Help I Need The Answer To These 4NH_3+ 3 O_2 2 NO+6 H_2 O1. How Many Grams Of NO Can Be Produced From

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Understanding chemical reactions and their stoichiometry is fundamental in chemistry, especially when calculating the amount of products formed from given reactants. If you're working with the reaction:

$4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$

and need to determine how many grams of nitric oxide (NO) can be produced from a specific amount of reactants, you've come to the right place. This guide will walk you through the process step-by-step, covering key concepts such as molar ratios, molar masses, and stoichiometric calculations, ensuring you can confidently solve similar problems in the future.

Understanding the Reaction and Its Components

Before diving into calculations, it's essential to understand the reaction's details:

The Balanced Chemical Equation

- The given reaction is: $4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$
- This is a balanced equation, meaning the number of atoms of each element is conserved on both sides.

What the Reaction Tells Us

- For every 4 moles of ammonia (NH_3), 2 moles of nitric oxide (NO) are produced.
- The molar ratio between NH_3 and NO is 4:2 or simplified as 2:1.
- It also indicates that 3 moles of oxygen (O_2) produce 2 moles of NO.

Relevance for Calculations

- To find the grams of NO produced, we need to know the amount of reactant used (e.g., NH_3 or O_2) in moles.
- Once the amount in moles is known, we use the molar ratio to find moles of NO.
- Finally, convert moles of NO to grams using molar mass.

Step-by-Step Calculation Approach

To determine how many grams of NO can be produced, follow these general steps:

1. Identify the Reactant and Its Quantity

- The problem should specify the amount of a reactant (e.g., grams of NH_3 or O_2).
- Convert that quantity to moles using molar mass.

2. Use the Stoichiometric Ratio

- Use the balanced equation to find the molar ratio between the reactant and NO.
- Multiply the moles of reactant by this ratio to find moles of NO produced.

3. Convert Moles of NO to Grams

- Multiply the moles of NO by its molar mass to get grams.

4. Finalize the Calculation

- Present the result, ensuring units are consistent and calculations are clear.

Calculating the Moles and Grams of NO Produced

Let’s illustrate this process with a specific example.

Example Scenario:

Suppose you start with 50 grams of ammonia (NH_3), and you want to find out how many grams of nitric oxide (NO) can be produced.

Step 1: Convert Grams of NH_3 to Moles

- Molar mass of NH_3:

  - Nitrogen (N): 14.01 g/mol

  - Hydrogen (H): 1.008 g/mol

- NH_3 molar mass = 14.01 + (3 × 1.008) = 14.01 + 3.024 = 17.034 g/mol

- Convert grams to moles:

$$
\text{Moles of NH}_3 = \frac{50\, \text{g}}{17.034\, \text{g/mol}} \approx 2.94\, \text{mol}
$$

Step 2: Use the Stoichiometric Ratio to Find Moles of NO

- From the balanced equation:

4 NH_3 → 2 NO

- Molar ratio:

$$
\frac{2\, \text{mol NO}}{4\, \text{mol NH}_3} = \frac{1}{2}
$$

- Calculate moles of NO:

$$
2.94\, \text{mol NH}_3 \times \frac{1\, \text{mol NO}}{2\, \text{mol NH}_3} = 1.47\, \text{mol NO}
$$

Step 3: Convert Moles of NO to Grams

- Molar mass of NO:

$$
\text{N} = 14.01\, \text{g/mol}, \quad \text{O} = 16.00\, \text{g/mol}
$$

$$
\text{NO} \text{ molar mass} = 14.01 + 16.00 = 30.01\, \text{g/mol}
$$

- Grams of NO:

$$
1.47\, \text{mol} \times 30.01\, \text{g/mol} \approx 44.07\, \text{g}
$$

Result: Starting with 50 grams of NH_3, approximately 44.07 grams of NO can be produced under ideal conditions.

Additional Considerations and Factors

While the above calculation provides a theoretical maximum, real-world scenarios may involve additional factors.

1. Reaction Efficiency

- Not all reactions proceed to completion; yield may be less than 100%.
- To account for this, multiply the theoretical amount by the reaction yield percentage.

2. Limiting Reactant

- If multiple reactants are involved, identify the limiting reactant to determine the maximum amount of product.
- In this reaction, if you have excess oxygen, ammonia limits the amount of NO produced; if oxygen is limiting, the calculation differs.

3. Purity of Reactants

- Impurities in reactants reduce actual product yield, so adjust calculations accordingly.

4. Temperature and Pressure Conditions

- These can affect reaction rates and yields but do not alter stoichiometric calculations.

