

Ethane Burns According To The Following Reaction: $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O} + 2.86 \times 10^3 \text{ kJ}$ How Much Heat

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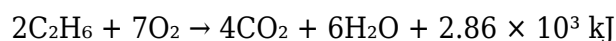
Understanding the heat released during the combustion of hydrocarbons like ethane is crucial in various fields, including energy production, chemical engineering, and environmental science. Ethane, a simple alkane with the chemical formula C_2H_6 , is a significant component of natural gas and a valuable feedstock in the petrochemical industry. Its combustion process releases energy that can be harnessed for electricity generation, heating, and industrial processes.

This article delves into the combustion reaction of ethane, examining the chemistry involved, calculating the amount of heat released, and exploring its practical implications. By understanding how much heat is produced during ethane combustion, industries can optimize energy efficiency, reduce environmental impact, and develop better energy management strategies.

Understanding the Combustion of Ethane

The Chemical Reaction

The combustion of ethane is an exothermic chemical process, meaning it releases heat energy upon reaction with oxygen. The balanced chemical equation for ethane combustion is:



This reaction indicates that two molecules of ethane react with seven molecules of oxygen to produce four molecules of carbon dioxide, six molecules of water, and release approximately 2,860 kilojoules of energy.

Significance of the Reaction

The combustion of ethane is representative of hydrocarbon fuel combustion processes. It serves as a model for understanding energy release in natural gas burning, which is a major source of energy worldwide. The heat released from this reaction can be utilized in various applications, from residential heating to industrial power generation.

Calculating the Heat Released During Ethane Combustion

Understanding Enthalpy of Combustion

The value 2.86×10^3 kJ in the reaction represents the total heat released when 2 moles of ethane are combusted under standard conditions. This is often referred to as the molar enthalpy of combustion.

To determine the heat released for a given amount of ethane, you need to apply the concept of molar enthalpy:

- Moles of ethane: The amount of ethane reacting.
- Heat per mole: The energy released per mole of ethane combusted.

Calculating Heat for Specific Quantities of Ethane

Suppose you want to find out how much heat is released when burning a certain mass of ethane, say m grams.

Step 1: Calculate Moles of Ethane

- Molecular weight of ethane (C_2H_6):

Carbon (C): 12.01 g/mol

Hydrogen (H): 1.008 g/mol

So,

Molecular weight = $(2 \times 12.01) + (6 \times 1.008) = 24.02 + 6.048 = 30.068$ g/mol

- Moles of ethane:

moles = $m / 30.068$

Step 2: Determine Total Heat Released

- Since 2 moles release 2,860 kJ,

1 mole releases 1,430 kJ.

- Therefore, for m moles,

Total heat (Q) = moles $\times$ 1,430 kJ

Step 3: Final Formula

$Q = (m / 30.068) \times 1,430$ kJ

This formula allows you to calculate the heat released for any amount of ethane in grams.

Example Calculation

If you burn 10 grams of ethane:

- Moles = $10 / 30.068 \approx 0.3326$ mol
- Heat released = $0.3326 \text{ mol} \times 1,430 \text{ kJ} \approx 475.4 \text{ kJ}$

Thus, burning 10 grams of ethane releases approximately 475.4 kilojoules of energy.

Practical Implications of Ethane Combustion

Energy Production

The combustion of ethane is a key process in natural gas utilization. Its high energy content makes it an efficient fuel source. Power plants often burn natural gas (primarily methane and ethane) to generate electricity due to its relatively clean burn and high calorific value.

Advantages of ethane as a fuel include:

- High energy density
- Cleaner combustion compared to coal and oil
- Abundant availability from natural gas sources

Environmental Considerations

While burning ethane releases significant energy, it also produces carbon dioxide, a greenhouse gas contributing to climate change. Efforts are ongoing to improve combustion efficiency and develop cleaner energy sources.

Mitigation strategies include:

- Carbon capture and storage (CCS)
- Improving combustion technology to minimize unburned hydrocarbons
- Transitioning to renewable energy sources

Industrial Applications

Besides energy production, ethane is a vital raw material in the petrochemical industry, used to produce ethylene, a precursor for plastics, antifreeze, and other chemicals.

- Cracking ethane to produce ethylene

- Using combustion heat in industrial processes

Environmental Impact and Sustainability

Greenhouse Gas Emissions

Burning ethane emits CO₂, contributing to global warming. The amount of CO₂ generated can be estimated based on the combustion reaction:

- Each mole of ethane produces 2 moles of CO₂.
- Moles of ethane burned $\times$ 2 = moles of CO₂ emitted.

