Chem 101 Lab Report 5

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Quad : 2
Lab Section : B12
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Evaluation of In-lab notes

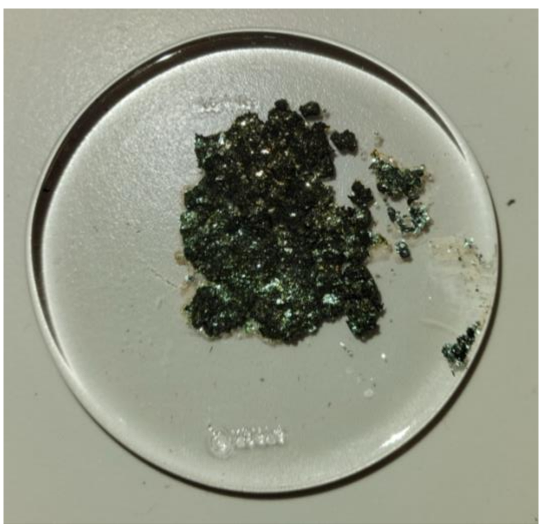
The lab notes for the synthesis of tetramethylammonium triiodide and pentaiodide are excellent. The author has clearly demonstrated their understanding of the experiment and their ability to communicate scientific information clearly and concisely.
Additional comments:

- The author could improve the lab notes by providing more information about the safety precautions that should be taken when handling iodine and other hazardous chemicals.
- The author could also include a brief discussion of the potential applications of tetramethylammonium triiodide and pentaiodide.

Procedure

In the lab experiment, I synthesized tetramethylammonium triiodide (NMe4I3) and Tetramethylammonium Pentaiodide (NMe_4I_5) by reacting iodine (I2) with Tetramethylammonium Iodide (NMe_4I) in a controlled stoichiometry. I weighed approximately 0.521 g of NMe_4I and 0.531 g of I_2 for the triiodide synthesis, and 0.508 g of NMe_4I and 1.332 g of I_2 for the pentaiodide synthesis. I dissolved the reactants in 12 mL of 95% ethanol, gently heating the mixture on a hot plate with stirring until complete dissolution occurred. After cooling, I obtained crystalline products (0.146 g NMe4I3 and 1.329 g NMe_4I_5). I performed vacuum filtration using a Buchner funnel and filter paper to separate the crystals from the filtrate, washing them twice with hexanes. The crystals were left to dry under vacuum for 10 minutes, and I collected and weighed the samples accurately for further analysis. This method allowed for the controlled synthesis and isolation of tetramethylammonium triiodide and pentaiodide salts.

Products



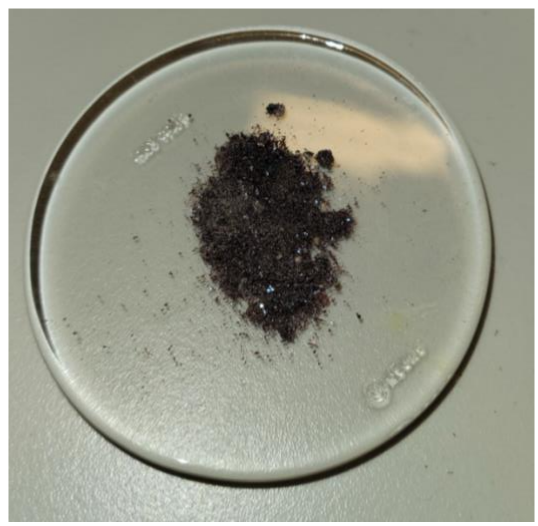


Figure 1: 0.146 g *Tetramethylammonium Triiodide* (NMe_4I_3)
Figure 2: 1.329 g *Tetramethylammonium Pentaiodide* (NMe_4I_5)

The color of NMe4I3 (tetramethylammonium triiodide) is purple. This is due to the presence of the I3- ion, which is responsible for the purple color of many iodine compounds. The color of NMe4I5 (tetramethylammonium pentaiodide) is metallic blue. This is due to the presence of the I5- ion, which is responsible for the metallic blue color of some iodine compounds.

