How Much Iron Can Be Recovered From 25.0 G Of Fe2O3?

How Much Iron Can Be Recovered From 25.0 G Of Fe2O3?

Understanding how to determine the amount of recoverable iron from a given compound such as ferric oxide (Fe_2O_3) is essential in fields like metallurgy, chemistry, and industrial processing. When working with Fe_2O_3, a common iron ore, knowing the theoretical yield of iron helps in planning extraction processes, estimating costs, and maximizing efficiency. In this detailed guide, we will explore the calculations involved in determining the amount of iron that can be recovered from 25.0 grams of Fe_2O_3, along with the relevant chemical principles, step-by-step procedures, and practical considerations.

Introduction to Fe_2O_3 and Its Importance

Ferric oxide (Fe_2O_3), also known as hematite, is a prevalent iron ore mineral used extensively in steel manufacturing. It contains a significant percentage of iron, making it a valuable resource for extracting metallic iron. The chemical composition of Fe_2O_3 consists of iron in the +3 oxidation state combined with oxygen.

Understanding the composition:

- Iron (Fe): 69.94% by mass
- Oxygen (O): 30.06% by mass

The process of extracting iron from Fe_2O_3 typically involves reduction reactions, often using carbon or carbon monoxide as reducing agents. Before delving into the practical extraction process, it's crucial to understand the theoretical basis for calculating the maximum possible recovery of iron from a known mass of Fe_2O_3.

Fundamental Concepts for the Calculation

Molecular Weight of Fe_2O_3

To determine the amount of iron in a given mass of Fe_2O_3, we need to know its molar mass:

- Iron (Fe): approximately 55.85 g/mol
- Oxygen (O): approximately 16.00 g/mol

Calculating molar mass:

1. Fe_2O_3: (2 × 55.85) + (3 × 16.00) = 111.70 + 48.00 = 159.70 g/mol

Mass of Iron in Fe_2O_3

The proportion of iron in Fe_2O_3:

1. Mass of Fe per mole: 2 × 55.85 = 111.70 g
2. Mass of Fe in molar formula: 111.70 g
3. Mass percentage of Fe in Fe_2O_3: (111.70 / 159.70) × 100 ≈ 69.94%

This percentage indicates that approximately 69.94 grams of iron are present in every 100 grams of Fe_2O_3.

Step-by-Step Calculation of Iron Recovery from 25.0 G of Fe_2O_3

Following a systematic approach ensures accurate calculation of the maximum amount of iron that can theoretically be recovered.

Step 1: Determine the amount of iron in 25.0 g of Fe_2O_3

Using the percentage of iron:

1. Mass of Fe in 25.0 g of Fe_2O_3 = (69.94 / 100) × 25.0 g
2. = 0.6994 × 25.0 g = 17.485 g

Thus, 17.485 grams of iron are present in 25.0 grams of Fe_2O_3.

Step 2: Understand the reduction process

The extraction of iron from Fe_2O_3 involves a reduction reaction, typically:

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

In this reaction:

- One mole of Fe_2O_3 yields two moles of Fe.
- The molar ratio: 1 mol Fe_2O_3 : 2 mol Fe

Step 3: Calculate theoretical yield of iron

Given the molar ratios:

- 1 mol Fe_2O_3 (159.70 g) contains 2 mol Fe (2 × 55.85 g = 111.70 g)

Therefore:

- 159.70 g Fe_2O_3 yields 111.70 g Fe
- 25.0 g Fe_2O_3 yields (111.70 / 159.70) × 25.0 g ≈ 17.485 g Fe (which matches our earlier calculation)

Hence, the maximum recoverable iron from 25.0 g Fe_2O_3 is approximately 17.49 grams.

Practical Considerations in Iron Recovery

While the theoretical calculation provides an ideal maximum, real-world factors often reduce actual yields:

- Incomplete reactions due to limited reducing agents or reaction conditions.

- Loss of material during handling and processing.
- Impurities in the ore that hinder complete reduction.
- Energy inefficiencies and equipment limitations.

Therefore, actual recoveries tend to be less than the theoretical maximum, often expressed as a percentage yield.

Estimating Actual Yield

If, for example, the process yields 85% efficiency:

1. Actual recovered iron = Theoretical maximum × efficiency
2. = 17.49 g × 0.85 ≈ 14.87 g

This example illustrates the importance of process optimization to approach theoretical yields.

Additional Factors Affecting Iron Recovery

Impurities in the Ore

Real-world Fe_2O_3 often contains impurities like silica, alumina, and other oxides that can interfere with reduction. These impurities may:

- Require additional processing steps.
- Lower the purity of recovered iron.
- Impact overall yield and economic viability.

