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Title: Double titration
Date of experiment :

Aim

The purpose of this experiment is to find the composition of a sample of sodium carbonate mixture by titration.

Theory

Double indicator titration is used in checking the composition of a mixture of sodium carbonate and sodium hydrogen carbonate. First, no of mol of Na_2CO_3 in mixture can be directly calculated in the data of first titration. For the calculation of no of mol of $NaHCO_3$ need to involve the data from both 1^{st} and 2^{nd} data , because the first titration will give out $NaHCO_3$ also and it will contaminated with the $NaHCO_3$ in the mixture.

Requirements

watch glass
weighing bottle
spatula
sodium carbonate Na_2CO_3
250 cm3 beaker,
wash bottle of distilled water
glass rod
250 cm^3 volumetric flask
filter funnel,
dropper

Procedure

1. 10.00 g of the sodium carbonate is transferred onto the watch glass and weighted in the nearest 0.01g
2. A standard solution is prepared.
3. Burette is rinsed with HCL and then filled with the acid. The tip is also be rinsed.
4. The initial burette reading is recorded in the 'Trial column'
5. 25 $cm^3$of the sodium carbonate solution is absorbed by the pipette and the pipette is rinsed by the sample solution.
6. 25 cm^3 of the sodium carbonate solution is transferred to a conical flask
7. Water is added to the volumetric flask until it reach to the graduation mark
8. 2-3 drops of phenolphthalein indicator solution is added
9. Hydrochloric acid is run from the burette into the volumetric flask until the

solution turn from pink to colourless

10. Final reading of burette is recorded
11. The burette is refilled by HCL, the initial reading of burette is recorded
12. 2-3 drops of methyl orange indicator is added
13. Hydrochloric acid is added from the burette into the flask until the solution turn from yellow to orange.
14. The final reading of burette is recorded
15. The steps from 5 to 14 should be repeated 3 times
16. The burette and the tip is washed after the experiment.

Results and calculation

Table 1 (Preparation of the Standard solution)

Concentration of the Hydrochloric acid	0.5mol dm^{-3}
Molar Mass of sodium hydrogen carbonate	84 g mol^{-1}
Molar mass of sodium carbonate	106 g mol^{-1}
Mass of bottle and contents before transfer, m1	12.05g
Mass of bottle and contents after transfer, m2	2.05 g
Mass of the sample, m = (m1-m2)	10.00 g
Volume of solution, V	0.25 dm^{-3}

Table 2(The titration data and results with indicator solutions)

Phenolphthalein	**Trial**	**1st**	**2nd**	**3rd**
Final Burette Reading(I)/cm^3	30.1	11.0	11.5	12.05
Initial Burette Reading(I)/cm^3	19.2	3.75	4.15	4.70
Volume used(I)/cm^3	10.9	7.25	7.35	7.35
Mean Volume of HCl(aq) used(I)/cm^3				7.28
Methyl Orange	**Trial**	**1st**	**2nd**	**3rd**
Final Burette Reading(II)/cm^3	49.4	34.0	34.2	34.0
Initial Burette Reading(II)/cm^3	30.1	12.5	12.5	12.05
Volume used(II)/cm^3	19.3	21.5	21.7	21.95
Mean Volume of HCl(aq) used(II)/cm^3				21.7

First stage of titration

$Na_2CO_3(aq) + HCl(aq) >> NaHCO_3(aq) + NaCl(aq)$

Since HCL : Na_2CO_3 = 1:1

No of mol of Na_2CO_3 = Mean volume 1 of HCL used x Concentration of HCL

= 7.28 /1000 x 0.5

= 3.64 x 10^{-3} mol

Second stage of titration

NaHCO3(aq) + HCl(aq) >> NaCl(aq) + H2O(l) + CO2(g)

No of mole of $NaHCO_3$ = Mean volume 2 of HCL used x Concentration of HCL

= 21.7/1000 x 0.5

=0.01085 mol

Calculation

From above , No of mole of Na_2CO_3 in 250 cm^3 solution

= 3.64 x 10^{-3} mol

No of mole of $NaHCO_3$ in the 250cm^3 solution

= (No of mole of $NaHCO_3$ in second stage) - (No of mole of $NaHCO_3$ in first stage)

= 0.01085 – 3.64 x 10^{-3}

= 7.21 x 10^{-3} mol

Mass of Na_2CO_3 = 0.0364 x 106 = 3.8584 g

Which is around 3.9 g

Mass of $NaHCO_3$ = 0.0721 x 84 = 6.0564 g

Which is around 6.1 g

Therefore the percerage of Na_2CO_3 is 39% and the perecentage of $NaHCO_3$ = 61 %

Discussion

In doing the experiment of titration , several precaution should be taken.

- Wear safety goggles to prevent the splitting of acid onto our body
- take readings at eye level to avoid parallax errors
- The beaker,pipette and the flask should be washed properly with distilled water.
- The flask containing the indicator (phenolphthalein or methyl orange) must be shaken well while acid is added to it.
- Excess of indicator should not be used.
- To read the buret accurately, hold a white card with a black stripe behind the buret, with the black stripe below the meniscus, and the meniscus itself in front of the white region above the black stripe
- Mix the solution in the titration flask thoroughly after each addition of titrant, to ensure complete reaction before adding more.

Some inaccurate result may due to :

- The molarity of sodium carbonate solution was not accurate
- Calculation errors (e.g. converting mL to L)
- Not rinsing and drying the beaker for the acid
- Over titrating
- Acid or base left on the side of the flask or on the tip of the burette
- Errors reading volumes.
- Using pipette (10 mL is measured from 0 mL to 10 mL, not from 10 mL to empty)

There are many kinds of titration in chemistry. In the experiment , it is an acid – base titration. First, phenolphthalein is used , it is colorless below around pH 8.5, but turns red above around pH 9.0 , so in step I , when the phenolphthalein turn from pink to colourless , it is nearly to neutral but not exactly neutral because $NaHCO_3$ is slightly alkali.

After that , methyl orange is used because $NaHCO_3$ is a weak base . It changes from red below pH 3.1 to yellow above pH 4.4. Therefore , in the second part of titration, when the indicator turn from yellow to orange, the solution is in acidic but not exactly neutral . Therefore , the result obtained from above is not accurate. If we want to get a more accurate result , ph meter should be used but not indicator.

The calculation above has a little bit complicated. Since Na_2CO_3 only involve in the first titration , no of mol in Na_2CO_3 will exactly equal to the no of mol of HCL used. After that , we need to calculate No of mole of $NaHCO_3$ in the mixture by using the (No of mole of $NaHCO_3$ in second stage) - (No of mole of $NaHCO_3$ in first stage) because the No of mol of $NaHCO_3$ in second stage contain both $NaHCO_3$ from the mixture and that from the first titration. Thus , we need to minus the no of mole of $NaHCO_3$ in first stage to obtain the no of mol of $NaHCO_3$ in the mixture.

References

Data – from Lam Chi Ho (absent on the day of experiment)