Lab One
AP Chemistry

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- This Lab Requires:
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- $NaHCO_3 + HCl \longrightarrow H_2O + NaCl + CO_2$
  1. Calculate how much NaCl formed
  2. Calculate Limiting Factor
  3. Determine how much NaCl should form
  4. Calculate % yield

2 Data

1. Mass of dish: 36.72[g]
2. Mass of $NaHCO_3$ (Baking Soda): 2.00[g]
3. Molarity of HCl: $6[\text{mol}\,\text{L}^{-1}]$
4. Moles of HCl: $3[\cancel{\text{mL}}] \cdot 6[\text{mol}\,\text{L}^{-1}] \cdot \frac{1[\cancel{\text{L}}]}{1000[\cancel{\text{mL}}]} = .018[\text{mol}_{\text{HCl}}]$
5. Mass Dish + NaCl after procedure: 38.00[g]

3 Question and Statement of Purpose

What is the theoretical mass of NaCl formed vs the experimental mass? What is the percent yield?

4 Calculations

The amount of NaCl formed may be easily determined by finding the excess $NaHCO_3$ and subtracting that from the change in the mass of the dish ($\Delta m_{dish} - m_{\mathrm{NaHCO_3}}$ (1)):

$$\begin{aligned} \Delta m_{dish} &= 38.00[\mathrm{g}] - 36.72[\mathrm{g}] \\ &= 1.28[\mathrm{g_{NaCl}}] \\ m_{\mathrm{NaHCO_3}} &= .006[\mathrm{mol}] \cdot 84 = .504[\mathrm{g}] \\ \mathrm{NaCl}Formed &= 1.28 - .504 = .776[\mathrm{g}] \end{aligned} \tag{1}$$

To find the limiting factor, one must first find the mass per mole (2). Then, it is necessary to find the moles of each molecule by dividing the experimental mass of the molecule by the mass per mole (3). Since, in this case, the amount of moles of each substance is one, the amount with the least moles is the limiting factor (4).

$$\begin{aligned} \frac{m_{\mathrm{NaHCO_3}}}{\mathrm{mol_{NaHCO_3}}} &= 23 + 1 + 12 + 3(16) \\ &= 84 \left[\frac{\mathrm{g}}{\mathrm{mol}}\right] \end{aligned} \tag{2}$$

$$\frac{2[\mathrm{g_{NaHCO_3}}]}{84[\mathrm{g_{NaHCO_3}}]} = .024[\mathrm{mol_{NaHCO_3}}] \tag{3}$$

$$\begin{aligned} .018[\mathrm{mol_{HCl}}] &< .024[\mathrm{mol_{NaHCO_3}}] \\ \therefore \mathrm{HCl}&\text{ is the limiting factor} \end{aligned} \tag{4}$$

Because the limiting factor is the $.018[\mathrm{mol_{HCl}}]$, and the chemical equation involves only one mole of each molecule, then .018[mol] of each molecule will be formed. To switch this value to grams, multiply the grams per mole by the amount of moles (5).

$$\begin{aligned} .018[\mathrm{mol_{NaCl}}] \cdot 58 \left[\frac{\mathrm{g}}{\mathrm{mol}}\right] &= m_{\mathrm{NaCl}} \\ &= 1.044[\mathrm{g_{NaCl}}] \end{aligned} \tag{5}$$

Finally, to calculate the percent yield, one must divide the experimental mass by the theoretical mass, while multiplying by 100% (6).

$$\frac{.776[\mathrm{g_{NaCl}}]}{1.044[\mathrm{g_{NaCl}}]} \cdot 100\% = 74.4\% \tag{6}$$

5 Conclusion

The results of this laboratory experiment demonstrate our percent yield as 74.4%. Therefore, it is evident that this experiment yielded a lesser amount of Sodium Chloride (NaCl), which is to be expected, given the limiting factor of Hydrochloric Acid (HCl).