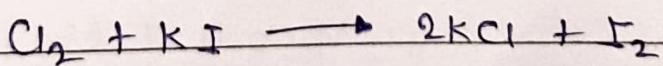


Object :- To determine the residual chlorine in a given water sample.

Apparatus and reagent :- Burette, pipette, Iodometric flask, Beakers, Droppers, Sodium thiosulphate ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ), potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ), potassium iodide (KI), Sulphuric Acid (Conc.  $\text{H}_2\text{SO}_4$ ), Acetic acid ( $\text{CH}_3\text{COOH}$ ), starch.

Theory :- Sterilized water is produced for drinking purposes by passing chlorine gas through the sample for complete removal of micro-organisms. The germicide action of chlorine gas produces hypochlorous acid ( $\text{HOCl}$ ) and nascent oxygen [ $\text{O}$ ]. If chlorine in water is beyond certain limit, the water will become unfit for drinking. It is therefore, necessary to determine the amount of free chlorine in water sample.

The analysis is based on the oxidation of potassium iodide (KI) by the free chlorine present in water. The liberated iodine is estimated iodometrically by titrating it against standard hypo solution using starch as indicator.



Procedure :-(A) Standardization of Hypo solution -

- (i) Wash all the apparatus with distilled water.
- (ii) Fill the burette with Hypo solution.
- (iii) Pipette out 10 ml of  $K_2Cr_2O_7$  solution becomes faint yellow.
- (iv) Add to it 10 ml  $H_2SO_4$  to maintain pH and 5 ml KI solution.
- (v) Titrate it against hypo solution till the solution becomes faint yellow.
- (vi) Now add few drops of freshly prepared starch indicator, a blue colour appears. Continue to add hypo solution drop by drop while constantly shaking till the blue color disappears, it indicates the end point.

(B) Titration of water sample with Hypo Solution -

- (i) Fill the burette with hypo solution.
- (ii) Take 10 ml of given water sample in a iodometric flask & add 3ml glacial acetic.
- (iii) Add acid to attain pH level 3-4. Shake the solution & add 5ml of KI solution.
- (iv) Titrate the water sample with standard hypo solution till the solution becomes faint yellow.
- (v) Now add few drops of freshly prepared starch indicator, a blue colour appears. Continue to add hypo solution drop by drop while constantly shaking till the blue color disappear, it indicates the end point.

Calculation:-

Titration between sample water with hypo solution

$$N_1 V_1 = N_2 V_2$$

$$N_1 \times 50 = N_2 \times V_2$$

$$N_1 = \frac{N}{50 \times 30}$$

Here  $N_1$  = Normality of sample water

$N_2$  = Normality of known Hypo

$V_1$  = Volume of sample water

$V_2$  = Volume of known Hypo.

Strength of free and residual chlorine.

Here  $N_3$  = Normality of  $K_2Cr_2O_7$

$V_3$  = Volume of  $K_2Cr_2O_7$

$N_4$  = Normality of Hypo solution

$V_4$  = Volume of  ~~$K_2Cr_2O_7$~~  Hypo solution.

$$N_3 = \frac{N}{50 \times 30} \times \frac{V_4}{V_3} \times 9.0$$

$$N_3 = 0.0024 \text{ ml}$$

$$\text{Strength} = N_3 \times \text{eq. weight} \times 1000$$

$$= 0.0024 \times 35.5 \times 1000$$

$$= 8.52 \times 1000$$

$$= 852 \text{ ppm Andley}$$

Expt. No. \_\_\_\_\_

(vii) Note down the burette reading.

(viii) Repeat the titration till the concordant reading is obtained.

Observation

Titration between  $K_2Cr_2O_7$  & hypo solution

S. No.	Volume of $K_2Cr_2O_7$ (ml)	Volume of hypo solution	Difference (ml)	Concordant reading (ml)
		Initial (ml)	Final (ml)	
1.	10 ml	0.0	9.0	9.0
2.	10 ml	9.0	18.0	9.0

Titration between  $K_2Cr_2O_7$  water and hypo solution.

