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Estd.:2001
Balaji Institute of Technology & Science
Laknepally (V), Narsampet (M), Warangal District - 506 331, Telangana State, India
(AUTONOMOUS)
Accredited by NBA (UG - CE, ME, ECE & CSE) & NAAC A+ Grade
(Affiliated to JNT University, Hyderabad and Approved by AICTE, New Delhi)
BITS AUTONOMOUS
www.bitswgl.ac.in, email: principal@bitswgl.ac.in, Ph:98660 50044, Fax: 08718-230521

ENGINEERINGCHEMISTRY LAB MANUAL

Course Code : **22CH102BS**
Regulations : **R22**
Class : **B.Tech**
Branch : **CE/EEE/ME/ECE/CSE/CSW/CSM/CSO**

Preparedby
Rizwana Farheen
Assistant Professor in Chemistry,
DepartmentofHumanitiesandSciences

VisionofDepartment

ToestablishacentreofexcellenceinbasicsciencessuchasMathematics,Physics,Chemistry & Environmental Sciences that provides foundation for engineering studies and also in EnglishLanguageCommunicationSkillsthathelpsstudentstoexpressthemselveseffectively and to create engineers with proficiency inengineering fundamentals – experimental, analytical, computational and designing abilities.

MissionofDepartment

M1:TocreateacademicexcellenceinfundamentalsciencesandcommunicationskillsfortheStudents.

M2:Toencourageadvancedteachinglearningprocess,qualitybasedknowledgeandQualityresearchat individual, department and institutional level.

M3:Toimpartpersonalitydevelopmentskillstostudentsthatwillhelpthemtosucceedandlead.

CourseObjectives

- To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
- To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it’s control to protect the structures.
- To imbibe the basic concepts of petroleum and its products
- To acquire required knowledge about engineering materials like cement, smart materials and Lubricants.

ProgramOutcomes	
PO1:	**Engineeringknowledge**:Applytheknowledgeofmathematics,science,engineering fundamentals,andanengineeringspecializationtothesolutionofcomplexengineering problems.
PO2:	**Problemanalysis**:Identify,formulate,reviewresearchliterature,andanalyzecomplex engineeringproblemsreachingsubstantiatedconclusionsusingfirstprinciplesof mathematics,naturalsciences,andengineeringsciences.
PO3:	**Design/developmentofsolutions**:Designsolutionsforcomplexengineeringproblemsand design system components or processes that meet the specified needs with appropriateconsiderationforthepublichealthandsafety,andthecultural,societal,and environmentalconsiderations.
PO4:	**Conductinvestigationsofcomplexproblems**:Useresearch-basedknowledge and researchmethodsincludingdesignofexperiments,analysisand interpretationofdata, andsynthesisoftheinformationtoprovidevalidconclusions.
PO5:	**Moderntoolusage**:Create,select,andapplyappropriatetechniques,resources,andmodern engineeringandITtoolsincludingpredictionandmodelingtocomplex engineeringactivitieswithanunderstandingofthelimitations.
PO6:	**Theengineerandsociety**:Applyreasoninginformedbythecontextualknowledgetoassess societal,health,safety,legalandculturalissuesandtheconsequent responsibilitiesrelevanttotheprofessionalengineeringpractice.
PO7:	**Environmentandsustainability**:Understandtheimpactoftheprofessional engineeringsolutionsinsocietalandenvironmentalcontexts,anddemonstratethe knowledgeof,andneed forsustainabledevelopment.
PO8:	**Ethics**:Applyethicalprinciplesandcommittoprofessionalethicsandresponsibilities andnormsoftheengineeringpractice.
PO9:	**Individualandteamwork**:Functioneffectivelyasanindividual,andasamemberorleaderin diverse teams, and in multidisciplinary settings.
PO10:	**Communication**:Communicateeffectivelyoncomplexengineeringactivitieswiththe engineeringcommunityandwithsocietyat large, suchas, beingabletocomprehendand writeeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgive andreceiveclearinstructions.
PO11:	**Projectmanagementandfinance**:Demonstrateknowledgeandunderstandingofthe engineering and management principles and apply these to one's own work, as a memberandleader inateam,tomanageprojectsandinmultidisciplinaryenvironments.
PO12:	**Life-longlearning**:Recognizetheneedfor, andhavethepreparationandabilityto engageinindependentandlife-longlearninginthebroadestcontextoftechnological change.

CourseOutcomes	
CO1:	Understand Water treatment, specifically hardness of water and purification of water by various methods..
CO2:	Determine the con**ductometry**, **potentiometry**, and **pH metry** & the concentrations or equivalence points of acids and bases would generally focus on building the students' understanding of these analytical techniques and their practical applications.
CO3:	Understanding Thermoplastics & the properties and characteristics of **thermoplastics**, with a focus on **Nylon 6**, including its flexibility, mold ability, and recyclability. Students will learn about the characteristics and properties of thermosetting plastics, particularly **Bakelite**.
CO4:	Estimation of physical properties like **viscosity** and **acid value** of oil samples. Students will understand the concept of **viscosity** as a measure of a fluid's resistance to flow, and how it relates to the internal friction of the oil.
CO5:	Illustrating the construction of **fuel cells**, **solar cells**, and **smart materials** focus on equipping students with both theoretical knowledge and practical skills to understand and design these advanced materials and technologies.

ATTAINMENTOFCOURSEOUTCOMES&PROGRAMOUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	3	--	3	-	3	3	-	-
CO2	2	-	-	-	3	-	-	--	3	3	-	-
CO3	3	-	-	-	3	-	2	-	3	3	-	-
CO4	3	-	-	-	3	-	-	-	3	3	-	-
CO5	3	-	-	-	3	-	2	-	3	3	-	-
Average	2.6	2	-	-	3	-	2.3	-	3	3	-	-

1=Slite(Low) **2=Moderate(Medium)** **3=Substantial(High)**

BALAJIGROUPOFINSTITUTION
LAKNEPALLY,NARSAMPET,WARANGAL

CERTIFICATE

NameoftheLaboratory……………………………………………………………………………………

Thisistocertifythat,thisisabonafiedrecordoflaboratory experimentalworkdoneby… bearingHall TicketNumber… ………………………………………………………………………. B.Tech/MBA/MCA ………………………………………………………..Semester student inthe department of……………………….ofthiscollegeduringtheyear……………………………………

(Signatureoftheconcernedteacher) APPROVED/ NOT

APPROVED

External Examiner *InternalExaminer*

Department of…………………………………………………..

INDEX

GENERAL PRECAUTIONS FOR AVOIDING ACCIDENTS IN A CHEMISTRY LABORATORY

- Use full length protective coat/an apron.
- Wear safety goggles for preventing eye injuries by splashing of chemicals.
- A pair of gloves must be used when handling poisonous or toxic chemicals.
- A rubber bulb should be used for pipetting solutions.
- Before leaving the laboratory, wash and clean every apparatus, wipe the table and keep all the apparatus in its original position.
- Laboratory must be kept clean and tidy at all times.
- Each laboratory must be equipped with first aid box.
- Strongacidsusedforconductingexperimentsshouldbedilutedbeforebeingpouredintothe sink.
- When the burner is not being used, lower the flame.As soon as the days work is over close the gas tap.
- Never handle chemicals with your finger .Always use fresh ,clean spatula.
- Never try to lift the glass bottle holding the neck alone.
- Don’teat, drinkinthelaboratory.
- Do not throw solid wastes or filter paper or other wastes into the sink.