For example, burning 10 grams (0.3326 mol) of ethane produces roughly 0.665 mol of CO₂.

Environmental impact summary:

- Significant CO₂ emissions per unit of energy released
- Part of the broader challenge of balancing energy needs and climate change mitigation

Future Outlook

To reduce environmental impacts, the industry is investing in:

- Cleaner combustion technologies
- Alternative renewable energy sources
- Carbon capture methods

The transition to sustainable energy is crucial to minimizing the ecological footprint of hydrocarbon combustion.

Conclusion

The combustion of ethane, represented by the reaction $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O} + 2.86 \times 10^3 \text{ kJ}$, releases a substantial amount of heat energy, approximately 1,430 kJ per mole of ethane burned. This energy is harnessed worldwide for electricity generation, heating, and as a chemical feedstock. Understanding the amount of heat produced during ethane combustion helps industries optimize energy use and address environmental concerns.

Calculating the heat released based on the amount of ethane burned involves fundamental principles of stoichiometry and thermodynamics. Whether for small-scale laboratory calculations or large-scale industrial applications, these calculations are essential for efficient energy management.

While ethane's combustion provides significant energy benefits, its environmental impact

necessitates ongoing efforts to improve efficiency and develop cleaner technologies. As the world moves toward sustainable energy solutions, understanding the chemistry and energy dynamics of hydrocarbon fuels like ethane remains vital.

Keywords: Ethane combustion, heat of combustion, energy calculation, hydrocarbon fuel, natural gas, environmental impact, thermodynamics, chemical reaction, energy efficiency, greenhouse gases

Frequently Asked Questions

What is the balanced chemical equation for the combustion of ethane?

The balanced chemical equation for the combustion of ethane is $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$.

How much heat is released during the complete combustion of 2 moles of ethane?

The combustion of 2 moles of ethane releases approximately 2.86×10^3 kJ of heat.

What is the significance of the value 2.86×10^3 KJ in the reaction?

It represents the total amount of heat energy released during the complete combustion of 2 moles of ethane.

How can the heat released per mole of ethane combustion be calculated from the given data?

Divide the total heat released (2.86×10^3 kJ) by 2 moles to get approximately 1.43×10^3 kJ per mole of ethane.

Why is understanding the heat of combustion of ethane important in energy production?

Knowing the heat of combustion helps in estimating energy efficiency and designing fuel systems for heating, electricity generation, and other applications.

What are the environmental implications of burning ethane based on its combustion reaction?

Combustion of ethane produces carbon dioxide and water, contributing to greenhouse gas emissions; understanding its heat release aids in assessing its environmental impact.

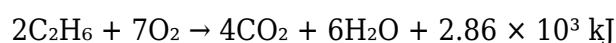
How can this reaction be used to compare the energy content of different hydrocarbons?

By examining the heat released per mole or per unit mass during combustion, we can compare the energy densities of ethane and other hydrocarbons to determine their efficiency as fuels.

Additional Resources

Ethane Burns

When examining the combustion of hydrocarbons, ethane stands out as a fundamental compound in both industrial applications and energy production. Its combustion not only provides insights into fundamental chemical reactions but also plays a crucial role in energy management and environmental considerations. In this article, we will explore the combustion process of ethane in detail, focusing on the reaction:



Our goal is to understand how much heat is released during this reaction, analyze its implications, and explore the chemistry behind it. This comprehensive review aims to serve as an authoritative resource for students, professionals, and enthusiasts interested in hydrocarbon combustion.

Understanding Ethane and Its Combustion

What Is Ethane?

Ethane (C_2H_6) is a simple alkane, a saturated hydrocarbon consisting of two carbon atoms bonded to six hydrogen atoms. It is a colorless, odorless gas at room temperature and pressure, commonly found in natural gas and as a byproduct of petroleum refining. Ethane is significant in the chemical industry, primarily because it serves as a feedstock for ethylene production, which is pivotal for plastics manufacturing.

Key Characteristics of Ethane:

- Chemical formula: C_2H_6
- Molecular weight: approximately 30.07 g/mol
- Physical state: gaseous at standard conditions
- Boiling point: -88.6°C
- Melting point: -183°C

The Combustion of Ethane: Significance and Applications

Combustion of ethane is a classic example of hydrocarbon oxidation, releasing energy harnessed for power generation, heating, and industrial processes. It is also fundamental in understanding broader concepts like energy efficiency, environmental impact, and chemical equilibrium.