S.No.	Volume of water Sample (ml)	Volume of hypo solution	Difference (ml)	Concordant reading (ml)
	Initial (ml)	Final (ml)		
1.	50 ml	0	5	5
2.	50 ml	5	7.7	2.7
3.	50 ml	7.7	11.7	4.0

Strength of free and residual chlorine is = ~~852~~

Normality  $\times$  eq. weight of chlorine  $\times 1000$

$$= 852 \text{ ppm}$$

Result :- Amount of free & residual chlorine in the given water sample = 25.2 ppm.

### Precautions:-

1. Freshly prepared starch solution should be used.
2. Distilled water should be used throughout the titration.
3. Starch solution be added just near ~~end~~ point.

### Industrial Application:-

1. Chlorine determination is used to control chlorination of domestic and industrial waste water.
2. Chlorine determination is important to avoid bad odor & change in taste of water.
3. It is determined in the swimming pools to avoid ill effects due to excess chlorination.

### Viva Question

Q1 What are iodometric titrations?

Ans: Iodometric titration is a type of redox titration that involves iodine ( $I_2$ ) which is used to determine the concentration of oxidizing agents. It is an indirect titration method where an oxidizing agent reacts with excess iodine ions to produce iodine ( $I_2$ ) which is then titrated with a reducing agent like sodium thiosulphate ( $Na_2S_2O_3$ ).

Q2 Differentiate between iodometric & iodimetric titration?

Ay Iodometric titration is an indirect method, where iodine is liberated by an oxidizing agent & then titrated.

Iodimetric titration is a direct method, where iodine itself is used as a titrant to react with a reducing agent.

Q3 Differentiate between primary & secondary solution.

Ay Primary solution are prepared from highly pure, stable compounds & have known concentration. Secondary solution have unknown or opportunities concentrations and must be standardized before use in titration.

Q4 Which type of indicator is used in this titration? Name it?

Ay Starch.

Q5 What is the equivalent weight of copper sulphate?

Ay equivalent weight of  $\text{CuSO}_4 = 79.75 \text{ gm/eq}$   
 $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  (hydrated)  $249.80 \text{ gm/eq}$

Q6 Why freshly prepared starch solution is used in this titration?

Ay Because starch decomposes over time, leading to inaccurate result.

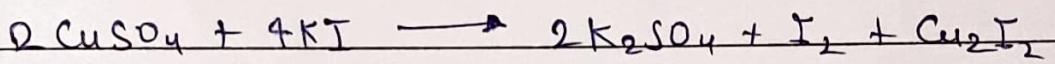
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Q7 Why starch is added near the end point of the titration?

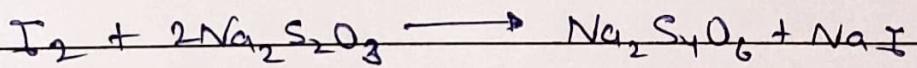
A7 Starch is added near the end point of titration, because it acts as an indicator for the presence of iodine. If we add starch in beginning then starch Iodine complex becomes too stable & may not dissociate.

Q8 Explain the reaction involved in this titration?

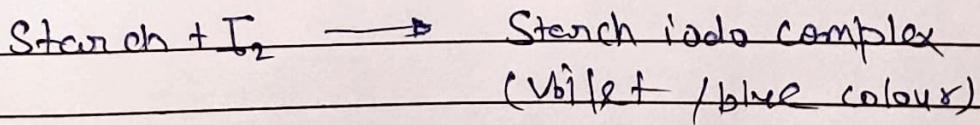
A8 When potassium iodide is added at pH (4 to 4.7) to copper sulphate solution, an equivalent amount of iodine is liberated & solution becomes brown.



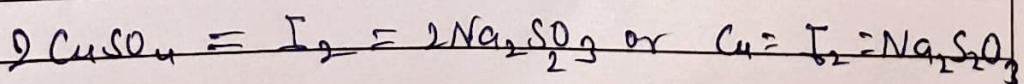
This liberated iodine is titrated with standard solution of sodium thiosulphate by using starch as an indicator



The liberated iodine absorbs on starch to give deep blue or violet colour



from the above reaction it follows that



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Q3 Write chemical name of & formula of Hypo solution.  
 Ans Hypo solution is nothing but sodium thiosulphate its  
 chemical formula is  $\text{Na}_2\text{S}_2\text{O}_3$   
 In aqueous form =  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

Q4 How will you prepare  $\text{N}_1/\text{CaSO}_4$ .