LABSAFETYRULES

- **ALWAYS** wear your apron or protective clothing when working with chemicals.
- **ALWAYS** tie back loose hair.
- **ALWAYS**weargogglesorsafetyglassestopreventgettingmaterialsinyoureyes.
- **ALWAYS** read the labels an heed all warnings.
- **NEVER** eat, drink of smell the chemicals .Rathercarefully“fan”thefumestoyournose.
- **NEVER**lookdirectlyintoatesttubeorflask.Lookatthecontentsfromtheside.
- **NEVER** play around during experiments.
- **ALWAYS** wash your hands after handling labmaterials.

VOLUMETRICANALYSIS

BASICCONCEPTSOFVOLUMETRICANALYSIS

Chemical analysis of the compounds is carried out in two ways

1. **Qualitative analysis.**
2. **Quantitative analysis.**

Qualitative analysis shows what element a given contains.

Quantitiesanalysisdeterminesthequantityofaparticularcomponentpresentinsubstance.Itis carried out in two ways

1. **Gravimetric analysis.**
2. **Volumetric analysis.**

Gravimetric analysis involves the estimation of the amount of a given compound from the results of weighing.

Volumetricanalysisisbasedonthemeasuringthevolumeofthesolutionofasubstance.Terms involved in volumetric analysis

1. **Titration:** Theprocessoffindingoutthevolumeofoneofthesolutionrequiredtoreact completely with a definite volume of one the other solution of known concentration is called titration.
2. **Titrant:** The solution of known strength is called titrant.
3. **Titrate:** The solution whose concentration to be estimated.
4. **Indicator:** The reagentwhichindicatestheendpointorequivalentpointofthetitration.The strength of concentration of a solution is expressed in the following ways.

NORMALITY: Number of gram equivalents of the substance dissolved per liter of the solution is called Normality. It is denoted by N

Normality=Wsolute/Esolute×1/Solvent (in lit)

Where E is Gram equivalent weight

MOLARITY: Number of grams moles of a solute dissolved perliterofsolutioniscalledMolarity.Itis denoted by M

Morality=Wsolute/Msolute×1/V solvent(inlit)

Where M is Gram molecular weight

MOLALITY: It is the number of mole ofthesubstancedissolvedin1kgofthesolventitisdenotedby(m).

Molality=W solute/Msolute×1/W solvent(in kg)

Standard Solution:

A solution whose concentration is known is called a standard solution. Again there are two types of standard solutions depending on the nature of the substance.

1. Primary Standard Substances:

Any substance stable, pure, readily soluble in water, with high equivalent weight and the composition of its solution should not change on standing or during storage is called primary standard substance.

For example crystalline oxalic acid, potassium dichromate and anhydrous sodium carbonate etc. are the primary standard substances.

2. Secondary Standard Substances:

The substance which do not fulfill the above mentioned requirements of primary standard substances, their solutions are not directly prepared by weighing and the exact strength of the solution is found by titrating it against some primary standard is called secondary standard substance and the process is called standardization.

Common secondary standard substances are NaOH, KOH which are hygroscopic, $KMnO_4$ which undergoes auto decomposition in permanganate solution on standing and inorganic acids like HCI, H_2SO_4 whose concentrations are known approximately.

Types of Titrations

Depending on the nature of chemical reaction involved, the volumetric titrations are classified into the following types.

1. **Acid Base Titrations**
2. **Oxidation-Reduction Titrations (Redox Titrations)**
3. **Complexometric Titrations**
4. **Precipitation titrations.**

1. **Acid Base Titrations:** Acid-base titrations, in which an acidic or basic titrant reacts with an analyte that is a base or an acid.
2. **Oxidation-Reduction Titrations (Redox Titrations):** The titrations in which reducting agent is titrated against an oxidizing agent and vice versa are called redox titrations
3. **Complexometric Titrations:** The titrations involving the formation of a stable soluble complex between the metal and the complexing reagent. The metal ion is called central atom and the complexing reagent is called ligand.
4. **Precipitation titrations:** Precipitation titrations, in which the analyte and titrant react to form a precipitate.

DETERMINATIONOFTOTALHARDNESSOFWATERBYCOMPLEXOMETRIC METHOD USING EDTA

Aim: Toestimatethehardnessofthegivenwatersamplebycomplexometricmethodusing EDTA.

InstrumentsandApparatus: Burette,pipette,conicalflask,standardflaskandburettestand.

Chemicals required: Magnesium Sulphate Heptahydrate ($MgSO_4.7H_2O$), Ethylene Diamine Tetra Acetic Acid (EDTA), Eriochrome Black T (EBT) indicator, Ammonia buffer solution, hard water and distilled water.

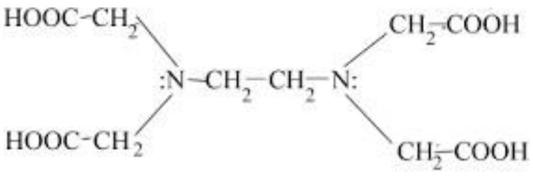
Principle: Hard water which contains Calcium and magnesium ions forms awine red coloured complex with the Eriochrome Black-T indicator. EDTA forms a colourless stable complex with free metal ions like Ca^{2+} and Mg^{2+}.

Metal+Indicator ------------→MetalIndicatorcomplex
(Blue) (Wineredcolour)

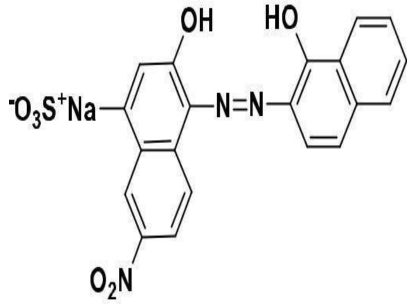
When EDTA is added from the burette, it extracts the metal ions from the metal ion-indicator complex thereby releasing the free indicator (The stability of metal ion-indicator complex is lessthan that of the metal ion-EDTAcomplex, and hence EDTAextractsmetal ion form the ion- indicator complex).

EDTA+Metalindicatorcomplex------→Metalion–EDTA+Indicator(Wine red colour) (Blue)

ThereactiontakeplaceatapH=10andthebufferismadebyAmmoniumchlorideandAmmoniasolution.



structure of EDTA



StructureofEBT

Procedure

PreparationofStandard$MgSO4.7H_2O$solution(0.05N):
Weight accurately 0.6162 g of Magnesium Sulphate and transfer it in to a clean 100 ml volumetric flask with the help of funnel, dissolved this crystal in minimum amount of distilled water and then madeuptothemarkwithdistilledwater.Itisshakenwelltogetuniformconcentrationandcalculate the normality of the prepared Standard MgSO4 solution.

NormalityofStandard$MgSO_4.7H_2O$solution=0.05NW=

weight of $MgSO_4.7H_2O$ = ?

