Preparation of a Standard Solution

Yiyang Gao

November 9, 2019

1 Aim

To prepare a standard solution of ethanedioic acid of a concentration of 0.100 $\mathrm{mol\,dm^{-3}}$ by dissolving a known amount of the ethanedioic acid into a known amount of water. This progress gives us a standard solution that its concentration is precisely known. Then the ethanedioic acid will be used to find the concentration of an alkali solution by titration.

2 Introduction

In Chemistry, standard solutions are used in order to perform volumetric analysis, in which the concentration of a unknown concentration substance can be determined by using titration, where an acidic solution and an alkali solution are mixed to form the state of neutralization. In this lab, 3.152 g of ethanedioic acid will be used based on its highly suitable and desirable attributes: Highly pure, stable, solid at room temperature, dissolves in water and has a high relative molecular mass.

3 Materials

1. 3.152 g of Ethandioic Acid ($(COOH)_2 \cdot 2\,H_2O$)
2. 500 cm^3 distilled water

4 Apparatus

1. 250 cm^3 beaker
2. 250 ± 0.15 cm^3 volumetric flask with stopper
3. 250cm^3 conical flask
4. electronic weighing scale ($\pm$0.001g)
5. metal spatula

6. plastic weighing boat
7. glass stirring rod

5 Safety Measures

Ethanedioic acid is corrosive, irritant and can cause health hazard to body [1]. Avoid inhaling the substance and contact with the skin.

6 Procedure

1. Turn on the electronic weighing, balance
2. Place the plastic weighing boat onto the weighing pan
3. Press the tare / zero button
4. Carefully use the metal spatula to measure out ethandioic acid ($(COOH)_2 \cdot 2\,H_2O$) as close to 3.152g as possible
5. Remove the plastic weighing boat containing the acid
6. Turn off the electronic weighing scale
7. Use 100cm^3 distilled water to rinse out the 250cm^3 beaker and the 250 ± 0.15cm^3 volumetric flask, to ensure that no impurities are present in them
8. Transfer the ethandioic acid ($(COOH)_2 \cdot 2\,H_2O$) from the plastic weighing boat to the 250cm^3 beaker, taking care not to let any particles of the powder go to waste.

   One approach can be to rinse the plastic weighing boat and direct the liquid into the beaker

   Another approach can be to bend the plastic weighing boat and tap on its back, forming a channel which the remaining particles can be transferred to the beaker
9. Pour 100cm^3 of the distilled water into the beaker
10. Stir the solution with the glass stirring rod until the acid dissolves completely
11. Carefully transfer the solution into the 250 ± 0.15cm^3 volumetric flask

    During the transfer, use the glass stirring rod in order to direct the resulting solution into the beaker
12. Pour the remaining 150cm^3 distilled water to the 250cm^3 beaker

    Also, rinse the glass stirring rod as well by pouring the water from the $\frac{1}{2}$ position of the glass stirring rod in order to rinse all the remaining particles on the glass stirring rod as much as possible

13. Transfer the resulting liquid into the $250 \pm 0.15\text{cm}^3$ volumetric flask
14. Put the stopper on the $250 \pm 0.15\text{cm}^3$ volumetric flask
15. Shake the $250 \pm 0.15\text{cm}^3$ volumetric flask well, so that way the solution is completely mixed
16. Calculate the exact concentration of the standard solution produced (see Section 7)
17. Label the $250 \pm 0.15\text{cm}^3$ volumetric flask including information below with a masking tape and pen:
    (a) Concentration of the solution
    (b) Date the solution was made
    (c) Initials of the makers

7 Calculation

$(\text{COOH})_2 \cdot 2\,\text{H}_2\text{O}$ has a molar mass of $126.08\text{g}\,\text{mol}^{-1}$, and for this experiment $0.1\text{mol}\,\text{dm}^{-3}$ are required.

Molar mass of ethandioic acid ($(\text{COOH})_2 \cdot 2\,\text{H}_2\text{O}$):

$$\begin{aligned}
\frac{1\text{mol}}{126.08\text{g}\,\text{mol}^{-1}} &= \frac{0.1\text{mol}}{x} \\
(1\text{mol})(x) &= (0.1\text{mol})(126.08\text{g}\,\text{mol}^{-1}) \\
(1\text{mol})(x) &= 12.608\text{g} \\
x &= 12.608\text{g}\,\text{mol}^{-1}
\end{aligned}$$

$12.608\text{g}\,\text{mol}^{-1}$ is required.

When making 250dm^3 solution, we will actually need:

$$12.608\text{g}\,\text{mol}^{-1}\frac{250\text{dm}^{-3}}{1000\text{mol}\,\text{dm}^{-3}} = 3.152\text{g}$$

of $(\text{COOH})_2 \cdot 2\,\text{H}_2\text{O}$.

Actual experiment weight of $(\text{COOH})_2 \cdot 2\,\text{H}_2\text{O}$ is 3.150g, so the actual concentration of the solution is:

$$\begin{aligned}
\frac{3.150\text{g}}{x} &= \frac{3.152\text{g}}{0.1\text{mol}\,\text{dm}^{-3}} \\
(3.152\text{g})(x) &= (3.150\text{g})(0.1\text{mol}\,\text{dm}^{-3}) \\
(3.152\text{g})(x) &= 0.315\text{g}\,\text{mol}\,\text{dm}^{-3} \\
x &= 0.099937\text{mol}\,\text{dm}^{-3}
\end{aligned}$$

7.1 Error analysis

- *Error in mass measurements* $\pm 0.001\text{g} \rightarrow 100 \times \dfrac{0.001}{3.148} = 0.0318\%$
- *Error in volume measurement (volumetric flask)* $\pm 0.15\text{cm}^3 \rightarrow 100 \times \dfrac{0.15}{250} = 0.06\%$
- *Purity* 0.5%

Total Error: 0.5918% **or** 0.6%

References

[1] "Oxalic Acid." *National Center for Biotechnology Information. PubChem Compound Database*, U.S. National Library of Medicine, pubchem.ncbi.nlm.nih.gov/compound/Oxalic-acid.