Type of Reducing Agent

Common reducing agents include:

- Carbon (C)
- Carbon monoxide (CO)
- Hydrogen (H_2) in some specialized processes

The choice affects:

- Reaction conditions (temperature, pressure).
- Efficiency and purity of recovered iron.

Energy and Temperature Considerations

High temperatures are required to facilitate reduction:

- Typically around 900°C to 1000°C in blast furnaces.
- Energy input impacts cost and environmental footprint.

Summary and Practical Implications

In summary:

- Theoretical maximum iron recoverable from 25.0 g of Fe_2O_3 is approximately 17.49 grams.
- Actual recovery depends on process efficiency, impurities, and operational conditions.
- Understanding these calculations assists in resource planning, cost

estimation, and process optimization.

For industries and laboratories, accurate calculations like these are crucial in ensuring efficient resource utilization and maximizing profitability.

Conclusion

Determining how much iron can be recovered from a specific amount of Fe_2O_3 involves understanding the compound's chemical composition, molar relationships, and reaction mechanisms. By calculating the percentage of iron in Fe_2O_3 and applying stoichiometry principles, we find that from 25.0 grams of Fe_2O_3, a theoretical maximum of approximately 17.49 grams of iron can be extracted. Real-world factors may reduce this yield, but these calculations provide an essential foundation for industrial processes, chemical research, and resource management.

Understanding these principles not only helps in optimizing extraction processes but also enhances our appreciation of the chemistry behind everyday materials and their transformations.

Frequently Asked Questions

How do you calculate the amount of iron recovered from 25.0 g of Fe_2O_3?

First, find the molar mass of Fe_2O_3, then determine the moles of Fe_2O_3 in 25.0 g, and finally, use stoichiometry to find the mass of Fe recovered.

What is the molar mass of Fe_2O_3 used in calculations?

The molar mass of Fe_2O_3 is approximately 159.69 g/mol.

How many moles of Fe_2O_3 are present in 25.0 g?

Number of moles = 25.0 g / 159.69 g/mol ≈ 0.1566 mol.

What is the molar ratio of Fe to Fe_2O_3 in the

reaction?

The ratio is 2 moles of Fe per 1 mole of Fe_2O_3.

How much iron (Fe) can be theoretically recovered from 25.0 g of Fe_2O_3?

Mass of Fe = (moles of Fe_2O_3) × (2 mol Fe / 1 mol Fe_2O_3) × (55.85 g/mol) ≈ 17.5 g.

Is the recovered iron from Fe_2O_3 pure, and what factors might affect yield?

Theoretically, it is pure, but actual yield may be less due to impurities and incomplete reactions.

Can this calculation be used for industrial scale recovery of iron from Fe_2O_3?

Yes, but industrial processes consider efficiency, impurities, and losses, so actual recovered amounts may vary.

What practical applications does this calculation have?

It helps in estimating the amount of iron obtainable from ore processing, aiding in resource management and cost estimation.

Additional Resources

Iron Recovery from Fe_2O_3: An In-Depth Analysis

When it comes to extracting valuable metals from their oxides, understanding the precise quantities recoverable through chemical processes is essential—whether for industrial production, recycling, or academic purposes. Today, we delve into the specifics of how much iron can be recovered from a given mass of ferric oxide, Fe_2O_3, focusing on a sample size of 25.0 grams. This exploration combines stoichiometry, chemical principles, and practical insights to provide a comprehensive understanding of the process.

Understanding the Composition of Fe_2O_3

Before diving into the calculations, it’s imperative to understand what Fe_2O_3 is and its significance in iron extraction.

What is Fe_2O_3?

Ferric oxide, or Fe_2O_3, is a common iron oxide mineral found naturally as hematite. It’s widely used in iron ore processing because it contains a substantial amount of iron, which can be recovered and purified for various applications, from steel manufacturing to pigments.

Structural and Molecular Insights

Fe_2O_3 consists of two iron (Fe^{3+}) ions bonded to three oxide (O^{2-}) ions. Its molecular weight is essential for calculations:

- Atomic weight of Iron (Fe): approximately 55.845 g/mol
- Atomic weight of Oxygen (O): approximately 16.00 g/mol

Calculating the molar mass of Fe_2O_3:

$$
\text{Molar mass of Fe}_2\text{O}_3 = (2 \times 55.845) + (3 \times 16.00) = 111.69 + 48.00 = 159.69 \text{ g/mol}
$$

This value forms the cornerstone of subsequent stoichiometric calculations.

Stoichiometry of Iron Extraction from Fe_2O_3

To determine how much iron can be recovered, we need to understand the chemical process involved. Typically, Fe_2O_3 is reduced to metallic iron (Fe) using a reducing agent such as carbon (C) or carbon monoxide (CO). The simplified reduction reaction with carbon is:

$$
\mathrm{Fe}_2\mathrm{O}_3 + 3\mathrm{C} \rightarrow 2\mathrm{Fe} + 3\mathrm{CO}
$$

This reaction illustrates that each mole of Fe_2O_3 yields two moles of iron metal.