Explain the principle  $\rightarrow^{30}$ :

Q5 Why pH should be maintained between 3 to 4  
 in this titration?

Ans Iodine remains stable & unreacted with hydroxide  
 or oxygen.

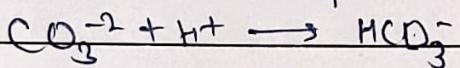
Accurate stoichiometry in the redox reaction.

Reliable endpoint detection using starch.

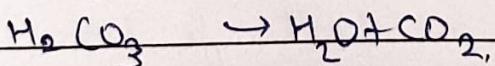
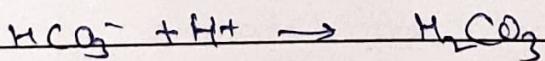
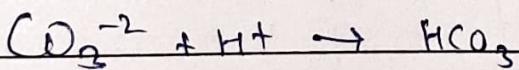
Object :- To determine the strength of sodium hydroxide & sodium carbonate in the given alkali mixture.

Apparatus & Reagent :- Burette, Pipette, conical flask, Measuring cylinder, Std. sodium carbonate solution, HCl solutions, phenolphthalein indicator, methyl orange indicator, and alkali mixture.

Theory :- In determination of NaOH &  $\text{Na}_2\text{CO}_3$  together, double indicator method is employed. The principle involved in this method is that when  $\text{Na}_2\text{CO}_3$  solution is titrated with HCl, the neutralization occurs in two stages. The step in hydrogen carbonate step.

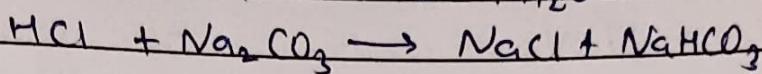
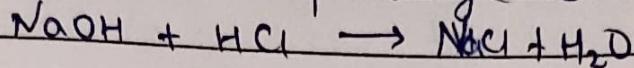


The equivalence for the first step on ionization of carbonic acid is at pH 8.3 which may be detected by using phenolphthalein indicator. The second step corresponds to the displacement of all the carbonic acid.

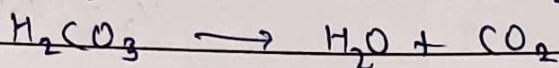
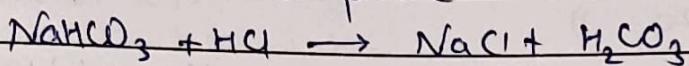


The equivalence point can be detected by using methyl orange indicator. The methyl orange end point comes in the pH range 3.1 to 4.4, whereas phenolphthalein

point occurs in the pH range 8.3 to 10.0.



If the titration is continued with methyl orange the neutralization of the bicarbonate to the carbonic acid takes place.



If  $[P]$  &  $[M]$  correspond to the phenolphthalein & methyl orange end point, then

$$[P] = \text{NaOH} + \frac{1}{2} \text{Na}_2\text{CO}_3 \quad \& \quad [M] = \text{NaOH} + \text{Na}_2\text{CO}_3$$

$$2[M-P] = \text{Na}_2\text{CO}_3 \quad \text{and} \quad [N] - 2[M-P] = [P-M] \\ = \text{NaOH}$$

### Procedure :-

- 1) Standardization of HCl : take 10 ml of std.  $\text{Na}_2\text{CO}_3$  solution in a conical flask, add 2-3 drops of methyl orange indicator to it & titrate it against HCl solution until a sharp colour change from yellow to red end point. Repeat for concordant reading & calculate the normality of HCl solution.
- 2) Take 10 ml of alkali mixture into a conical flask and add 2-3 drops of phenolphthalein indicator. Pink colour appears.
- 3) Titrate it against HCl & observe the colour. The disappear of pink colour provides the first end point i.e. phenolphthalein end point  $[P]$ .

