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An investigation into the non - primary standard nature of sodium hydroxide (NaOH): A classroom demonstration

A. G. Kassim
Department of Chemistry,
Federal College of Education, Zaria

ABSTRACT

Samples of sodium hydroxide were exposed to air and the level of impurities absorbed was determined. General increase in mass of sample was found to be about 95% when exposed for about 24 hours. The amount of Na_2CO_3 content increased by about 300% and the NaOH content decreased by about 13.74%. This information can be used to teach the concept of non- primary standard nature of NaOH to secondary school students. The procedure can also be used to expose them to the idea of experimentation in general.

INTRODUCTION

Preparation of solutions is an integral part of chemistry and its importance cannot be over-emphasized. Various forms of chemical analysis involve preparation of solutions of accurately known concentrations, the so called standard solutions. For this to be successful the substance directly involved in the preparation of the standard solution must be a primary standard substance otherwise serious errors can be introduced into the analysis and the results rendered invalid. Vogel (1975) described a primary standard substance as a substance which can be obtained in a high state of purity, anhydrous, non- deliquescent, non-hygroscopic, stable in air, and readily soluble in the required solvent.

If a substance is a primary standard, a solution of accurately known concentration of the substance can be prepared by dissolving a weighed amount of the pure material in a solvent and diluting to an exact volume in a volumetric flask.

Many common laboratory reagents encountered at the secondary school level are not primary standards such as hydrochloric acid, sulphuric acid, sodium hydroxide and nitric acid. This is however taken for granted and solutions for titration experiments are indiscriminately prepared with the pretense that it does not matter at this level. It is good however to always point out to students the necessity of preparing solutions of accurately known concentration. This will help them in developing the proper orientation in chemical analysis and thus becoming better chemists in the future.

This paper is aimed at describing a simple procedure to clearly demonstrate the fact that sodium hydroxide (NaOH) is not a primary standard substance under ordinary conditions. Students can be asked to perform the experiment themselves and to report their findings. This can be used to introduce them to the principle of acid-base titration. The exercise is likely to ginger their interest more than when ready- made solution of NaOH is provided for them. This procedure will expose students not only to the technique of titration but to the idea of experimentation in general.

Behaviour of NaOH when exposed to air

When exposed to air, NaOH absorbs enough moisture from the atmosphere to form a saturated solution if exposed for sufficiently long time.

$$NaOH_{(s)} + H_2O \rightarrow NaOH_{aq}$$

This phenomenon is so fast that within just a few minutes of exposure, the pellets become moist and sticky. Simultaneously the NaOH solution being formed absorbs carbon dioxide from the air to form Na_2CO_3

$$2Na\ OH_{(aq)} + CO_2 \rightarrow Na_2CO_{3(aq)} + H_2O$$

These two processes make samples of Na OH to be contaminated with water and Na_2CO_3. Therefore a standard solution cannot be prepared by dissolving a known mass of the solid in a definite volume of water.

EXPERIMENTAL PROCEDURE

General Purpose Reagent NaOH was first analyzed for NaOH and $Na_2\ CO_3$ content present in the fresh samples. This was carried out by the double indicator method using hydrochloric acid.

2.00g of the solid sample were exposed to air in a 25ml beaker. The beaker and content were immediately weighed and then exposed to air for 24 hours. The beaker and its contents were again weighed . All the

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	Vol. HCl for NaOH content (cm^3)	Vol. Hcl for Na_2CO_3 contents (cm^3)	Increase in mass of sample (g)	% Increase in mass of sample	% increase in Na_2CO_3 content	% decrease in NaOH content
Before exposure	21.1	0.4	-	-	-	-
After exposure	18.2	1.6	1.9	95	300	13.74

mixture obtained, which has turned to a liquid substance, was dissolved in 250cm^3 of solution in a volumetric flask. 25.00cm^3 portions of the solution were titrated with standard hydrochloric acid using the double indicator method. The table below shows the average of three separate determinations.

DISCUSSION AND CONCLUSION

Looking at the results from the table it can be seen that the amount of Na_2CO_3 increased by about 300% after the exposure and the total percentage increase in mass of impurities accumulated (Na_2CO_3 and water) amounted to about 95%. The NaOH content of the sample decreased by about 13.74%. The increase in the total amount of impurities and the decrease in the NaOH
content means that a sample of NaOH so exposed cannot be used to get accurate results in a titration.

Though sodium hydroxide is normally stored in covered containers in the laboratory, such samples can remain for many months or even years without being exhausted. During this period the containers are opened many times as samples are taken out. This exposes the NaOH to air and the subsequent absorption of impurities.

It is necessary to point out all these to beginners in chemistry so as to give them the proper orientation as they develop their skill of chemical analysis.

REFERENCES

Vogel, A.I. (1975) Quantitative in organic Analysis, ELBS, London.

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