Moles of Fe_2O_3 in 25.0 g Sample

First, determine the number of moles of Fe_2O_3 in the sample:

\[

\text{Moles of Fe}_2\text{O}_3 = \frac{\text{Mass of Fe}_2\text{O}_3}{\text{Molar mass of Fe}_2\text{O}_3} = \frac{25.0 \text{ g}}{159.69 \text{ g/mol}} \approx 0.1566 \text{ mol}
\]

Iron Yield Calculation

Since the reduction reaction produces 2 mol of Fe per mol of Fe_2O_3:

\[
\text{Moles of Fe} = 2 \times 0.1566 \text{ mol} \approx 0.3132 \text{ mol}
\]

Now, converting moles of iron to grams:

\[
\text{Mass of Fe} = \text{Moles of Fe} \times \text{Atomic weight of Fe} = 0.3132 \times 55.845 \text{ g/mol} \approx 17.50 \text{ g}
\]

Therefore, from 25.0 grams of Fe_2O_3, approximately 17.50 grams of pure iron can be recovered under ideal conditions.

Practical Considerations and Yield Efficiency

While the theoretical yield offers a maximum estimate, real-world processes rarely achieve 100% efficiency. Several factors influence the actual amount of iron recovered:

Factors Affecting Iron Recovery

- Reaction Completeness: Not all Fe_2O_3 may react completely; incomplete reduction reduces yield.
- Purity of Starting Material: Impurities in Fe_2O_3 can affect the reduction process.
- Reaction Conditions: Temperature, reducing agent quantity, and reaction time impact efficiency.
- Losses During Processing: Handling, filtration, and purification steps can lead to material loss.

Typical Yield Ranges

- Industrial processes often achieve yields between 85-95%. Assuming a conservative efficiency of 90%, the actual recovered iron would be:

\[
17.50 \text{ g} \times 0.90 \approx 15.75 \text{ g}

\]

Summary of Practical Yield Estimation:

Parameter	Value
Theoretical maximum iron recovered (g)	17.50 g
Assumed process efficiency	90%
Estimated actual iron recovered (g)	approximately 15.75 g

Environmental and Economic Implications

Understanding the quantifiable recovery of iron from Fe_2O_3 isn't just an academic exercise; it bears significant environmental and economic implications.

Environmental Benefits

- Resource Conservation: Efficient recovery reduces the need for mining new ore, conserving natural resources.
- Waste Minimization: Proper reduction processes can minimize waste and tailings that might contain residual toxic substances.
- Energy Considerations: Advanced reduction techniques aim to optimize energy consumption, reducing carbon footprint.

Economic Impact

- Cost-Effective Production: Maximizing recovery minimizes raw material costs.
- Recycling and Sustainability: Reclaimed iron adds value to recycling streams, supporting sustainable manufacturing.

Summary and Final Thoughts

To encapsulate, the process of recovering iron from 25.0 grams of Fe_2O_3 involves a series of precise calculations rooted in stoichiometry and chemical reaction principles. Under ideal conditions, approximately 17.50 grams of pure iron can be obtained from this sample. However, real-world yields are influenced by various operational factors, with practical recoveries often slightly lower.

Key takeaways:

- The molar mass of Fe_2O_3 is 159.69 g/mol.
- Each mole of Fe_2O_3 yields two moles of Fe.
- The maximum theoretical recovery from 25.0 g of Fe_2O_3 is about 17.50 g of Fe.
- Real-world yields are typically around 90% of the theoretical maximum, resulting in approximately 15.75 g of iron.

This detailed understanding empowers industries, researchers, and students alike to optimize their extraction processes, ensuring maximum efficiency and sustainability. Accurate calculations and awareness of practical limitations enable better planning, cost estimation, and environmental stewardship in iron production and recycling endeavors.

In Conclusion: When extracting iron from Fe_2O_3, a precise scientific approach reveals that from 25 grams of ferric oxide, you can theoretically recover around 17.5 grams of pure iron, with real-world efficiencies slightly reducing this figure. Understanding these quantities not only enhances technical proficiency but also underscores the importance of optimizing industrial processes for environmental and economic benefits.

How Much Iron Can Be Recovered From 25 0 G Of Fe2o3

How Much Iron Can Be Recovered From 25 0 G Of Fe2o3

Related Articles

- What Is The Common Denominator Of 3/4 And 2/6
- What Type Of Slope Doesthis Line Have?y = 7
- Find Th Areas And Circumference 5 Cm 2 Cm

Back to Home