Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

Date:

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Principle:

Neutralisation of Na_2CO_3 solution by strong acid (HCl) occurs in two steps:

$Na_2CO_3 + HCl = NaHCO_3 + NaCl$ ($P^H = 8.3$ at the equivalence point)

$NaHCO_3 + HCl = NaCl + CO_2 + H_2O$ ($P^H = \sim 4$ at the equivalence point)

The acid base indicator is to be so selected that its P^H range for the colour change coincides with the sudden sharp change of P^H at the equivalence point. So at the first neutralisation point (PH = 8.3), phenolphthalein (P^H range 3.1-10) shows its colour change from pink to colourless. At this stage Na_2CO_3 consumes only half the amount of HCl required for complete neutralisation. If methyl orange (P^H range = 3.1 to 4.4) is added to this titrated solution and the titration with HCl is continued upto second equivalence point, then this titre value corresponds to the amount of HCl required to convert $NaHCO_3$ to NaCl (i.e. $NaHCO_3$ derived from Na_2CO_3 plus the amount of $NaHCO_3$ present in the original mixture.

1000ml 1(N) HCl $\equiv$ 53 g of Na_2CO_3 $\equiv$ 84 g of $NaHCO_3$

Experimental Data

Table-1: Standardization of supplied NaOH solution with the supplied standard (N/20) oxalic acid solution

No of titration	Volume of oxalic acid solution (ml)	Volume of NaOH solution required (ml)	Mean volume of NaOH solution (ml)	Strength of NaOH solution
1	25	22.1	22.1	1.1312 (N/20)
2	25	22.1		

Calculation:

Applying $V_1 \times S_1 = V_2 \times S_2$

Strength of NaOH solution (S_2) $= \dfrac{25 \times N/20}{22.1}$

$= \mathbf{1.1312 \ (N/20)}$

V_1 = Vol. of oxalic acid solution
S_1 = Strength of oxalic acid solution
V_2 = Vol. of NaOH solution

Table-2: Standardization of supplied HCl solution with the standardized (N/20) NaOH solution

No of titration	Volume of HCl solution (ml)	Volume of NaOH solution required (ml)	Mean volume of NaOH solution (ml)	Strength of HCl solution
1	25	19.5	19.5	0.8823 (N/20)
2	25	19.5		

Calculation:

Applying $V_1 \times S_1 = V_2 \times S_2$

Strength of HCl solution $(S_1) = \dfrac{19.5 \times 1.1312 \, (N/20)}{25}$

$= 0.8823 \, (N/20)$

V_1 = Vol. of HCl solution
V_2 = Vol. of NaOH solution
S_2 = Strength of NaOH solution

Table-3: Titration using phenolphthalein as indicator

No of titration	Volume of supplied mixture solution (ml)	Volume of HCl solution required (ml)	Mean volume of HCl solution (ml)
1	25	9.5	9.5
2	25	9.4	
3	25	9.6	

Table-4: Titration using methyl orange as indicator

No of titration	Volume of supplied mixture solution (ml)	Volume of HCl solution required (ml)	Mean volume of HCl solution (ml)
1	25	23.5	23.5
2	25	23.4	
3	25	23.6	

Calculation

Estimation of Na_2CO_3 solution:

Volume of HCl required for 1/2 mole Na_2CO_3 solution = 9.5 ml

Volume of HCl required for 1mole Na_2CO_3 solution = 2× 9.5 ml = 19 ml

1000 ml 1 (N) HCl solution $\equiv$ 53 g of Na_2CO_3

19 ml 0.8823 (N/20) $= \dfrac{53 \times 19 \times 0.8823}{1000 \times 20}$

$= 0.0444$ g of Na_2CO_3

25 ml supplied mixture sample solution contains 0.0444 g of Na_2CO_3

1000 " $= 0.0444 \times 40$

$= \mathbf{1.7769}$ g of Na_2CO_3

∴ The amount of Na_2CO_3 in the supplied mixture sample = **1.7769** g /lt

Estimation of $NaHCO_3$:

Volume of HCl required for $NaHCO_3$ solution present in the mixture = 23.5-2×9.5 = 4.5 ml

1000 ml 1(N) HCl solution $\equiv$ 84 g of $NaHCO_3$

4.5 ml 0.8823 (N/20) " $\equiv \dfrac{84 \times 4.5 \times 0.8823}{1000 \times 20}$ = 0.01667g of $NaHCO_3$

25 ml supplied solution contains 0.01667 g NaHCO$_3$

1000 ml   " $= \frac{0.01667 \times 1000}{25}$ g NaHCO$_3$

$= 0.6668$ g NaHCO$_3$

$\therefore$ Therefore, NaHCO$_3$ present in supplied solution $= 0.6668$ g/L

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Estimation of total hardness of water sample by complexometric EDTA titration

Date:

Principle:

Hardness of water is of two types- temporary hardness and permanent hardness. Temporary hardness is due to dissolved bicarbonates and permanent hardness is due to dissolved chlorides and sulphates, mainly of Ca^{2+}, Mg^{2+} and Fe^{2+}. Hardness is expressed interms of ppm of $CaCO_3$ (i.e. mg of $CaCO_3$ per 1000 ml of sample water).

Total hardness may be estimated complexometrically by titrating a known volume of the water sample with a standard EDTA solution in NH_4Cl-NH_3 buffer medium (P^H 10) using Erichrome Black- T (EBT) indicator.

EDTA, ethylenediamine tetraacetic acid, is commercially obtained as its disodium salt, $Na_2H_2EDTA.2H_2O$). If it reacts with metal ions (M^{2+} = Ca^{2+}, Mg^{2+}, Fe^{2+}) to form stable 1:1 complexes.

$$M^{2+} + H_2EDTA^{2-} \rightleftharpoons M(EDTA)^{2-} + 2H^+$$

$$\therefore EDTA \equiv M^{2+} \equiv CaCO_3$$

$$\therefore 1000 \text{ ml } 1 \text{ (M) EDTA} \equiv 100 \text{ g of } CaCO_3$$

Experimental Data

Table-1: Standardization of supplied EDTA solution with the supplied standard (M/100) zinc acetate solution

No of titration	Volume of zinc acetate solution (ml)	Volume of EDTA solution required (ml)	Mean volume of EDTA solution (ml)	Strength of EDTA solution
1	25	27.0	27	0.9259 (M/100)
2	25	26.9		
3	25	27.1		

Calculation:

Applying $V_1 \times S_1 = V_2 \times S_2$

Strength of EDTA solution (S_2) $= \frac{V1 \times S1}{V2}$ V_1 = Vol. of zinc acetate solution

$= \frac{25 \times M/100}{27}$ S_1 = Strength of zinc acetate solution

$= 0.9259$ (M/100) V_2 = Vol. of EDTA solution

Table-2: Estimation Hardness of water sample

No of titration	Volume of water sample (ml)	Volume of EDTA solution required (ml)	Mean volume of EDTA solution(ml)
1	50	7	7
2	50	7	

Calculation:

1000 ml 1 (M) EDTA solution ≡ 100 g of CaCO₃

$$7 \quad '' \quad 0.9259 \ (M/100) = \frac{100 \times 7 \times 0.9259}{1000 \times 100} \text{g of CaCO}_3$$

$$= 6.4813 \times 10^{-3} \text{g of CaCO}_3$$

50 ml water sample contains 6.4813×10^{-3} g of CaCO₃

$$10^6 = \frac{6.4813 \times 10^{-3} \times 10^6}{50}$$

Total hardness of supplied water = 129.626 ppm

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