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Calculation

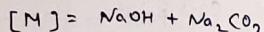
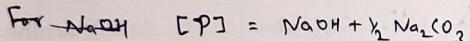
for HCl

$$N_1 V_1 = N_2 V_2$$

$$N_1 \times 11.0 = \frac{N}{20} \times 10$$

$$N_1 = \frac{N}{20} \times \frac{10}{11}$$

here Normality of HCl

 $N_1$  = Volume of
 $N_2 = N_{20}$  = normality of known  
 $\text{Na}_2\text{CO}_3$ 
 $V_1$  = Volume of HCl
 $V_2$  = Volume of known  
 $\text{Na}_2\text{CO}_3$ 


$$[P] = 3$$



$$[M] = 2$$



For NaOH

$$N_3 V_3 = N_4 V_4$$

$$N_3 \times V_3 = \frac{N}{20} \times \frac{10}{11} [2P - M]$$

$$\begin{aligned} N_3 &= \frac{1}{22} \times (2 \times 3 - 2) = 0.045N \\ \text{Strength of NaOH} &= N_3 \times 40 \\ &= 0.045 \times 40 \text{ gm/l} \\ &= 1.818 \text{ gm/l} \end{aligned}$$

here

 $N_3$  = Normality of NaOH $V_3$  = Volume of NaOH

$$N_4 = N_1$$

 $V_4$  = Volume of HClFor  $\text{Na}_2\text{CO}_3$ 

$$N_5 V_5 = N_6 V_6$$

$$N_5 = \frac{N}{20} \times \frac{10}{11} \times 2(M-P)$$

$$\begin{aligned} V_5 &= \frac{1}{22} \times 2 [1] \\ &= 0.009 \text{ ml} \end{aligned}$$

here

 $N_5$  = Normality of  $\text{Na}_2\text{CO}_3$  $V_5$  = Volume of  $\text{Na}_2\text{CO}_3$ 

$$N_6 = N_1$$

 $V_6$  = Volume of HCl

4) Now add 2-3 drops of methyl orange indicator to the same solution to continue the titration until a sharp colour change from yellow to red occurs at the end point. This titre value is known as methyl orange end point (M).

Observation:-Standardization of HCl:

S.N.	Volume of $\text{Na}_2\text{CO}_3$ (ml)	Volume of HCl Initial	Volume of HCl Final	Difference	Concordant reading (ml)
1.	10 ml	0	11.0	1.0	> 11.0
2.	10 ml	11.0	92.0	11.0	

Analysis of the given alkali mixture:-

Given Volume of Alkali mixture	Volume of HCl used	Concordance Test			
		Phenolphthalein end point [P]	Concordant reading [P]	Methyl orange end point [M]	Concordant reading [M]
1.	10	0	3	3	3
2.	-	-	-	-	-

$$\begin{aligned}\text{Strength of } \text{Na}_2\text{CO}_3 &= N_s \times 53 \\ &= 0.009 \times 53 \text{ gm/L} \\ &= 0.477 \text{ gm/L}\end{aligned}$$

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### Result:-

Strengths of sodium hydroxide and sodium carbonate in the given alkali mixture are -

$$\text{NaOH} = 1.818 \text{ gm/L}$$

$$\text{Na}_2\text{CO}_3 = 0.477 \text{ gm/L}$$

### Precautions:-

- 1) All the reading must be repeated until concordant reading are obtained.
- 2) Observe carefully the decolorization of phenolphthalein colour at the end point.
- 3) Freshly prepared starch reagent should be used.

### Industrial Application:-

1. It is used to determine the amount of NaOH in boiler feed water so that it can be removed.
2. Removal of NaOH prevents the caustic embrittlement in boilers.
3. Removal of  $\text{Na}_2\text{CO}_3$  prevents the scale & sludge in boilers.
4. Measuring alkalinity is important in determining a stream's ability to neutralize acidic pollution from rainfall or wastewater.
5. It is one of the best measures of the sensitivity of the stream to acid inputs.

Teacher's Signature \_\_\_\_\_

### Yoga Question

Q1 Why burette & pipette should be rinsed with the solutions for which they are to be used?