246.48=Molecularweightof$MgSO_4.7H_2O$

123.24=Equivalentweightof$MgSO_4.7H_2O$

Normality=□□□□□□–x□–
□□.□□.□□ □

Weight=NormalityxGr.Eq.wtx□–
□

TitrationI: Standardisation of EDTA Solution
Pipetteout 20 ml magnesium sulphate solution in to a clean conical flask. To this add 2ml of buffer solution and 3 to 4 drops of EBT indicator. Then there develops a wine red colour. This solution is titrated against EDTA solution taken in the burette. The end point in this reaction is conversion of wine red colour into blue. Repeat the titrations till concurrent values are obtained. The normalityof EDTA is calculated.

S.No.	VolumeofStandard $MgSO_4(V_1)$ (ml)	Burettereading(ml)		VolumeofEDTASolution(V_2)(ml)
		Initial	Final	

Volume of standard $MgSO_4$solution (V_1) = ml

Strength of standard $MgSO_4$solution (N_1) = N

Volume of EDTA Solution (V_2) = ml

StrengthofEDTASolution(N_2)=N

N_1V_1=

$N_2V_2N_2$=

N_1V_1/V_2

TitrationII:EstimationofTotalhardnessofWater

Pipetteout 20mlofhard water sample into a cleanconicalflask. Tothis add 2mlofbuffer solution followed 3 to 4 drops of EBT indicator and titrate the solution till a clear blue colour persists. This markstheendpointofthetitration.Repeatthetitrationsforconstantvaluesandcalculatetheamount of total hardness present in the given sample.

S.No.	Volumeofhardwater (V_3) (ml)	Burettereading(ml)		VolumeofEDTASolution(V_2)(ml)
		Initial	Final	

Volumeofhardwatersolution(V_3)= ml

Strengthofhardwatersolution(N_3)= N

VolumeofEDTASolution(V_2) = ml

StrengthofEDTASolution(N_2) = N

$$N_2V_2=N_3V_3$$

$$N_3=N_2V_2/ V_3$$

Amountoftotalhardnesspresentinthegivensample=N_3x100x1000=ppm

TitrationIII:EstimationofPermanentHardness

Transfer 100 ml ofthe given sample water into abeaker and boil it gently for 20 minutes. Cooland filter it directly into a 100mlstandard flask. Make up the solutionwithdistilled water and mix well. Pipette out 20 ml of this solution into a clean conical flask. To this add 2ml of buffer solution followed 3 to 4 drops of EBT indicator and titrate the solution till a clear blue colour persists. This markstheendpointofthetitration.Repeatthetitrationsforconstantvaluesandcalculatetheamount of permanent hardness present in the given sample.

S.No.	Volumeofsample water (V_4) (ml)	Burettereading(ml)		VolumeofEDTASolution(V_2)(ml)
		Initial	Final	

Volume of water solution (V_4) = ml

Strength of water solution (N_4) = N

Volume of EDTA Solution (V_2) = ml

StrengthofEDTASolution(N_2)= N

N_2V_2=

N

${}_4V_4N_4=N_2V_2/V_4$

Calculation:

Amountofpermanenthardnesspresentinthegivensample=N_3x100x1000=ppm

Temporary hardness= Total hardness – Permanent hardness = ppm

Result: Total hardness of water sample = ppm

Permanent hardness of water sample = ppm

Temporaryhardnessofwatersample= ppm

ESTIMATION OF ACID BY CONDUCTOMETRIC TITRATIONS

Aim: To determination the strength of given HCl solution by titrating against standard NaOH solution conductometrically.

Instruments and Apparatus: Burette, pipette, glass rod, beaker, standard flask, conductivity meter and conductivity cell with known cell constant.

Chemicals required: Hydrochloric acid (HCl), Oxalic acid and sodium hydroxide.

Principle:
According to Kohlarausch's law electrical conductivity of a solution depends on number of the ions present in it. In the titration of strong acid HCl with Strong base NaOH solution, before addition of NaOH solution there will be high conductance due to presence of large number H^+ of ions in it. Gradual addition of NaOH solution decreases the conductance due to the combination of H^+ ions with OH^- ions of the base to form undissociated water molecule. The conductance of solution decreases till neutralization point is reached and increases quickly due to free Na^+ and OH^- ions are added excess of NaOH solution. A plot of conductivity Vs volume of NaOH added will consist of two straight lines intersecting at the equivalent point. The shape of plot is V.

HCl+NaOH→NaCl+□□□

Procedure:

Preparation of standard oxalic acid solution (0.1N):
Weigh 0.63 gram of oxalic acid crystals into a clean 100 ml standard flask, dissolve in small amount of water and make up the solution up to the mark with distilled water. Shake the flask well for uniform concentration.

Normality of Oxalic Acid=0.1N, W=weight of Oxalic Acid =?

126.07=Molecular weight of Oxalic Acid 63=Equivalent weight of Oxalic Acid

Normality=□□□□□□ x □
□□.□□.□□ □

Weight=Normality x Gr.Eq.wt x □
□

Titration I: Standardisation of NaOH solution
Fill the burette with given NaOH solution. Pipette out 20 ml of oxalic acid into a conical flask and add 2 to 3 drops of phenolphthalein indicator and titrate the colourless solution against NaOH till pale pink colour is obtained as end point. Repeat the titration to get concurrent values.

S.No.	Volume of Oxalic acid solution (ml) (V_1)	Burette reading (ml)		Volume of NaOH (ml) (V_2)
		Initial	Final	

Volume of standard Oxalic acid solution (V_1)= ml

StrengthofstandardOxalicacidsolution(N_1)= N

VolumeofSodiumhydroxide(V_2) = ml

StrengthofSodiumhydroxide(N_2) = N

$$N_1V_1 = N_2V_2$$

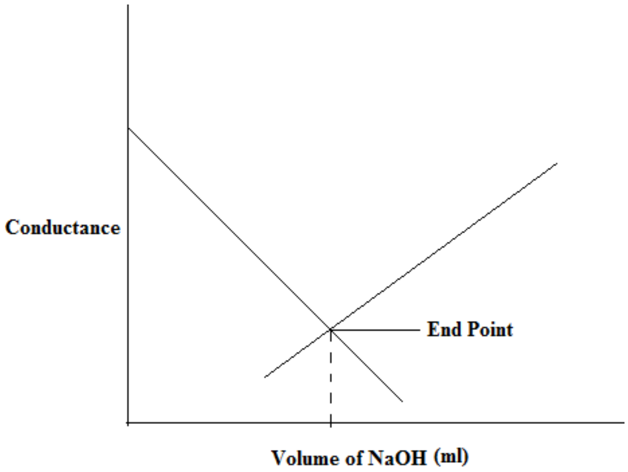
$$N_2=N_1V_1/V_2$$

TitrationII:DeterminationofstrengthofHClbyconductivitymeter

Transfer the given unknown HCl solution into a clean 100 ml standard flask and make up the solution upto mark with distilled water and mix wellto obtainuniformconcentration. Pipetteout 20ml of the given acid into a clean 100ml beaker, dip the conductivity cell in it and measure the conductance initially. Fill the burette with standard NaOH solution and rundown into the beaker (at a time 1 ml) with gentle stirring of the contents of the beaker and note the conductance after eachaddition. The measured conductance are recorded and tabulated. Take about 20readings, by plotting the graph (conductivity Vs volume of NaOH) we can get the amount of NaOH required for theneutralizationofHCltaken in thebeaker (i.e. end point) and calculatetheconcentrationof HCl solution from the known concentration of NaOH solution.

