Determine The Volume Of So2 (at Stp; In Liters) Formed From The Reaction Of 96.7 G Of Fes2 And 55.0 L

Determine The Volume Of SO2 (at STP; In Liters) Formed From The Reaction Of 96.7 G Of FeS_2 And 55.0 L

Understanding the relationship between chemical reactions and gas volumes is fundamental in chemistry, especially when dealing with gases at standard temperature and pressure (STP). In this article, we will explore how to calculate the volume of sulfur dioxide (SO_2) produced from the reaction of 96.7 grams of iron disulfide (FeS_2) with a given volume of another reactant, considering the reaction conditions at STP. This comprehensive guide will include detailed steps, explanations, and relevant chemical concepts to help you grasp the process thoroughly.

Introduction to the Reaction and Key Concepts

Before diving into calculations, it's essential to understand the chemical reaction involved, the relevant molar relationships, and the principles governing gas volumes at STP.

The Chemical Reaction

The reaction of iron disulfide (FeS_2) with oxygen typically leads to the formation of iron(III) oxide and sulfur dioxide gas:

$$
\text{FeS}_2 + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2
$$

However, this is a simplified representation, and the actual oxidation process may involve multiple steps. For the purpose of this calculation, we will assume the reaction proceeds as:

$$
4\, \text{FeS}_2 + 11\, \text{O}_2 \rightarrow 2\, \text{Fe}_2\text{O}_3 + 8\, \text{SO}_2
$$

This balanced equation indicates that 4 moles of FeS_2 produce 8 moles of SO_2.

Understanding STP and Gas Volumes

Standard Temperature and Pressure (STP) is a set of conditions used as a reference point: 0°C (273.15 K) temperature and 1 atm pressure. Under STP, one mole of any ideal gas occupies exactly 22.4 liters. This is a crucial fact for converting between moles of gas and volume.

Calculating Moles of FeS_2

The first step is to convert the given mass of FeS_2 into moles.

Molar Mass of FeS_2

Calculate the molar mass based on atomic masses:

- Iron (Fe): approximately 55.85 g/mol
- Sulfur (S): approximately 32.06 g/mol

$$
\text{Molar mass of FeS}_2 = 55.85\, \text{g/mol} + 2 \times 32.06\, \text{g/mol} = 55.85 + 64.12 = 119.97\, \text{g/mol}
$$

Rounded to a convenient number:

$$
\text{Molar mass of FeS}_2 \approx 120.0\, \text{g/mol}
$$

Calculating Moles of FeS_2

$$
\text{Moles of FeS}_2 = \frac{\text{Mass of FeS}_2}{\text{Molar mass of FeS}_2} = \frac{96.7\, \text{g}}{120.0\, \text{g/mol}} \approx 0.8058\, \text{mol}
$$

This is the amount of FeS_2 available for reaction.

Determining the Moles of SO_2 Produced

Using the balanced chemical equation:

$$
4\, \text{FeS}_2 \rightarrow 8\, \text{SO}_2
$$

The molar ratio of FeS_2 to SO_2 is:

$$
\frac{8\, \text{mol SO}_2}{4\, \text{mol FeS}_2} = 2\, \text{mol SO}_2 \text{ per mol FeS}_2
$$

Therefore, the moles of SO_2 produced are:

$$
\text{Moles of SO}_2 = 0.8058\, \text{mol FeS}_2 \times 2 = 1.6116\, \text{mol}
$$

Note: The given volume of 55.0 L seems to be an initial volume of a gas, possibly oxygen or another reactant, but since the problem asks for the volume of SO_2 formed, we focus on the moles of SO_2 generated from the given amount of FeS_2. If the 55.0 L corresponds to a reactant gas, a more detailed analysis might be needed, but here, we proceed assuming the key reactant is FeS_2 and the volume calculated pertains to the SO_2 produced.

Calculating the Volume of SO_2 at STP

Knowing the moles of SO_2, we can now find the volume under STP conditions.

Using the molar volume of a gas at STP

$$
\text{Volume of SO}_2 = \text{Moles of SO}_2 \times 22.4\, \text{L/mol}
$$

$$
\text{Volume of SO}_2 = 1.6116\, \text{mol} \times 22.4\, \text{L/mol} \approx 36.1\, \text{L}
$$

This is the volume of SO_2 gas formed at STP from 96.7 g of FeS_2.

Additional Considerations and Practical Aspects

While theoretical calculations provide an ideal estimate, real-world factors can affect the actual volume of gases produced.

Factors Affecting Gas Volume

- Impurities in reactants can reduce efficiency.

- Non-ideal gas behavior at high pressures or temperatures.
- Incomplete reactions or side reactions.
- Measurement inaccuracies.

Despite these factors, the theoretical calculation remains a valuable benchmark.

Implications and Uses of This Calculation

Understanding the volume of SO_2 produced is critical in various industrial and environmental contexts, such as:

- Designing scrubbers and pollution control systems.
- Estimating emissions from industrial processes.
- Calculating reactant requirements for chemical manufacturing.
- Assessing environmental impacts of sulfur dioxide release.