A1 Burette & pipette are rinsed with the solution to avoid contamination, ensure accurate concentration & deliver correct volume for precise result.

Q2 Why conical flask is not rinsed with the solution taken in it?

A1 The conical flask is not rinsed because leftover solution could affect the volume & it doesn't affect the accuracy of the titration.

Q3 Why hot solution are not filled in burette in titrations?

A1 Hot solution are not used in burette because they can cause volume errors, damage the burette, and affect accuracy.

Q4 Define alkalinity of water?

A1 Alkalinity of water is its ability to neutralize acids, mainly due to the presence of bicarbonates, carbonates & hydroxides.

Q5 Differentiate between acidity & alkalinity of water?

A1 Acidity of water is its ability to neutralize bases while alkalinity is its ability to neutralize acids.

(Q6) Why two indicators are used to determine alkalinity of water.

Ans Two indicators are used to detect different types of alkalinity; phenolphthalein for hydroxide / carbonate & methyl orange for bicarbonate.

(Q7) Name the indicators used in this titration.  
Write their pH range.

Ans Phenolphthalein and methyl orange indicator are used in this titration.

For phenolphthalein pH should be 8.3 to 10.0 whereas for methyl orange pH should be 3.1 to 4.4.

(Q8) Write the structure of phenolphthalein & methyl orange indicators.

Ans For Phenolphthalein -

Structure -  $C_{16}H_{10}O_4$

colour = in acidic  $\rightarrow$  colourless  
in basic  $\rightarrow$  Pink

For Methyl orange

Structure -  $C_{19}H_{19}N_3NaO_3S$

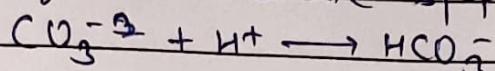
Colour - in acidic  $\rightarrow$  Red.  
in basic  $\rightarrow$  Yellow

Q9 Explain the reactions involved in this titration.

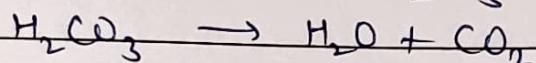
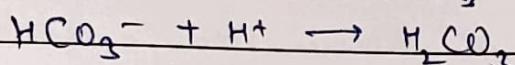
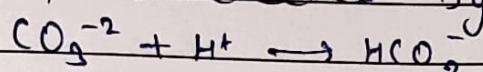
A1 In the titration,

$\text{Na}_2\text{CO}_3$  solution is titrated with HCl, the neutralization occurs in two stage.

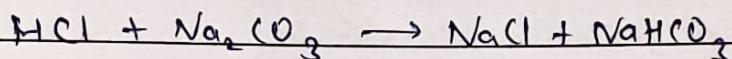
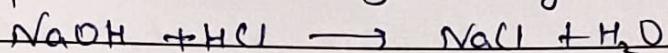
Hydrogen carbonate step-



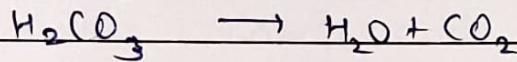
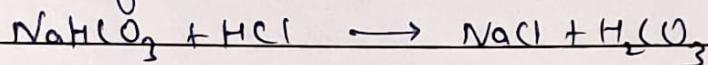
The equivalence for the first step, carbonic acids is at  $\text{pH } 8.3$ , it's detected by Phenolphthalein.



At this point, orange methyl orange is added.



Neutralization of bicarbonate -



If  $[P]$  &  $[M]$  correspond to the phenolphthalein & methyl orange end point. then

$$[P] = \text{NaOH} + \frac{1}{2} \text{Na}_2\text{CO}_3 \quad \& \quad [M] = \text{NaOH} + \text{Na}_2\text{CO}_3$$

$$2[P-M] = \text{Na}_2\text{CO}_3 \quad \& \quad [M]-2[P-M] = [2P-M] = \text{NaOH}$$

Q10 How will you prepare  $N_{1/20}$   $\text{Na}_2\text{CO}_3$  solution in 500 ml.