S.NO	**VolumeofNaOHadded(ml)**	**Conductance (Ohm^{-1}orSiemen's)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

ModelGraph:



Calculation:

NormalityofNaOH(N_2)=N

VolumeofNaOH(fromgraph)(V_2)=ml

Normality of HCl (N_3) = N

VolumeofHCl(V_3)=ml

$N_2V_2=$

N

$_3V_3N_3=N_2V_2/V_3$

StrengthofgivenHClsolution=NormalityofHCl(N_3)xEq.Wt.ofHCl(36.54)

Result: The strengthofHCl= g /lit

AdvantageofConductometricTitrations:

1. Colouredsolutionswhichcannotbetitratedbyordinaryvolumetrictitrationcanbecarriedout withoutthehelpofindicator.
2. Thismethodcanalsobeemployedincaseofverydilutesolutionandalsoforweakacidandweak base.
3. Nospecialcareisnecessaryneartheendpointasitisdeterminedgraphically.

ESTIMATION OF Fe+2 BY POTENTIOMETRY USING $KMnO_4$

Aim: Todeterminationtheamountofferrousionpresentingivenwholesolutionbytitratingagainststandard $KMnO_4$solution potentiometrically.

InstrumentsandApparatus: Burette,pipette,glassrod,beaker,standardflask,potentiometer,Platinum electrode and saturated calomel electrode (SCE).

Chemicalsrequired: FerrousAmmoniumSulphate(FAS),Potassiumpermanganate,Dil.Sulphuricacid.

Principle:

Redoxtitrationscanbecarriedoutpotentiometricallyusingplatinum-calomelelectrode combination. For the reaction

Reductionform⇆Oxidisedform+n electrons

ThepotentialisgivenbyNernstequation,

$$E=E^\circ+\frac{\square\,\square\square\square\square}{\square}\log\frac{[\square\square\square\square\square\square\square\square\square\square\square\square]}{[\square\square\square\square\square\square\square\square\square\square\square]}$$

Where, E° is the standard potential of the system. The potential of the system is thus controlled by the ratio of the concentration of the oxidized to that of the reduced species present. As the reaction proceeds,theratioandhencethepotentialchangesmorerapidlyinthevicinityoftheendpointofthe titration. This may be followed potentiometrically and a plot of change in potential against volume (Titration curve) is characterized by sudden change in the potentialat the equivalence point.

ThereactionthattakesplaceinthedeterminationofFe(II)is

$$5\square\square^{+\square}\rightarrow\square\square\square^{+\square}+\square\square$$

$$\square\square\square^{-}+\square^{+}+5e\rightarrow\square\square^{+\square}+4\square_{\square}\square$$

$$\square\square\square^{+\square}+\square\square\square^{-}+\square\square^{+}\rightarrow\square\square\square^{+\square}+\square\square^{+\square}+$$

$4\square$Theexperimentcelltobeusedis:

$Hg/Hg2Cl2(s)$,SaturatedKCl‖Fe^{3+},Fe^{2+}/ Pt

Procedure:

PreparationofaStandardFASsolution(0.01N):

Weight accurately 0.392g of FAS and transfer it in to a clean 100 ml volumetric flask with the help of funnel, dissolve this crystal in minimumamount of distilled water and 2 mlof dil. Sulphuric acid and make up the solution up to the mark, shake well for uniform concentration and calculate the normality of the prepared FAS (Mohr's salt) solution.

NormalityofFAS=0.01,W=weight ofFAS= ?

392.13=MolecularweightofFAS

392.13=EquivalentweightofFAS

Normality= [illegible] **x** [illegible]

[illegible]

Weight=NormalityxGr.Eq.wtx [illegible]

TitrationI:StandardisationofKMnO4

Pipette out 20 ml of standard FAS solution into a clean conical flask. Add one test tube full (about 20 ml) of dilute sulphuric acid solution. Titrate this mixture against potassium permanganate taken in the burette. The end point is the appearance of light pink violet colour. Repeat the titration for concordant titre values. From the strength of FAS calculate the strength of $KMnO_4$solution.

S.No.	VolumeofFAS(V_1) (ml)	Burettereading(ml)		VolumeofKMnO$_4$(V_2)(ml)
		Initial	Final	

VolumeofstandardFASsolution(V_1)= ml

StrengthofstandardFASsolution(N_1)= N

VolumeofKMnO$_4$(V_2) = ml

StrengthofKMnO$_4$(N_2) = N

N_1V_1=

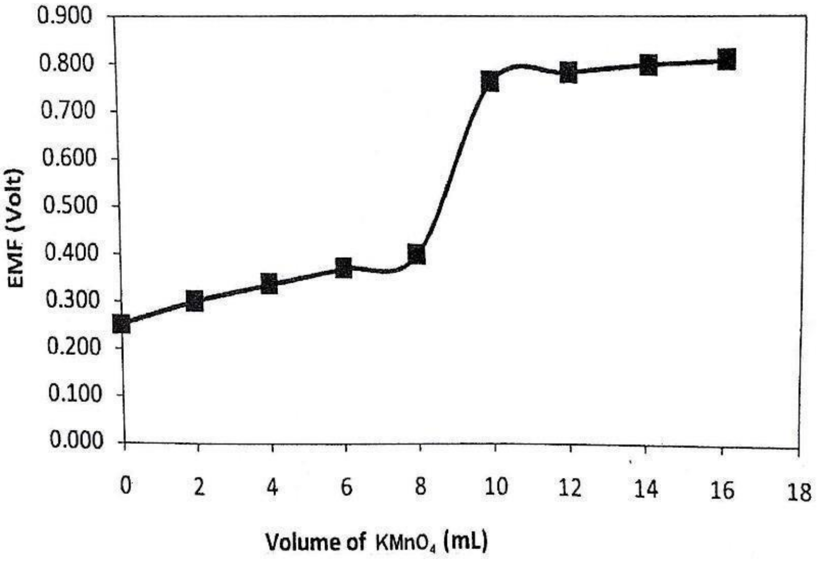
N

$_2V_2N_2=N_1V_1/V_2$

CalibrationofPotentiometer:
Switchonthepotentiometer and connect thestandard cellterminalsto either channelA(move channelswitchtopositionA)orchannelB(movethechannelswitchtopositionB). The meter should read 1.018 V. In case it is not 1.018 V, adjust the Std. knobto obtain reference value.

