이산화탄소 흡수관에 흡수된 CO_2 부피 측정방법

How to calculation of CO_2 volume

There are many techniques for analyzing CO_2, such as gas chromatography, spectrophotometry, gravimetric absorption, etc., but this lab is supposed to be about titrations, so we will focus on an analysis involving a titration.

Carbon dioxide readily reacts with aqueous hydroxides to make carbonates and water.

$$2NaOH_{(aq)} + CO_{2(g)} \rightarrow Na_2CO_{3(aq)} + H_2O_{(l)}$$

So if someone bubbles air through a solution of NaOH, the CO_2 in the air will rapidly react with the NaOH to make Na_2CO_3, which can then be easily analyzed by a titration.

During the titration, $Na_2CO_{3(aq)}$ will react with $HCl_{(aq)}$ in two steps as described below.

$$Na_2CO_{3(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + NaHCO_{3(aq)}$$
$$NaHCO_{3(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

It is as though there are two bases for the HCl to react with, Na_2CO_3 then $NaHCO_3$. Not surprisingly, the overall reaction with HCl (an acid) basically reverses the reaction in which the $CO_{2(g)}$ was originally captured in the NaOH (a base) solution.

You can determine the moles of CO_2 associated with the titration sample, knowing the volume and concentration of the HCl solution needed to complete either one of the steps in the reaction. That is…

$$\text{moles } CO_2 = \text{vol HCl} \times \frac{\text{moles HCl}}{\text{L}} \times \frac{1 \text{ mole } Na_2CO_3}{1 \text{ mole HCl}} \times \frac{1 \text{ mole } NaHCO_3}{1 \text{ mole } Na_2CO_3} \times \frac{1 \text{ mole } CO_2}{1 \text{ mole } NaHCO_3}$$

or

$$\text{moles } CO_2 = \text{vol HCl} \times \frac{\text{moles HCl}}{\text{L}} \times \frac{1 \text{ mole } NaHCO_3}{1 \text{ mole HCl}} \times \frac{1 \text{ mole } CO_2}{1 \text{ mole } NaHCO_3}$$

이산화탄소 흡수관에 있는 2 M NaOH 용액 8 mL 중 1 mL를 취하여 100 mL 비이커에 넣고 49 mL의 증류수를 넣어 희석한다. 0.1 M HCl 용액을 준비하여 비이커에 적정하고 pH 8.3에서 pH 4.3까지 들어간 HCl 용액의 부피를 측정한다. 예를 들어 pH 8.3까지 64.3 mL의 염산이 소요되고 pH 4.3까

지 59.8 mL의 염산이 들어갔다면

$$(64.3-59.8)\ \text{mL HCl} \times \frac{0.1\ \text{moles HCl}}{1000\ \text{mL}} \times \frac{1\ \text{mole } HCO_3^-}{1\ \text{mole HCl}} \times \frac{1\ \text{mole } CO_2}{1\ \text{mole } NaHCO_3}$$

$$= 0.00045\ \text{moles } CO_2$$

흡수관에 들어있던 NaOH용액은 8 mL 이므로 **0.0036 moles CO_2**가 흡수되었음을 알 수 있다. 이를 100% 이산화탄소 부피로 계산을 하면

$$0.0036\ \text{moles } CO_2 \times \frac{22.4\ \text{L}}{1\ \text{mole}} \times \frac{(273+20)}{273} = 86.5\ \text{mL of } 100\%\ CO_2$$

86.5mL of 100% CO_2가 된다.