A1 Steps 1 Molar mass of  $\text{Na}_2\text{CO}_3 = 105.99 \text{ gm/mol}$

2. Normality required =  $0.1 \text{ N}$  (Since  $N_{1/20} = 0.1 \text{ N}$ )

3. For 500 ml (0.5 L) weigh  $0.946 \text{ gm}$  of  $\text{Na}_2\text{CO}_3$

4. Dissolve in 1L then 500 ml of distilled water then dilute to 500 ml. in a volumetric flask.

5. Mix well.

Teacher's Signature \_\_\_\_\_

**Object:-** To determine the moisture contents in a given sample of coal by proximate analysis

**Apparatus/ Reagent Required:-** Balance, electric oven, Muffle furnace, Crucible, Slica crucible with lid, tongs, powdered coal sample.

**Theory:** Coal is considered as the most important fuel amongst the solid fuels & available in many parts of the world in very large quantities. The coal is analyzed in order to determine the quality for their practical use in power generation. There are two type of analysis one ultimate analysis which is determination of moisture element (C, H, O, N, S) & second is proximate analysis which involves the determination of moisture, volatile matter and fixed carbon. Proximate analysis is empirical & important to assess the quality of coal.

**Moisture:-** It is weight loss on heating & expressed in the percentage as

$$\% \text{ of moisture} = \frac{\text{Loss of weight}}{\text{wt of coal sample}} \times 100$$

Lesser the moisture content, better the quality of coal as a fuel.

Calculation:-

$$\text{weight of moisture content (c-d)} = 0.11 \text{ gram.}$$

$$\% \text{ of moisture content} = \frac{\text{weight of moisture}}{\text{amount of coal sample}} \times 100$$

$$= \frac{0.11}{1} \times 100$$

$$= 11\%. \quad \text{Answer}$$

Procedure:-

- 1) Clean the silica crucible, dry & weigh.
- 2) Transfer 1wgm of air dried coal sample in to silica crucible.
- 3) keep the crucible in the electric oven maintained at 102-110°C for about one hour.
- 4) After heating, put crucible into a desiccator for cooling & weigh the crucible. The difference in weight is reported in percentage as the amount of internal moisture in coal.
- 5) The crucible is heated again in similar way for two times & concordant weight is noted. The loss in weight is equivalent to moisture present in the given sample.

Observation:-

1. Weight of empty crucible (a) = 22.74 gram.
2. Weight of coal sample (b) = 1.00 gram
3. Weight of empty crucible + Coal sample (c) = 23.74 gram  
(a+b)
4. Weight of sample after heating (d) = 23.63 gram.

Result: The percentage of moisture content in a given sample of coal was found 11%.

### Accountant-

1. Proximate analysis helps in giving an idea about the quality of coal used in different industries based on their requirements.
2. Composition of foods (moisture, ash, nitrogen free instances, ether extract etc) can be determined by proximate analysis.

### Viva Question

Q1 What is the difference between volumetric & gravimetric analysis.

A1 Volumetric analysis → measures the volume of a solution (titration) to find concentration.

Gravimetric analysis → Measure the mass of a substance (precipitates) to determine quantity.

Q2 Define calorific value of a fuel?

A2 Calorific value of a fuel is the amount of heat energy produced when a certain amount (usually 1 gram or 1 kilogram) of the fuel is completely burned in oxygen.

Q3 Differentiate between higher & lower calorific value?

Ans Feature	Higher Calorific Value	Lower Calorific Value
(i) Water formed	Condensed	Remains as vapor
(ii) Heat from water condensation	Included	Not included
(iii) Energy value	Higher	Lower
(iv) Also known as	Gross Calorific Value	Net calorific value

Q4 Differentiate between proximate & ultimate analysis.

Ans Feature	Proximate analysis	Ultimate analysis
Tells about	Fuel content	Elemental composition
Includes	Moisture, volatile matter etc.	C, H, S, N, O
Usefulness	For quick fuel quality check	For detailed combustion study.

Q5 What are the characteristics of a good fuel?

Ans Good fuel should be - High in energy (Calorific value), Cheap, Easy to ignite (moderate ignition temp), low smoke / ash, available, safe to store & transport.

Q6 What are the units of calorific value?