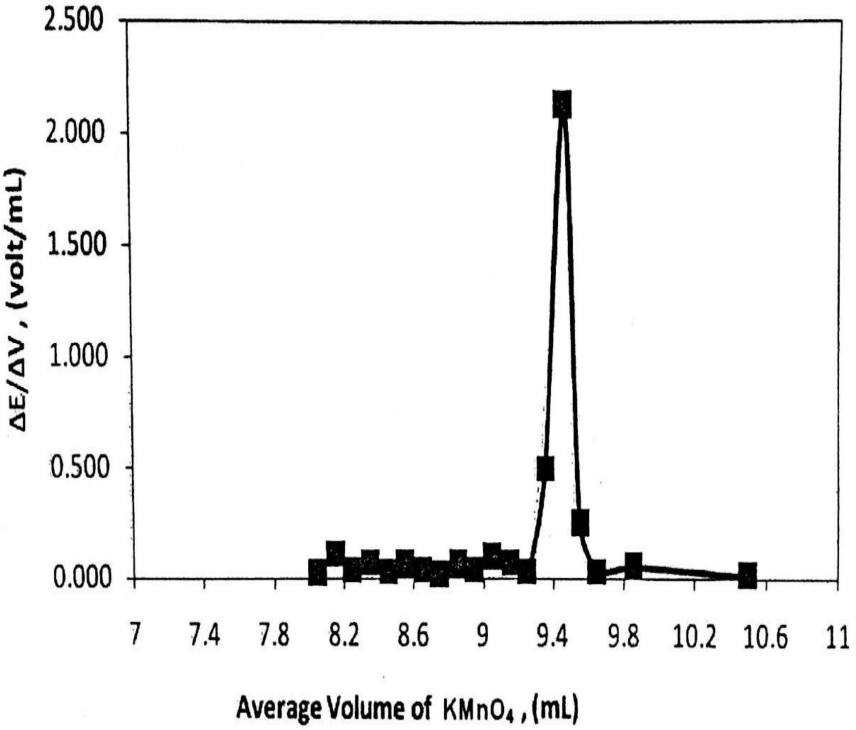
TitrationII:EstimationFerrousion
Transfer the given unknown ferrous ion solution into a clean 100 mlstandard flask and make up the solution up to mark with distilled water and mix wellto obtain uniformconcentration. Pipetteout 20 ml of above solution into a clean 100 ml beaker and add one test tube of Dil. Sulphuric acid. Place theelectrodeassembly(platinumelectrodeasindicatorelectrodeandaSCEasreferenceelectrode)in the beaker and connect the same to the potentiometer. Add permanganate from burette in 1 ml portions to the ferrous solution, stir it and note down the EMF values. Continue the titration till a sudden inflexion in EMF occurs, than take about 6 to 8 readings after in 1 ml intervals. From the titration approximate volume of permanganate required is found out. Draw a graph of E cell Vs volume of permanganate added, the intersecting point gives an approximate equivalence point.

S.No	VolumeofKMnO$_4$(ml)	EMF(volt)



The titration is repeated with addition of permanganate in 0.2 ml lots in the vicinity of end point (in 2 ml range). Plot a graph ΔE / ΔV *Vs* volume of $KMnO_4$added. Calculate the normality of ferrous solution and determine the amount of iron in the given solution.

S.No	Volume of $KMnO_4$(ml)	EMF(volt)	ΔE(volt)	ΔV(ml)	$\Delta E/\Delta V$ (volt/ml)	Average Volume (ml)



Calculation:

NormalityofKMnO$_4$(N$_2$)= N

VolumeofKMnO$_4$(fromgraph)(V$_2$)= ml

NormalityofFAS(N$_3$)= N

VolumeofFAS(V$_3$)= ml

$N_2V_2=$

N

$_3V_3N_3=N_2V_2/V_3$

Weight of FAS perlitre=Normality ofFAS(N$_3$)xEq.Wt.ofFAS(55.85)

WeightofFASper100ml=Weight of FASperlitre/10

Result: The weight of Fe(II)presentinthegivensolutionbypotentiometryisfoundto be ________________gr/lit

DETERMINATION OF STRENGTH OF GIVEN HCI USING ph METER

AIM

To determine the strength of given HCl using pH meter, a standard solution of NaOH of .... N is provided.

PRINCIPLE

Since the pH of the solution is related to the H+ ion concentration by the following formula,

$pH = - \log [H]$

measurement of pH of the solution gives the concentration of H+ ions in the solution. When NaOH is added slowly from the burette to the solution of HCI, the fast moving H+ ions are progressively replaced by slow moving Na+ ions. As a result pH of the solution increases.

$HCI + NaOH \rightarrow NaCl + H2O$

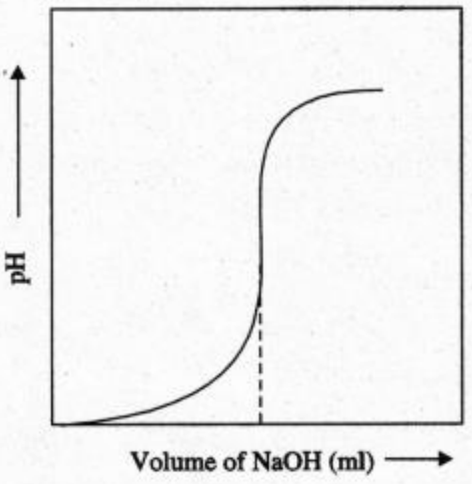
The increase in pH takes place until all the H+ ions are completely neutralised (upto the end point). After the end point, further addition of NaOH increases the pH sharply as there is an excess of fast moving OH- ions.

MATERIALS REQUIRED

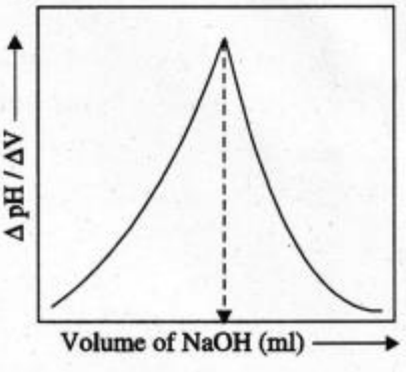
(i) pH meter, (ii) Glass electrode, (iii) 100 Beaker, (iv) Standard NaOH, (v) Given HCI, (vi) Burette, pipette, Glass rod etc., (vii) Distilled water.

S.No.	Volume of NaOH (ml)	pH	ΔpH	ΔV (ml)	ΔpH/ΔV
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

Graph I (Titration I)



Graph II (Titration II)



Calculation

Step I: Calculation of Strength of HCI

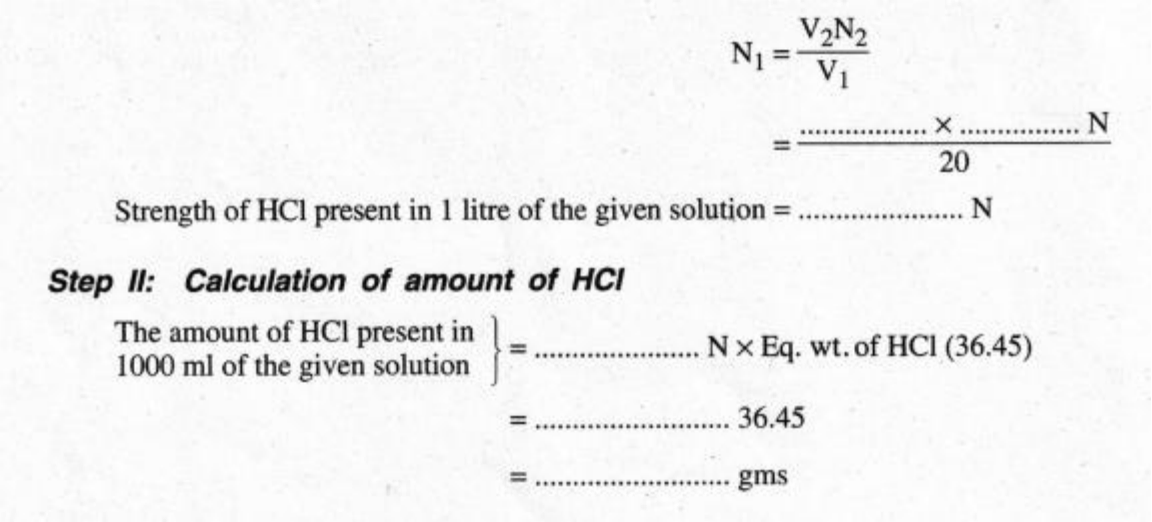
Volume of HCl, V1 = 20 ml

Strength of the HCl, N1 = ... ?