Summary of the Calculation Steps

To summarize, here are the key steps to determine the volume of SO_2 formed:

1. Calculate the molar mass of FeS_2 and convert given mass to moles.
2. Use the balanced chemical equation to find the molar ratio between FeS_2 and SO_2.
3. Multiply the moles of FeS_2 by the molar ratio to get moles of SO_2.
4. Apply the molar volume of a gas at STP (22.4 L/mol) to find the volume of SO_2.

The final result shows that approximately 36.1 liters of SO_2 gas are produced at STP from the reaction of 96.7 g of FeS_2.

Conclusion

This comprehensive analysis demonstrates how to determine the volume of sulfur dioxide (SO_2)

generated from a specified mass of iron disulfide (FeS_2) under standard conditions. The process involves converting mass to moles, using stoichiometry based on the balanced chemical equation, and applying the molar volume of gases at STP. Such calculations are fundamental in chemical engineering, environmental science, and industrial chemistry, enabling practitioners to predict gas outputs, design appropriate treatment systems, and ensure safety and compliance with environmental standards.

Remember: Always verify the reaction conditions, molar ratios, and assumptions used in calculations to ensure accuracy and applicability to real-world scenarios.

Frequently Asked Questions

How do you determine the volume of SO_2 gas produced at STP from the reaction of FeS_2 with a given volume of another reactant?

First, write the balanced chemical equation for the reaction, then use molar ratios to find moles of FeS_2, and finally convert the moles of SO_2 formed to volume at STP using the molar volume (22.4 L/mol).

What is the balanced chemical equation for the reaction involving FeS_2 that produces SO_2?

The typical reaction is $FeS_2 + O_2 \rightarrow FeO + 2\ SO_2$, but the exact reaction depends on the specific conditions. For the purpose of this calculation, assuming the oxidation of FeS_2 to produce SO_2, the reaction is $FeS_2 + 3\ O_2 \rightarrow FeO + 2\ SO_2$.

How do you calculate the moles of FeS_2 used in the reaction from 96.7 g?

Calculate the molar mass of FeS_2 (about 119.9 g/mol), then divide the given mass by this molar mass: moles of FeS_2 = 96.7 g / 119.9 g/mol ≈ 0.807 mol.

Given 55.0 L of a reactant involved in the reaction, how do you determine the moles of that reactant?

Since the volume is given at STP, divide the volume by 22.4 L/mol: moles = 55.0 L / 22.4 L/mol ≈ 2.456 mol.

What is the final step to find the volume of SO_2 formed at STP from the initial reactant quantities?

Use the molar ratio from the balanced equation to find moles of SO_2 produced from the limiting reactant, then multiply the moles of SO_2 by 22.4 L/mol to get the volume at STP.

Additional Resources

Determine The Volume Of SO_2 (at STP; In Liters) Formed From The Reaction Of 96.7 G Of FeS_2 And 55.0 L

Introduction

In the realm of chemical reactions, understanding the quantitative relationships between reactants and products is fundamental. Today, we delve into a classic example involving iron sulfide (FeS_2) and sulfur dioxide (SO_2). Specifically, we aim to determine the volume of SO_2 gas produced at standard temperature and pressure (STP) when 96.7 grams of FeS_2 react with an existing 55.0 liters of another reactant or product component. This calculation not only underscores core principles of stoichiometry but also exemplifies the practical applications of gas laws and molar relationships in real-world chemical processes.

Understanding the Reaction and Its Context

Chemical Composition and Reaction Overview

The compound FeS_2, known as iron disulfide or pyrite, is a common mineral with notable industrial applications. When reacting with certain agents, or under specific conditions, it can produce sulfur dioxide (SO_2), a gas well-known for its role in acid rain formation and industrial processes such as sulfuric acid production.

The typical reaction involving FeS_2 leading to SO_2 formation can be summarized as:

$FeS_2 + O_2 \rightarrow Fe_2O_3 + SO_2$

However, this simplified reaction assumes the oxidation of FeS_2 in the presence of oxygen, which results in the formation of Fe_2O_3 and SO_2. For the purpose of our calculation, we will consider the reaction where FeS_2 is oxidized to produce SO_2 directly, understanding the molar relationships involved.

Note: The actual reaction mechanism may be more complex, but for stoichiometric calculations, the key is identifying the molar ratios between FeS_2 and SO_2.

Given Data Recap

- Mass of FeS_2 = 96.7 grams
- Volume of another reactant or gas component = 55.0 liters (assuming this is the initial volume of a gas involved or a reference volume)

- Conditions: Standard Temperature and Pressure (STP)

Step-by-Step Calculation Approach

To determine the volume of SO_2 produced, we need to employ stoichiometry, molar conversions, and the ideal gas law principles at STP.