Ans For solid & liquids  $\Rightarrow$   $\text{KJ/kg}$ , for gases  $\text{KJ/m}^3$  and  $\text{kcal/kg}$  and  $\text{MJ/kg}$ .

Q7 what do you understand by ignition temperature?

Ans Ignition temperature is the minimum temperature at which a substance catches fire & starts burning on its own without any external flame.

Q8 what is the temperature range for estimation of moisture content?

Ans The temperature range for estimating moisture content is typically  $105^{\circ}\text{C}$  to  $110^{\circ}\text{C}$ .

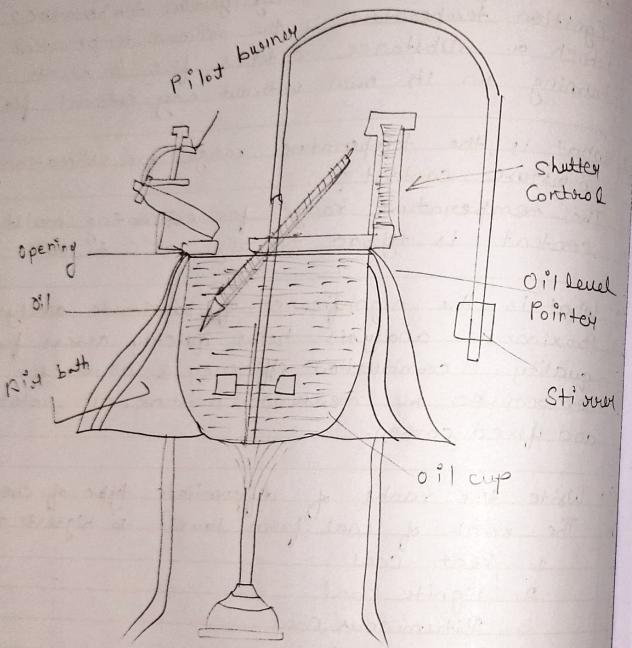
Q9 what is the significance of proximate analysis?

Ans Proximate analysis helps quickly assess fuel quality, combustion efficiency & allows for fuel comparison by measuring moisture, ash, volatile matter and fixed carbon.

Q10 Write the ranks of different type of coal.

Ans The rank of coal from lowest to highest are.

1. Peat Coal.
2. Lignite Coal
3. Bituminous Coal
4. Anthracite Coal.



Object:- To determine the flash and fire point of a given lubricant by Pensky-Marten's apparatus.

Apparatus & Reagent:- Pensky-marten's apparatus, given sample of lubricating oil.

### Theory:-

Flash Point:- It is the lowest temperature at which sufficient vapours are produced by the oil, which oxidize in presence of air and give a momentary flash with sound like flash of camera when brought in contact with a flame.

Fire point:- The lowest temperature at which the vapours of the oil burn continuously for at least five second, when a tiny flame is brought near it. The fire point is about  $5-20^{\circ}\text{C}$  higher than the flash point, depending upon the nature of oil.

Pensky-marten's apparatus is used for those oils, which have flash point nearly  $50^{\circ}\text{C}$ . It is a colored cup apparatus consisting of following parts:-

Oil cup:- It is made up of brass & is of a standard size having flash point nearly  $50^{\circ}\text{C}$ , a mark up to which oil had to be filled.

Lid of the oil cup:- The lid has four opening, which was used for stirrer, thermometer, an air inlet & a device for introducing the standard flame. The shutter provide at the top of the cup has a lever mechanism.

Heating jacket: A heating jacket containing air bath surrounds the oil. The assembly is heated in a controlled manner by keeping it on an electrical heater.

- Procedure:-
- 1) Clean thoroughly and dry the oil cup.
  - 2) Fill the cup with given sample of oil.
  - 3) Cover the lid and insert the thermometer & stirrer carefully.
  - 4) Heat the apparatus homogeneously in a manner that the temperature of oil increases by  $5-6^{\circ}\text{C}$  per minute with continuous stirring.
  - 5) When the temperature is within the range of anticipated flash point, the test flame is brought in contact with oil vapours.
  - 6) Record the temperature at which a flash appears in the form of weak sound and light. This temperature is known as the flash point of that sample.
  - 7) The procedure is continued until oil vapours catch fire which persists at least for 5 seconds. The temperature is recorded as the fire point of given sample of the oil.