Volume of the NaOH, V2 = ……. (titre value)

Strength of the NaOH, N2 =.......... N

According to the law of volumetric analysis, V1N1 = V2N2



$$N_1 = \frac{V_2N_2}{V_1}$$

$$= \frac{\text{................} \times \text{................ N}}{20}$$

Strength of HCl present in 1 litre of the given solution = ... N

Step II: Calculation of amount of HCl

$$\left.\begin{array}{l}\text{The amount of HCl present in}\\ \text{1000 ml of the given solution}\end{array}\right\} = \text{...................... N} \times \text{Eq. wt. of HCl (36.45)}$$

$$= \text{.......................... 36.45}$$

$$= \text{.......................... gms}$$

Step II: Calculation of amount of HCl

The amount of HCl present in 1000 ml of the given solution = …..... N × Eq. wt. of HCl (36.45)

= ……….. 36.45

= ……….. gms

PROCEDURE

TITRATION - I

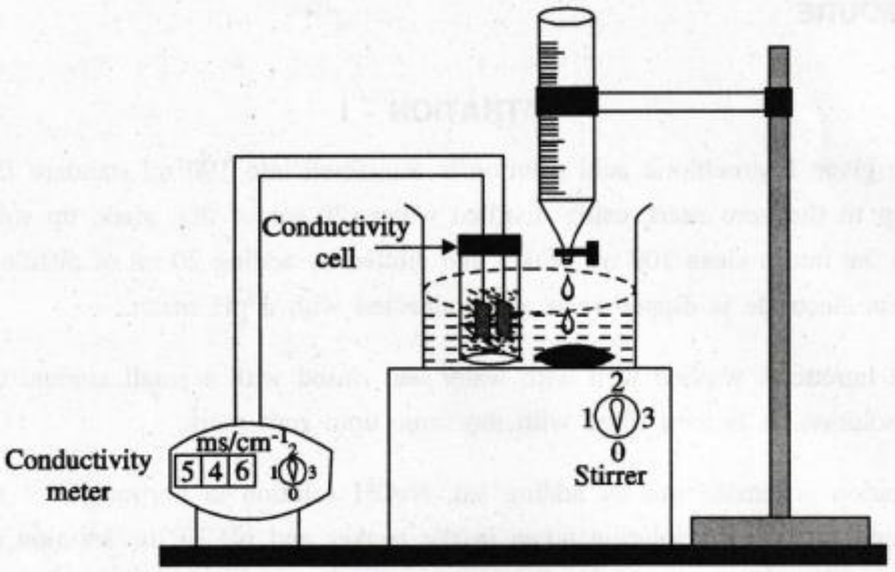
The given hydrochloric acid solution is transfered into 100 ml standard flask and made up to the zero mark using distilled water. 20 ml of this made up solution is pipetted out into a clean 100 ml beaker and diluted by adding 20 ml of distilled water The glass electrode is dipped in it and connected with a pH meter.

The burette is washed well with water and rinsed with a small amount of given NaOH solution. It is then filled with the same upto zero mark.

Titration is carried out by adding std. NaOH solution in portions of 1 ml from the burette to the HCl solution taken in the beaker and pH of the solution is noted for each addition. This process is continued until atleast 5 readings are taken after the end point, and the range at which the end point lies is found out by plotting volume of NaOH added against pH (graph I).

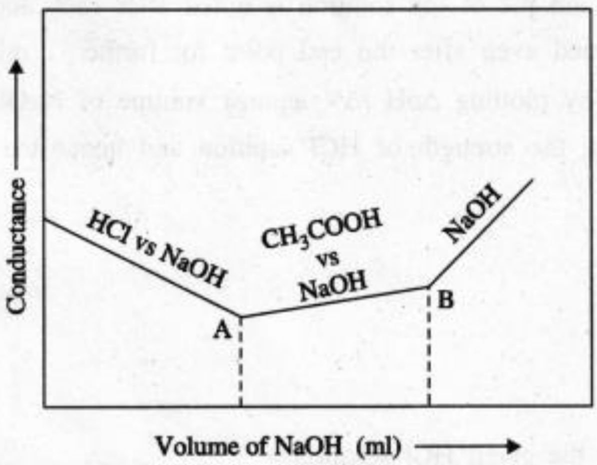
TITRATION - II

Another titration is carried out by adding std. NaOH solution in portions of 0.1 ml near the end point and pH of the solution is noted after each addition. The addition of NaOH is continued even after the end point for further 1 ml. The accurate end point is found out by plotting ΔpH /ΔV against volume of NaOH added (graph II). From the end point, the strength of HCl solution and hence the amount of HCl is calculated.



Determination of Conductance

Graph :



RESULT

1. Strength of the given HCl solution = …………. N

2. Amount of HCl present in 1 litre of the solution = …… gms.

PREPARATION OF BAKELITE

AIM: - To prepare phenol formaldehyde resin. (Bakelite)

CHEMICALS USED: -

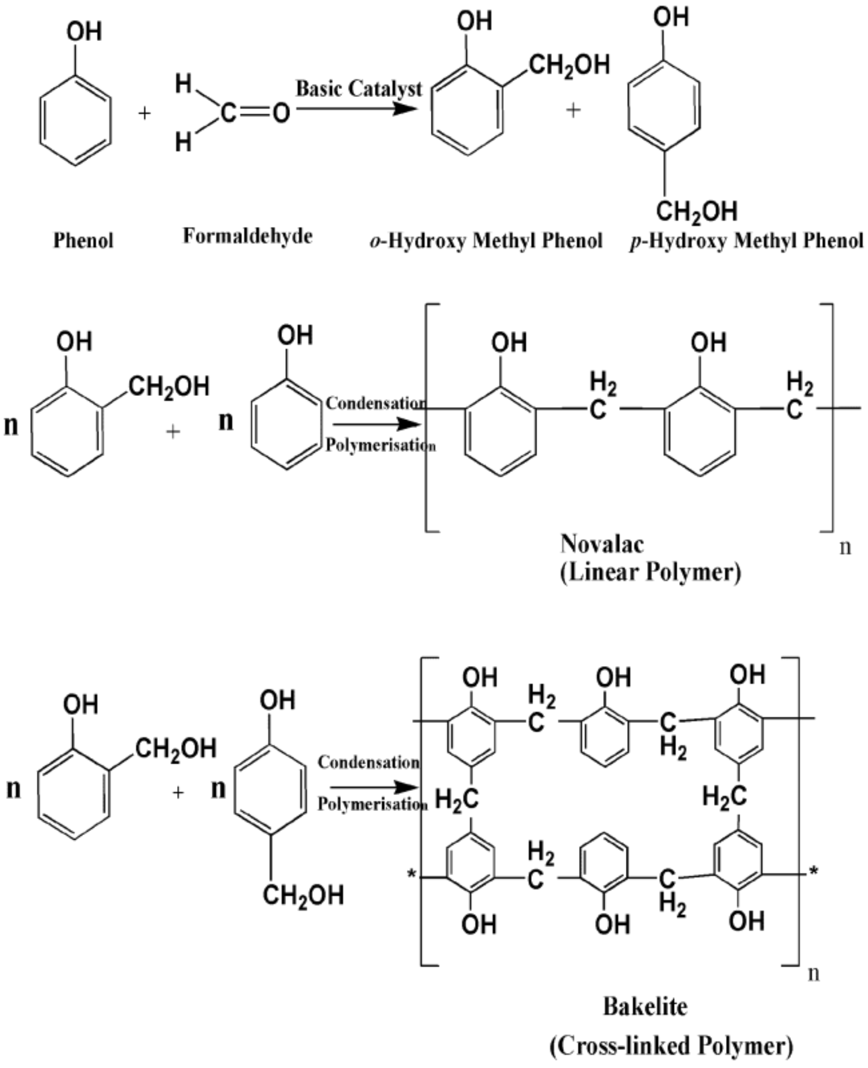
Glacial acetic acid or 2N NaOH,
40% formaldehyde solution,
Phenol,
conc. H_2SO_4 /HCl