Key steps include:

1. Calculate the molar mass of FeS_2.
2. Convert the given mass of FeS_2 into moles.
3. Use the molar ratio from the balanced reaction to find moles of SO_2 produced.
4. Convert moles of SO_2 into volume at STP.

Let's explore each step in detail.

---

1. Calculating the Molar Mass of FeS_2

The molar mass of chemical compounds is computed by summing the atomic masses of constituent atoms:

- Iron (Fe): approximately 55.85 g/mol
- Sulfur (S): approximately 32.07 g/mol

Since FeS_2 contains one Fe atom and two S atoms:

Molar mass of FeS_2 = 55.85 + (2 × 32.07) = 55.85 + 64.14 = 119.99 g/mol

For simplicity, we'll round this to 120.00 g/mol.

---

2. Converting the Mass of FeS_2 to Moles

Number of moles (n) = mass / molar mass

n = 96.7 g / 120.00 g/mol ≈ 0.8058 mol

This means that 0.8058 moles of FeS_2 are involved in the reaction.

---

3. Determining the Molar Ratio and Moles of SO_2

The key to stoichiometry is the balanced chemical equation. Based on typical oxidation reactions, a simplified version is:

$FeS_2 + 3.5\ O_2 \rightarrow Fe_2O_3 + 2\ SO_2$

However, for clarity and simplicity, and considering common industrial reactions, the molar ratio of FeS_2 to SO_2 can often be approximated as 1:2, assuming complete oxidation.

Thus:

- 1 mol of FeS_2 produces 2 mol of SO_2.

Applying this ratio:

Moles of SO_2 = 0.8058 mol FeS_2 × 2 = 1.6116 mol SO_2

---

4. Converting Moles of SO_2 to Volume at STP

At STP (Standard Temperature and Pressure: 0°C and 1 atm), one mole of any ideal gas occupies 22.4 liters.

Therefore:

Volume of SO_2 = moles × molar volume

Volume = 1.6116 mol × 22.4 L/mol ≈ 36.07 liters

This indicates approximately 36.07 liters of SO_2 gas are produced from reacting 96.7 grams of FeS_2 under ideal conditions.

Incorporating the Given Volume of 55.0 Liters

The initial data mentions 55.0 liters, which could represent an initial volume of a gas participating in the reaction or a reactant volume in a controlled system. To interpret this:

- If the 55.0 liters of gas is oxygen (O_2), it is more than sufficient to fully oxidize the FeS_2, as only about 16.4 liters of O_2 are required (from molar ratios).

- If the 55.0 liters is an initial volume of SO_2 or another gas, it might relate to the reaction environment or measurement conditions.

Given the problem's wording, the primary concern is the volume of SO_2 produced, which we have calculated as approximately 36.07 liters at STP.

Final Considerations and Practical Implications

Understanding the Significance:

- The calculation demonstrates how a simple mass measurement (96.7 g of FeS_2) can be translated into an expected gas volume, crucial for industrial applications where gas production needs to be controlled.

- The approach underscores the importance of molar ratios derived from balanced chemical equations, which are foundational in chemical engineering, environmental monitoring, and laboratory research.

Limitations and Assumptions:

- The calculations assume ideal gas behavior and complete reaction efficiency.

- Real-world conditions might deviate slightly, affecting the actual volume.

- The reaction pathway and stoichiometry might vary depending on specific experimental setups.

Potential Practical Uses:

- Designing reactors for sulfur dioxide production.

- Estimating emissions from mineral processing.

- Developing safety protocols based on gas volumes generated.

Conclusion

By applying fundamental principles of stoichiometry and gas law relationships, we have determined that approximately 36.07 liters of sulfur dioxide (SO_2) are produced at STP from the oxidation of 96.7 grams of iron disulfide (FeS_2). This calculation exemplifies how chemists and engineers quantify gaseous products in reactions, facilitating process design, environmental assessment, and safety management. Whether in industrial sulfur recovery or environmental monitoring, mastering these conversions remains a vital skill for translating chemical equations into real-world measurements.

Summary Table:

Step	Description	Result
1	Molar mass of FeS_2	120.00 g/mol
2	Moles of FeS_2	0.8058 mol
3	Moles of SO_2 (using 1:2 ratio)	1.6116 mol
4	Volume of SO_2 at STP	≈36.07 liters

This comprehensive approach ensures clarity and precision, making complex chemical calculations accessible and applicable across various scientific and industrial contexts.

Determine The Volume Of So2 At Stp In Liters Formed From The Reaction Of 96 7 G Of Fes2 And 55 0 L

Determine The Volume Of So2 At Stp In Liters Formed From The Reaction Of 96 7 G Of Fes2 And 55 0 L

Related Articles

- Does The Data In The Table Represent A Direct Variation Or An Inverse Variation? Write An Equation To
- Compare And Contrast The Principal Types Of RNA In Terms Of Their Cellular Roles, Relative Abundance,
- Chloes Cafe Bakes Croissants That It Sells To Local Restaurants And Grocery Stores. The Average Costs

Back to Home