trap

Out of the above three types of traps are shown here. A trap essentially consists of a U-tube, which retains water, acting as a seal between foul gases inside the pipes and the outside atmosphere. They are largely used for bathrooms, sinks and lavatories. In all such needs, they are made with enlarged mouth, so that the waste pipe may be thoroughly flushed out.

2. NIPPLE:

This is used for connecting the piece of pipe. The nipple is a smaller piece than the full length. Nipple are used to connect the sockets, elbows, enlarger and reducers, end plugs and union socket etc. They are designated as 20mm, 25mm or so G.I. (galvanized iron) nipple.

3. REDUCER:

It is used to join the pipes of different diameter. When a large size pipe is to be joined to small size pipe, reducers are used. They are designated as 25mm X 20mm G.I. reducer.

4. TEE:

Tees are used to bifurcate the flow. The bifurcation may be to the same size pipe or different size. The tee is used in the main line for the connection of the branch line. . The tee is always perpendicular the main line. They are designated as 25mm X 25mm X 25mm or 25mm X 25mm X 20mm or so.

5. END PLUG:

It is used at the end of pipelines to stop the flow. It may be internal or external threaded depending upon the use.

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6. ELBOW:

This is used to change the direction of pipe line at right angle. The size of the elbow is small. Whenever a sharp turn is required for example besides the corners of a building elbows are used though, there is larger head loss compared to the bends.

7. BEND:

The bend is used to change the direction of the line in any direction generally to the right angle. The size of the bend is larger than the elbow and there is a smooth transaction of flow so the head loss is lesser. It requires more space to be accommodated and is costlier than the elbow.

8. SOCKET:

The socket is a small piece of G.I. pipe to connect the two similar diameter pipe lengths. It is generally internally threaded. A special type of socket is known as union socket which had two detachable collars by which it can be unthreaded without disturbing the whole assembly

9. SOCKET & SPIGOT JOINT:

This type of joint is used to join the same diameter pipe lines for the proper joining of two pipes cement mortar or the lead is used and it is also used to prevent the leakage.

10. C.I. DETACHABLE JOINTS:

These types of joints are very much useful in connecting A. C. or mild steel etc pipes. They can be easily repaired or replaced.

11. STONE WARE or SALT GLAZED PIPES:

These pipes are widely used for carrying sewage in the house connection as well as lateral sewers. They are available in various sizes of 5cm increments from 10 to 30 cm and 7.5cm increments from 30 to 90cm. Their length is generally 75cm only.

These pipes are manufactured from clay and shales of special quality, which are first pulverised and mixed with water and salt glazing is done during baking at high temperature.

ADVANTAGES OF PIPES:

- i. These pipes are highly resistant to sulphide corrosion.
- ii. They are hydraulically very efficient.
- iii. They are quite strong in compression.
- iv. These pipes are highly impervious and do not allow any sewage to seep out of them.
- v. These pipes are quite cheap, durable, easily available and can be easily laid and jointed.

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