APPARATUS REQUIRED: -Glass rod, beakers, funnel, measuring cylinder, dropper and filter paper.

PRINCIPLE: - Phenol formaldehyde resins (PFs) are condensation polymers and are obtained b condensing phenol with formaldehyde in the presence of an acidic or alkaline catalyst. They were first prepared by ***Backeland***, an American Chemist who gave them the name as ***Bakelite.*** Tese are thermosetting polymers.

PREPARATION:- PFs are prepared by reaction of phenol with formaldehyde in the presence of acidic or basic catalyst. The process may be carried out as follows

A mixture of phenol and formaldehyde are allowed to react in the presence of a catalyst. The process involves formation of methylene bridges in *ortho*, *para* or *both ortho* and *para* positions. This results first in the formation of linear polymer (Called *NOVALAC*) and then in to cross-linked polymer called phenol-formaldehyde resin or *Bakelite*



PROCEDURE: -

1. Place 5ml of glacial acetic acid and 2.5ml of 40% formaldehyde solution in a 500ml beaker and add 2 grams of phenol.
2. Add few ml of conc. Sulphuric acid into the mixture carefully. With in 5 min. a large mass of plastic is formed.
3. The residue obtained is washed several times with distilled water, and filtered product is dried and yield is calculated.

USES:-

They are used for making moulded articles such as radio and TV parts, combs, fountain pen barrels, phonograph records etc.

PRECAUTIONS:

1. The reaction is sometimes vigorous and it is better to be a few feet away from thebeaker while adding the H_2SO_4 and until the reaction is complete.
2. The experiment should be preferably carried out in fume cupboard.

RESULT: - The weight of the phenol formaldehyde resin is **___** g

Preparation Nylon – 6

AIM: -

To synthesize Nylon-6 polymer through ring-opening polymerization of caprolactam.

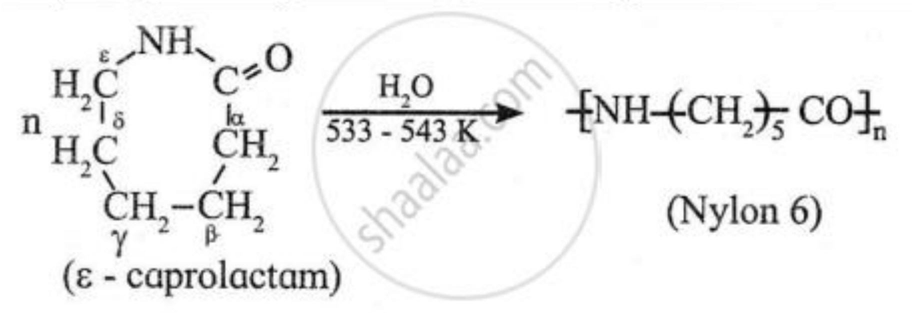
CHEMICALS USED: -

- ε-Caprolactam (monomer)
- Acetic acid (to terminate the reaction)
- Heat source (oil bath or hot plate)
- Glass rod
- Beaker or test tube
- Ice bath
- Distilled water

PRINCIPLE: -

Nylon-6 is a **synthetic polyamide** made by the **ring-opening polymerization** of ε-caprolactam. Unlike Nylon-6,6, which is made from two monomers (hexamethylenediamine and adipic acid), Nylon-6 is derived from a single monomer. This reaction is typically catalyzed by heat.

Reaction:



Procedure:

Take 5–10 grams of ε-caprolactam in a clean, dry test tube or small beaker.

Place the test tube in an oil bath and heat it to around 220–250°C. Stir gently using a glass rod.

Maintain this temperature for about 15–20 minutes until a viscous melt is formed.

Cool the melt slowly at room temperature and then place it in an ice bath.

The solid polymer that forms is Nylon-6.

Wash the solid polymer with cold water and a few drops of acetic acid to remove unreacted monomer and neutralize any residual base.

Dry the product and note its appearance and texture.

RESULT: - The weight of the Nylon-6 is ___ g.

Precautions:

Handle hot apparatus with care.

Perform the experiment in a well-ventilated area or under a fume hood.

Use gloves and goggles as caprolactam may irritate skin.

DETERMINATIONOFACIDVALUEOFCOCONUTOIL

Aim: TodeterminetheacidvaluepresentingivenCoconutoil.

Chemicals: Oxalicacid,KOHSolution,Alcohol,Coconutoil,Phenolphthaleinindicatoranddistilledwater.

Apparatus:Burette,pipette,conicalflask,Washbottle,Dropper.

Principle: Acid value indicates the proportion of free fatty acid present in an oil or fat and may be defined as the number of milligrams of caustic potash required to neutralize the acid in 1 gm of the sample. The normalacid value for most samples lies within0.5. Ifanytitrable acid otherthana fattyacid is present in the sample, it will be an error. A high acid value indicates a stale oil or fat stored under improper conditions.

Procedure

Standardization of KOH: Pipetteout20mlof0.1Noxalicacidsolutionina250mlconicalflask.Add1 or 2 drops of phenolphthalein indicator to this solution. Titrate this solution against KOH taken in a burette. The appearance of pink color indicates the end point. From the volume of the KOH solution in burette, find the normality of KOH.

Determination of Acid value in coconut oil: Weigh 5 gm ofcoconut oil and transfer it into 250 ml conical flask. Add 50 ml of neutralized alcohol solution to the oil solution. Heat this mixture for 10 minutes by using the heater. Take the solution after 10 minutes and add 1 or 2 drops of phenolphthalein indicator. Titratethis against the KOH solution fromthe burette. The appearance of pink color indicates the end point

Calculation

TitrationI:StandardisationofPotassiumhydroxidesolution:

S.No	Volume of Oxalicacid(ml)	BuretteReading		Concordant VolumeofKOH(ml)
		Initial	Final	

Burette:KOH

Pipettesolution:OxalicacidIndicator:
Phenolphthalein

Endpoint:Appearanceofpinkcolour

Volumeofoxalicacid(V_1)=Normality of

oxalic acid (N_1)=

VolumeofKOHconsumed(V_2)=

NormalityofKOHconsumed(

N_2)=V_1N_1/V_2Normality of KOH (N_2) = _____.