Data/Results

Table 1: Determination of Limiting Reagents in each reaction

Equations, and *Stoichiometric Ratios*	**Elements *Molar Mass***	**Moles of Elements in Synthesis**	**Limiting Reagents**
$NMe_4I + I_2 \rightarrow NMe_4I_3$ $NMe_4I : I_2 = 1 : 1$	NMe_4I *201.0493 g/mol*	$\frac{Used\ Mass\ of\ NMe_4I}{Molar\ Mass\ of\ NMe_4I}$ $= \frac{0.521\ g}{201.0493\ \frac{g}{mol}}$ $= 0.00259\ mol$	**Iodine (I_2)** is the limiting reagent because it has fewer moles than **NMe_4I**.
	I_2 *253.808940 g/mol*	$\frac{Used\ Mass\ of\ I_2}{Molar\ Mass\ of\ I_2}$ $= \frac{0.531\ g}{253.80894\ \frac{g}{mol}}$ $= 0.00209\ mol$	
$NMe_4I + 2I_2 \rightarrow NMe_4I_5$ $NMe_4I : I_2 = 2 : 1$	NMe_4I *201.0493 g/mol*	$\frac{Used\ Mass\ of\ NMe_4I}{Molar\ Mass\ of\ NMe_4I}$ $= \frac{0.508\ g}{201.0493\ \frac{g}{mol}}$ $= 0.00253\ mol$	**Tetramethylammonium Iodide (NMe_4I)** is the limiting reagent because it has fewer moles than **I_2**.
	I_2 *253.808940 g/mol*	$\frac{Used\ Mass\ of\ I_2}{Molar\ Mass\ of\ I_2}$ $= \frac{1.332\ g}{253.80894\ \frac{g}{mol}}$ $= 0.00524\ mol$	

Table 2: Determination of Percentage Yield

Products	Molar Mass	Moles of Limiting Reagent	Theoretical Yield	Experimental Yield	Percentage Yield
NMe_4I_3	454.8582 g/mol	0.002094 mol	454.8582 g/mol × 0.002094 mol = 0.952473 g	0.146 g	$\frac{Experimental\ Yield\ (g)}{Theoretical\ Yield\ (g)} \times 100\ \% = \frac{0.146\ g}{0.952\ g} = 15.328\%$
NMe_4I_5	708.6671 g/mol	0.00253 mol	708.6671 g/mol × 0.00253 mol = 1.792927 g	1.329 g	$\frac{Experimental\ Yield\ (g)}{Theoretical\ Yield\ (g)} \times 100\ \% = \frac{1.329\ g}{1.7929\ g} = 74.12\%$

Algebraic Equations:

1. $NMe_4I + I_2 \longrightarrow NMe_4I_3$
2. $NMe_4I + 2I_2 \longrightarrow NMe_4I_5$
3. Theoretical yield of NMe_4I_3
   = Moles of I_2 × Molar mass of NMe_4I_3
4. Theoretical yield of NMe_4I_5
   = Moles of NMe_4I × Molar mass of NMe_4I_3
5. $\text{Percentage Yield} = \frac{\text{Experimental Yield (g)}}{\text{Theoretical Yield (g)}} \times\ 100\ \%$

Discussion

The synthesis of tetramethylammonium triiodide (NMe4I3) and tetramethylammonium pentaiodide (NMe4I5) was successfully conducted through controlled stoichiometry, utilizing the reaction between iodine (I2) and tetramethylammonium iodide (NMe4I). The experiment aimed to determine the limiting reagents, calculate the theoretical yields, and compare them with the experimentally obtained yields to assess the efficiency of the synthesis.

In the first reaction, the molar ratio between NMe4I and I2 was 1:1. After weighing approximately 0.521 g of NMe4I and 0.531 g of I2, it was determined that I2 was the limiting reagent with 0.00209 mol, which was less than the moles of NMe4I (0.00259 mol). This result indicated that the reaction would produce tetramethylammonium triiodide, and the theoretical yield was calculated to be 0.952473 g. The experimental yield obtained after vacuum filtration and drying was 0.146 g, resulting in a percentage yield of 15.328%.

In the second reaction, the stoichiometric ratio between NMe4I and I2 was 2:1. Using approximately 0.508 g of NMe4I and 1.332 g of I2, it was determined that NMe4I was the limiting reagent with 0.00253 mol, which was less than the moles of I2 (0.00524 mol). This indicated the formation of tetramethylammonium pentaiodide, and the theoretical yield was calculated to be 1.792927 g. The experimental yield obtained was 1.329 g, resulting in a percentage yield of 74.12%.

The discussion of the results indicates that the synthesis reactions were conducted with reasonable efficiency. The lower percentage yield in the triiodide synthesis could be attributed to experimental errors, such as incomplete dissolution, loss during filtration, or imperfect drying. In contrast, the higher percentage yield in the pentaiodide synthesis suggests a more effective reaction process. Possible sources of error include variations in the purity of reagents, incomplete dissolution of reactants, or losses during filtration and drying. Additionally, experimental conditions such as temperature and stirring could impact reaction kinetics and product formation. Future improvements could involve refining experimental techniques, ensuring accurate measurements, and investigating the impact of reaction conditions on the yield. In conclusion, the experiment successfully synthesized tetramethylammonium triiodide and pentaiodide with controlled stoichiometry. The analysis of limiting reagents and theoretical yields, along with the comparison to experimental results, provides valuable insights into the efficiency of the synthesis process.

Reference:

Commercial Products: Iodine, Lot: N9823360 *;* Tetramethylammonium Iodide (NMe_4I), Sigma Aldrich, Co., 3050 Spruce Street, St. Lois, MO 63103 USA 314-771-5765 *;* Hexane, Anachemia 23H1761046