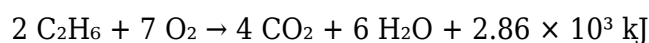
Applications include:

- Power plants using natural gas (rich in ethane) as fuel
- Industrial processes requiring controlled combustion
- Research into alternative fuels and cleaner energy sources

Dissecting the Combustion Reaction

The Reaction Equation

The combustion of ethane can be summarized as:



This reaction signifies that two molecules of ethane react with seven molecules of oxygen to produce four molecules of carbon dioxide, six molecules of water, and a substantial release of energy, quantified as approximately 2860 kilojoules.

Key points about this reaction:

- It is an exothermic process, releasing heat.
- Complete combustion ensures that all carbon converts to CO_2 and all hydrogen to H_2O .
- The reaction is balanced, reflecting conservation of atoms and charge.

Thermodynamics of Ethane Combustion

The energy released during combustion results from the differences in chemical bonds of reactants and products. The magnitude of heat released (enthalpy change, ΔH) indicates the energy change associated with the reaction.

Understanding ΔH :

- Negative ΔH signifies an exothermic reaction.
- The specified energy release of $2.86 \times 10^3 \text{ kJ}$ per reaction indicates a highly energetic process.

Calculating the Heat Release: How Much Heat Is Released?

Quantitative Analysis of Heat Released

The key question: How much heat is produced during the combustion of a specific amount of ethane?

Assuming the reaction as written:

- 2 moles of ethane release 2.86×10^3 kJ.

Therefore:

- 1 mole of ethane releases $(2.86 \times 10^3 \text{ kJ}) / 2 = 1.43 \times 10^3$ kJ

Calculating heat per mole:

Quantity	Value
-----	-----
Moles of ethane	1 mol
Heat released	1430 kJ

This means that burning one mole of ethane releases approximately 1430 kJ of energy.

Practical Implications: Fuel Calculations

Suppose you want to determine how much heat is released when burning a certain quantity of ethane, for example, 10 grams.

Step 1: Convert grams to moles

- Molar mass of ethane = 30.07 g/mol
- Number of moles in 10 g:

$$\text{moles} = \frac{10 \text{ g}}{30.07 \text{ g/mol}} \approx 0.333 \text{ mol}$$

Step 2: Calculate heat released

\[
\\text{Heat} = 0.333\\, \\text{mol} \\times 1430\\, \\text{kJ/mol} \\approx 476.7\\, \\text{kJ}
\\]

Conclusion: Burning 10 grams of ethane releases approximately 477 kJ of energy.

Environmental and Practical Considerations

Efficiency and Energy Use

Understanding the heat release is critical for designing efficient combustion systems. The energy output influences:

- The size and design of burners and engines
- The amount of fuel needed for specific energy outputs
- Cost calculations for energy production

Optimal combustion maximizes energy release while minimizing pollutants.

Environmental Impact

Complete combustion of ethane produces carbon dioxide and water, both of which are less problematic than unburned hydrocarbons. However, CO₂ is a greenhouse gas, contributing to climate change. Understanding the heat of combustion helps in:

- Designing cleaner combustion systems
- Developing carbon capture strategies
- Transitioning toward renewable energy sources

Advanced Topics: Thermochemical Data and Reaction Conditions

Standard Enthalpy of Combustion

The value of 2.86×10^3 kJ is typically reported under standard conditions (25°C and 1 atm). Variations in temperature and pressure influence the actual heat released.

Factors affecting combustion heat:

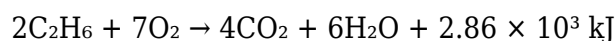
- Incomplete combustion
- Presence of impurities
- Variations in oxygen supply

Calculating Enthalpy Change

Using Hess's Law, the enthalpy of the reaction can be derived from bond energies, standard enthalpies of formation, or calorimetry measurements.

Summary and Final Thoughts

The combustion of ethane, represented by the reaction:



is a highly exothermic process releasing approximately 1430 kJ per mole of ethane burned. This energy release underscores ethane's role as a valuable fuel source, with applications spanning power generation, industrial heating, and chemical synthesis.

Understanding the amount of heat produced enables engineers and scientists to optimize combustion systems, improve energy efficiency, and address environmental concerns related to greenhouse gas emissions. As energy demands increase and environmental considerations become more pressing, precise knowledge of hydrocarbon combustion reactions such as ethane's is crucial for sustainable development.

In conclusion, the combustion of ethane exemplifies the fundamental principles of chemical energy release, offering both practical benefits and environmental challenges. Its detailed thermodynamic profile informs better energy management and fuels ongoing research into cleaner, more efficient combustion technologies.

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