Summary of Key Steps and Formulas

Step	Description	Formula	Example Calculation
1	Convert grams of reactant to moles	$\text{moles} = \frac{\text{grams}}{\text{molar mass}}$	$\frac{50\, g}{17.034\, g/mol} \approx 2.94\, mol$
2	Use molar ratio to find moles of product	$\text{moles of product} = \text{moles of reactant} \times \frac{\text{coefficient of product}}{\text{coefficient of reactant}}$	$2.94 \times \frac{2}{4} = 1.47\, mol$
3	Convert moles of product to grams	$\text{grams} = \text{moles} \times \text{molar mass}$	$1.47 \times 30.01 \approx 44.07\, g$

Conclusion: Mastering the Calculation of NO Production

Calculating the amount of nitric oxide (NO) produced from a specified amount of reactants involves understanding the balanced chemical equation, converting quantities to molar units, applying molar ratios, and converting back to grams. By following the outlined steps and understanding the fundamental concepts of stoichiometry, you can solve similar problems efficiently and accurately. Whether dealing with laboratory experiments or industrial processes, these calculations are vital for optimizing reactions, estimating yields, and understanding chemical efficiencies.

Remember, always double-check your molar masses, units, and ratios, and consider real-world factors such as reaction yields and purity to refine your estimates. With practice, these calculations become straightforward and an essential skill in the chemist's toolkit.

Frequently Asked Questions

What is the balanced chemical equation for the reaction involving 4 NH_3

and 3 O_2 producing NO and H_2O?

The balanced chemical equation is 4 NH_3 + 3 O_2 → 2 NO + 6 H_2O.

How do I calculate the grams of NO produced from a given amount of NH_3?

First, determine the moles of NH_3 you have, then use the molar ratio from the balanced equation (4 mol NH_3 to 2 mol NO). Convert moles of NO to grams using its molar mass (about 30.01 g/mol).

What is the molar mass of NO, and why is it important in this calculation?

The molar mass of NO is approximately 30.01 g/mol. It is essential for converting moles of NO into grams after determining the moles produced from the reaction.

If I start with 10 grams of NH_3, how many grams of NO can be produced?

First, convert 10 g NH_3 to moles: 10 g / 17.03 g/mol ≈ 0.588 mol. Using the molar ratio (4 mol NH_3 to 2 mol NO), moles of NO produced = 0.588 mol × (2/4) = 0.294 mol. Convert to grams: 0.294 mol × 30.01 g/mol ≈ 8.82 g NO.

What assumptions are made when calculating the amount of NO produced in this reaction?

Assumptions include complete reaction with no side reactions, the reaction goes to completion, and the starting materials are pure and measured accurately.

How does limiting reactant affect the amount of NO produced in this reaction?

The limiting reactant determines the maximum amount of NO that can be produced. If NH_3 or O_2 is in excess, the limiting reactant will cap the amount of NO formed based on its quantity.

What are common real-world applications of this reaction involving ammonia and oxygen?

This reaction is part of nitric acid production in the Ostwald process and is relevant in producing nitric oxide for various industrial processes, including fertilizer manufacturing and chemical synthesis.

Additional Resources

Help I Need The Answer To These 4NH_3 + 3O_2 → 2NO + 6H_2O: How Many Grams Of NO Can Be Produced From?

Introduction

Chemical reactions are the backbone of numerous scientific and industrial processes. Understanding how to manipulate these reactions for desired outputs is fundamental for chemists, engineers, and students alike. One such reaction that garners significant interest is the oxidation of ammonia (NH_3) to nitric oxide (NO), a critical step in the production of nitric acid, fertilizers, and various industrial applications.

The reaction in question:

$4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$

This reaction, often referred to as the Ostwald process's initial step, involves the oxidation of ammonia to nitric oxide, which subsequently undergoes further oxidation to produce nitrogen dioxide and eventually nitric acid.

In this detailed review, we aim to dissect this reaction comprehensively, focusing on the question: "How many grams of NO can be produced from a given amount of reactants?"

Understanding the Reaction

The Balanced Chemical Equation

The reaction:

$4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$

is balanced to maintain conservation of mass, atoms, and charge. From the stoichiometry:

- 4 moles of ammonia react with 3 moles of oxygen.
- The products are 2 moles of nitric oxide and 6 moles of water.

This ratio forms the foundation for calculating theoretical yields based on the amount of reactants.

Significance of the Reaction

This oxidation process is vital in industrial chemistry:

- Production of nitric acid via the Ostwald process.
- Environmental considerations, as NO is a precursor to NO_2, contributing to smog and acid rain.
- Engine emissions, where unburned ammonia can be oxidized similarly.

