

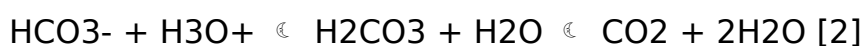
Quantitative analysis of soda ash essay sample



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Titration is a method of chemical analysis that can be used to determine the amount of analyte present in the solution through the determination of the endpoint of the reaction (Dartmouth College, 2000). In the experiment, the percent composition of soda ash was determined. Soda ash could be composed of NaOH, Na₂CO₃, NaHCO₃, or a mixture of NaOH and Na₂CO₃, and NaHCO₃ and Na₂CO₃. A mixture of NaOH and NaHCO₃ is impossible because OH⁻ and HCO₃⁻ will react to form CO₃⁻ and H₂O. This reaction could cause errors in the analysis because it could change the concentration of the HCl standard. To be able to determine the composition, acid-base titration, which uses the concept of a neutralization reaction, was used. Also, double-indicator titration was used since soda ash could contain two bases. This means that there could be two endpoints in the titration process.

Phenolphthalein and methyl orange indicators were used. Bromocresol green indicator could also be used in place of methyl orange indicator as it is also an acid-range indicator and actually encompasses a better and more suitable pH range for the experiment. The primary standard that was used to standardize HCl (titrant) was Na₂CO₃ which has 99% purity. CO₃²⁻ + H₃O⁺ ⇌ HCO₃⁻ + H₂O [1]



According to the University of Adelaide, primary standards must be extremely pure, stable, has no waters of hydration, and has a high molecular weight. These characteristics qualify Na₂CO₃ to be a valid primary standard for HCl. However, NaOH cannot be used as a primary standard for HCl. Obviously, NaOH has a relatively low molecular weight. Moreover, it easily absorbs water from the air, and it cannot be weighed and diluted so getting

its exact concentration would be not so accurate (Spurlock, 2012). Soda ash was weighed and diluted with boiled water. Boiled water removes CO₂ in the solution which could form H₂CO₃ when dissolved in water. H₂CO₃ could react with the base components of soda ash which could change the soda ash's composition concentration. Since the phenolphthalein indicator has a higher pH range (8.30-10.00) it was used first until the solution becomes clear. For the methyl orange indicator, the solution was heated when the color started changing. This is to remove the CO₂ that forms when HCO₃⁻ was being neutralized. Formation of CO₂ contributes to the change in color.

The volumes of HCl used at the phenolphthalein were 4.10 ± 0.05 mL and 4.30 ± 0.05 mL. The volumes of HCl used at the methyl orange endpoint were 8.20 ± 0.05 mL and 11.8 ± 0.05 mL. The second volume is higher than the first volume. This means that more acid was used to neutralize HCO₃⁻ than CO₃²⁻. If only CO₃²⁻ is present, both volumes must be equal theoretically because there is supposedly the same amount of moles being titrated. This means that there is more HCO₃⁻ than CO₃²⁻ so it can be concluded that HCO₃⁻ present. From these volumes and the concluded components on the soda ash, the percent composition was calculated. For the molarity of HCl, the equation

It was multiplied by two since the ratio of the H⁺ and CO₃²⁻ is two. The average of the computed molarity was then used to calculate for the percent composition.

For Na₂CO₃,

For NaHCO₃

Table 1. Percent Composition of Soda Ash Components % Composition

	Trial 1	Trial 2	Average
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Na ₂ CO ₃	13.0 ± 10.6	13.5 ± 11.1	13.3 ± 15.3
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NaHCO ₃	10.3 ± 8.5	18.7 ± 15.3	14.5 ± 17.5
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