TitrationII:
Estimation of acid value

S.No	Volume of Oxalicacid(ml)	BuretteReading		Concordant VolumeofKOH (ml)
		Initial	Final	

Burettesolution:KOH

Pipettesolution:Oil+50mlofneutralizedalcohol

Indicator: Phenolphthalein

Endpoint:Appearanceofpinkcolour

Acid value=(Volume of KOH x Normality of KOH x Eq.wtx1000)/Weight of Oil sample

Acid Value = __________.

RESULT

TheacidvalueofthegivenCoconutoilsamplewasfoundtobe_________________.

DETERMINATION OF VISCOSITY OF CASTOROIL AND GROUNDNUT OIL BY USING OSTWALD'S VISCOMETER.

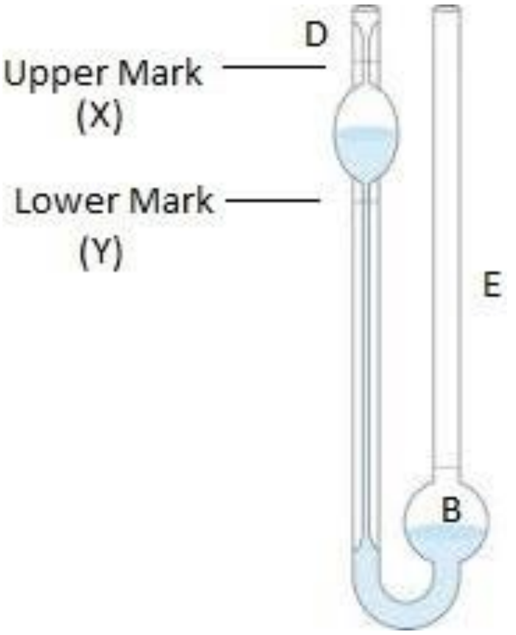
Aim: TodeterminetheviscosityofagivenliquidsamplebyOswald'sviscometer.

InstrumentsandApparatus: Oswald'sviscometerandstopwatch.

Chemicalsrequired: Liquidsampleandwatersample.

Principle: Viscosityisthemostimportantpropertyofanylubricatingoil.Itdescribesthesuitabilityof liquid for lubrication purposes. Viscosityofany liquid is that characteristics of fluid by virtue of which it hinder its own flow. Absolute viscosity is a measure ofthe internal resistance. Absolute viscosityisthetangentialforceperunitarearequiredtomoveonehorizontalplanewithrespectto theotherat unitvelocitywhenmaintainedaunit distance apart bythefluid.Kinematic viscosityis the ratio of absolute or dynamic viscosityto density- a quantity in which no force is involved. Kinematicviscositycanbeobtainedbydividingtheabsoluteviscosityofafluidwithitsmassdensity.

Viscosityindex(vi)isanarbitrarymeasureforthechangeofviscositywithtemperature.Itisusedto characterize lubricating oil in the automotive industry.



Procedure:

Determination of density of given sample

Weight of specific gravity bottle+givensampleW_1= g

WeightofspecificgravitybottleW_2= g

Weightofgivensample(W_1–W_2)= g

Volumeofgivensample(V)= ml

Densityofgivensample(d_2)=W_1–W_2/V(gm/cc)=

Take a clean and dryOswald viscometer and set it verticallyon a stand. Introduce 10 ml of water throughE(refer figure) intothe largebulb(B). Suckthe liquidup intothebulb‘A’througharubber tubing attached to the end ‘D’to a levelabove the mark ‘X’. Allow the liquid to flow freelythrough thecapillaryand notethetimet$_1$(usethewrist watchor stop watch) fortheliquid flow fromXto Y. repeat stepstwoormoretimesandgetanaveragevalueoft$_1$.Repeattheprocesstoobtainthe averagetime for the liquids to flow fromX to Y. Tabulate the data as follows.

S.No.	Sample	Density	Timeflowtime average		Timeaverage
			Exp1	Exp2	
1	Water	1			
2					
3					

Calculations:

$$\eta 1 /\eta 2=(d1t1)/(d2t2)$$

Whereη_1=viscosityofwater,
η_2=viscosityofgivenliquid d_1=
density of water,
d_2=densityofgivenliquid
t_1=timeflow ofwaterfromX toY
t_2=timeflowofgivenliquidfromXtoY

Result: The viscosity of the given liquid = (unitsof viscosity are poise, Pascal - second or stokes)

Determination of Rate of Corrosion of Mild Steel in the Presence and Absence of Inhibitor

Aim:

- Mild steel specimens (pre-weighed and cleaned)
- 1N HCl solution (as the corrosive medium)
- Corrosion inhibitor (e.g., sodium benzoate, hexamine, or potassium dichromate)
- Beakers
- Digital balance (accuracy: 0.001 g)
- Stop watch or timer
- Glass rod
- Tongs and gloves

Principle: Corrosion is the electrochemical deterioration of metals due to reactions with their environment. The corrosion rate can be calculated using the weight loss method:

Corrosion Rate (mg/cm2/day)=Area×TimeInitial Weight−Final Weight

Corrosion inhibitors reduce the rate of corrosion by forming a **protective film** on the metal surface or altering the electrochemical reaction.

Procedure:

Step 1: Surface Preparation

Clean the mild steel specimens with emery paper.

Wash with distilled water, then with acetone or alcohol, and dry.

Measure and record the initial weight (W_1) using a digital balance.

Measure the surface area of each specimen.

Step 2: Without Inhibitor
Place one specimen in a beaker containing 100 mL of 1N HCl.

Leave it undisturbed for a fixed duration (e.g., 60 minutes).

Step 3: With Inhibitor

Prepare a second beaker with **100 mL of 1N HCl + known concentration of inhibitor**.

Immerse the second specimen for the **same duration**.

Step 4: Post-Exposure

After the exposure time, remove both specimens, clean off corrosion products using a soft brush, rinse with water, dry, and **reweigh (W_2)**.

Calculate the **weight loss (W_1 - W_2)** and use it to determine the corrosion rate.

Calculations:

**weight Loss (mg)=W1−W2\text{Weight Loss (mg)} = W_1 - W_2Weight Loss (mg)=W1−W2
Corrosion Rate=Weight LossSurface Area×Time (days)\text{Corrosion Rate} = \frac{\text{Weight Loss}}{\text{Surface Area} \times \text{Time (days)}}Corrosion Rate=Surface Area×Time (days)Weight Loss**

Compare the corrosion rates **with and without the inhibitor**.

Result:

The corrosion rate without inhibitor was found to be: ____ mg/cm^2/day

The corrosion rate with inhibitor was found to be: ____ mg/cm^2/day

The inhibitor **effectively reduced** the corrosion rate of mild steel.

Virtual lab experiments:

Construction of Fuel cell and its working.

https://youtu.be/kIPMhijlcbs

Smart materials for Biomedical applications

https://youtu.be/QYkjFTgF8_k

Batteries for electrical vehicles

https://youtu.be/ZIJMwyLfO88

Functioning of solar cell and its applications

https://youtu.be/IODbzD8LiKM