Theoretical Framework: From Moles to Grams

Molar Masses

To convert between moles and grams, we need molar masses:

Substance	Molar Mass (g/mol)
NH_3	17.03
O_2	32.00
NO	30.01
H_2O	18.02

Calculating Theoretical Yield

Suppose we start with a known amount of reactant(s). The goal is to determine how many grams of NO can be produced.

General Approach

1. Identify limiting reactant: Determine which reactant limits the production of NO.
2. Calculate moles of limiting reactant: Based on initial quantities.
3. Use molar ratios: From the balanced equation to find moles of NO produced.
4. Convert moles of NO to grams: Using molar mass.

Practical Example: Calculating NO Production

Suppose you are provided with x grams of ammonia and y grams of oxygen. Which is limiting? How much NO can be produced?

Step 1: Convert grams to moles

- Moles of NH_3 = (mass of NH_3) / 17.03

- Moles of O_2 = (mass of O_2) / 32.00

Step 2: Determine the limiting reactant

Compare the ratio of actual moles to the coefficients in the balanced equation:

- For NH_3: Moles / 4
- For O_2: Moles / 3

The smaller ratio indicates the limiting reactant.

Step 3: Calculate moles of NO produced

- Moles of NO = (moles of limiting reactant) × (2 / coefficient of limiting reactant)

Step 4: Convert moles of NO to grams

- Grams of NO = moles of NO × 30.01

In-Depth Chemical Analysis

Reaction Conditions and Efficiency

While stoichiometry provides a theoretical maximum, real-world yields are often lower due to:

- Incomplete reactions
- Side reactions
- Losses during purification

Understanding these factors is critical for industrial applications.

Energy Considerations

- The reaction requires a high activation energy, often supplied by a catalyst (typically platinum) and elevated temperatures (~900°C).
- The energy input influences the overall efficiency and cost-effectiveness.

Environmental Impact

- NO formation contributes to nitrogen oxides (NOx) emissions.
- Catalytic reduction and scrubbers are employed to mitigate environmental effects.

Advanced Calculations: From Specific Quantities to Total Production

Suppose an industrial process uses 1000 grams of ammonia. How much NO can theoretically be produced?

Step-by-Step Calculation

1. Moles of NH_3 = 1000 g / 17.03 g/mol ≈ 58.75 mol
2. Since the molar ratio of NH_3 to NO is 4:2 (or 2:1), moles of NO = (58.75 mol) × (2 / 4) = 29.38 mol
3. Grams of NO = 29.38 mol × 30.01 g/mol ≈ 880.60 g

Conclusion: Approximately 880.60 grams of NO can be produced from 1000 grams of ammonia, assuming 100% conversion and no losses.

Factors Affecting Actual Yield

While theoretical calculations are straightforward, real-world yields depend on several factors:

- Purity of reactants: Impurities can reduce efficiency.
- Reaction conditions: Temperature, pressure, and catalyst activity.
- Reaction time: Insufficient duration can lead to incomplete conversion.
- Equipment limitations: Losses during transfer and purification.

Understanding these factors helps optimize processes for maximum yield.

Environmental and Industrial Considerations

Industrial Application: The Ostwald Process

The production of nitric acid involves three main steps:

1. Oxidation of ammonia to NO:

$4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$

2. Oxidation of NO to NO_2:

$2NO + O_2 \rightarrow 2NO_2$

3. Absorption of NO_2 in water to produce nitric acid.

Each step's efficiency influences overall production and environmental impact.

Emission Control Strategies

- Catalytic converters to reduce NO emissions.
- Use of scrubbers and filters.
- Optimization of reaction conditions to minimize NO formation.

Conclusion

The reaction:

$4NH_3 + 3O_2 \rightarrow 2NO + 6H_2O$

serves as a fundamental example of stoichiometry and industrial chemistry. By understanding the molar relationships, molar masses, and reaction conditions, chemists and engineers can calculate the theoretical yield of nitric oxide given specific amounts of reactants.

In practical terms, if someone begins with a known quantity of ammonia or oxygen, the principles outlined allow for precise estimation of NO production. However, real-world yields depend on various operational factors, emphasizing the importance of process optimization.

Ultimately, mastering these calculations not only aids in efficient resource utilization but also supports environmental stewardship by minimizing harmful emissions during industrial processes.

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Disclaimer

This article provides a comprehensive overview of the stoichiometry involved in the oxidation of ammonia to nitric oxide. For specific industrial applications or safety considerations, consulting detailed process engineering references and safety data sheets is recommended.

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