Observation:-

S.No.	Temp ( $^{\circ}\text{C}$ )	Observation	Inference
1.	50	No flash Point	
2.	52	No flash Point	
3.	55	Flash Point	
4.	60	No fire Point	
5.	65	No fire Point	
6.	70	No fire Point	
7.	75	Fire Point	

Teacher's Signature

Results :-

The flash point of given oil sample:-  $55^{\circ}\text{C}$

The fire point of given oil sample:-  $75^{\circ}\text{C}$

Precaution:-

- 1) The cup & receiver should be properly washed with appropriate solvent.
- 2) The temperature of bath and oil cup should be same.
- 3) For each experiment the fresh oil has to be used to get correct value of flash and fire point.

Industrial Application:-

- 1) It is used to select the proper lubricants for various vehicles and machines.
- 2) The knowledge of flash & fire point is helpful in providing safeguards against fire hazards during storage, transportation, handling & use.
- 3) Liquids having flash point above  $140^{\circ}\text{F}$  are called combustible liquids & those having flash point less than  $140^{\circ}\text{F}$  are called flammable liquids.
- 4) Low flash point indicates possibility of formation of gas locks in fuel pipes.
- 5) The flash & fire point are useful in determining the transportation and storage temperature requirement for lubricants volatility & resistance of fire.
- 6) The flash point can be used to determine the transportation and storage temperature requirement for lubricants.

- 7) Lubricant producers can also use flash point to detect potential product contamination.
- 8) A lubricant exhibiting a flash point significantly lower than normal will be suspected of contamination with volatile products. Products with flash points less than  $38^{\circ}\text{C}$  will usually require special precautions for safe handling.
- 9) Flash point can help reveal both the quality of the crude oil from which the lubricant was derived.
- (e) To know about the quality of the refining process.
- II) Flash point may give some indication about the volatility & content of the most volatile components of the test oil.

### Viva Question

Q1 What do you mean by lubricants?

A1 Lubricants are substances used to reduce friction between moving surface and protect them from wear & tear. Example - oil, grease, graphite.

Q2 What are the functions of lubricants?

A1 Reducing friction, Minimize wear, cool surface, prevent rust, seal gaps, clean parts are the functions of lubricants.

Q3 What are the characteristics of a good lubricant?

Ans Good lubricant should have -

Proper viscosity, High thermal stability, low volatility, corrosion resistance, chemical stability, good spreadability.

Q4 What are the types of lubricant?

Ans Types of lubricants -

Liquid - oils (Petroleum or synthetic) etc.

Semi-Solid - greases etc.

Solid lubricants - graphite, molybdenum disulfide etc.

Gaseous lubricants - air or other inert gases (used in special application)

Q5 What are the properties of lubricants?

Ans Properties of lubricants - Viscosity, viscosity index, flash and fire point, pour point, oiliness, thermal stability, corrosion resistance.

Q6 Define Flash & fire point?

The lowest temperature at which a lubricant gives off enough vapour to ignite briefly (flash) when exposed to a flame. → Flash point.

The temperature at which the vapour continues to burn for at least 5 seconds after ignition known as fire point.

Q7 what is the significance of flash & fire point determination?

Ans Flash and Fire point determination help to ensure safety, assess flammability, ensure product quality and meet regularity standards.

Q8 Name the apparatus used for determination of flash & fire point.

Ans Apparatus for flash & fire points -

Pensky - Martens = For oil & lubricants

Cleveland open cup = for higher flash point liquids

Tag open cup = For lighter oils.

Q9 What are the important parts of Pensky - Martens apparatus?

Ans Parts of Pensky - Martens Apparatus -

- 1) Sample Cup 2) Heater 3) Thermometer
- 4) Test flame 5) Test Cover 6) Stirring Mechanism.

Q10 Give examples of liquid lubricants.

Ans Mineral oil, synthetic oil, vegetable oil, motor oil, gear oil, Hydraulic oil etc. are the example of liquid lubricants.