A Mass Of Gasoline Occupies 70. 01 At 20C. What Is The Volume At 35C?

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Understanding how the volume of a substance such as gasoline changes with temperature is essential in various fields, including chemistry, engineering, and transportation. The question of determining the volume of gasoline at a different temperature involves principles of thermal expansion and the properties of liquids. This article provides a comprehensive and SEO-structured overview of how to calculate the new volume of gasoline when temperature varies from 20°C to 35°C, including relevant formulas, explanations, and practical applications.

Introduction to Gasoline Volume and Temperature Relationship

Gasoline, like many liquids, expands when heated and contracts when cooled. This behavior can be quantitatively described using the concept of coefficient of volumetric expansion. The initial volume of gasoline at a known temperature, combined with the temperature change and the expansion coefficient, allows us to calculate the final volume.

Key Concepts to Understand:

- Initial Volume (V_1): The volume of gasoline at the initial temperature.
- Final Volume (V_2): The volume of gasoline at the new temperature.
- Temperature Change (ΔT): The difference between the initial and final temperatures.
- Coefficient of Volumetric Expansion (β): A material-specific constant indicating how much a substance expands per degree change in temperature.

Fundamental Principles and Formulas

To determine the volume of gasoline at 35°C, given its volume at 20°C, we rely on the linear relation provided by the coefficient of volumetric expansion:

$$V_2 = V_1 \times [1 + \beta \times (T_2 - T_1)]$$

Where:

- V_2 = final volume at temperature T_2

- V_1 = initial volume at temperature T_1
- β = coefficient of volumetric expansion for gasoline
- T_1 = initial temperature (20°C)
- T_2 = final temperature (35°C)

Note: The coefficient β for gasoline typically ranges around 950×10^{-6} /°C, but values can vary depending on purity and specific formulation. Always refer to specific data if available.

Step-by-Step Calculation of Gasoline Volume at 35°C

1. Gather Known Data

- Initial volume, V_1 = 70.01 units (assumed to be in liters, cubic meters, etc., based on context)
- Initial temperature, T_1 = 20°C
- Final temperature, T_2 = 35°C
- Coefficient of volumetric expansion, $\beta \approx 950 \times 10^{-6}$ /°C

2. Calculate Temperature Difference

$\Delta T = T_2 - T_1 = 35°C - 20°C = 15°C$

3. Apply the Expansion Formula

$V_2 = V_1 \times [1 + \beta \times \Delta T]$

$V_2 = 70.01 \times [1 + 950 \times 10^{-6} \times 15]$

4. Perform the Calculation

Calculate the expansion factor:

Expansion factor = $1 + 950 \times 10^{-6} \times 15$
$= 1 + (950 \times 15) \times 10^{-6}$
$= 1 + (14{,}250) \times 10^{-6}$
$= 1 + 0.01425$

Now, calculate the final volume:

$V_2 = 70.01 \times 1.01425 \approx 70.01 \times 1.01425 \approx 71.13$

5. Final Result

The volume of gasoline at 35°C is approximately 71.13 units.

Understanding the Impact of Temperature on Gasoline Volume

The calculated increase from 70.01 to approximately 71.13 units illustrates how gasoline expands with temperature. This expansion is roughly 1.62 units or about 2.3% of the initial volume over a 15°C temperature increase.

Practical implications include:

- Fuel Storage & Transportation: Proper accounting for volume changes prevents overflows or shortages.
- Fuel Metering: Accurate measurement depends on understanding thermal expansion.
- Material Compatibility: Storage tanks must accommodate expansion to prevent damage.

Additional Factors Influencing Gasoline Volume Changes

While the primary calculation considers the volumetric expansion coefficient, other factors can influence the actual volume change:

1. Purity and Composition

- Variations in gasoline formulation can alter the coefficient, affecting the expansion rate.

2. Pressure Conditions

- Changes in pressure, especially in closed containers, can also influence volume.

3. Real vs. Ideal Behavior

- Liquids generally behave close to ideal liquids in terms of thermal expansion, but slight deviations can occur.

4. Container Constraints

- If the container is rigid, volume change may be restricted, leading to pressure buildup instead of expansion.

Applications and Importance of Accurate Volume Calculations

Understanding how gasoline volume varies with temperature is critical in several sectors:

- Fuel Industry: Ensuring accurate billing and safe storage.
- Transportation: Designing tanks that accommodate thermal expansion.
- Environmental Safety: Preventing leaks or spills caused by expansion.
- Engineering Design: Creating systems that factor in thermal properties for efficiency and safety.

Conclusion: Summarizing the Volume Change of Gasoline from 20°C to 35°C

By applying the principles of thermal expansion, we have determined that a mass of gasoline occupying 70.01 units at 20°C would occupy approximately 71.13 units at 35°C, assuming a typical volumetric expansion coefficient of 950×10^{-6} /°C. This calculation demonstrates the importance of accounting for temperature variations in practical applications involving liquids. Whether in storage, transportation, or measurement, understanding these thermal effects ensures safety, accuracy, and efficiency across industries.

Key Takeaways

- The volumetric expansion of gasoline can be calculated using the initial volume, temperature change, and the expansion coefficient.
- Gasoline expands approximately 2.3% over a 15°C increase in temperature.
- Accurate calculations prevent operational issues in fuel storage and transportation.
- Always verify the specific expansion coefficient for precise applications.

By mastering these concepts, professionals and enthusiasts can better manage and predict the behavior of liquids like gasoline under varying thermal conditions.

Frequently Asked Questions

What is the initial volume of the gasoline at 20°C?

The initial volume of the gasoline is 70.01 units (assuming liters or mL, as specified in the problem).

How does temperature affect the volume of a gas like gasoline?

As temperature increases, the volume of a gas expands due to increased molecular motion, following Charles's Law.

What law can be used to determine the change in volume with temperature in this scenario?

Charles's Law, which states that at constant pressure, volume is directly proportional to temperature (V/T = constant).

How do you convert temperatures from Celsius to Kelvin for calculations?

Add 273.15 to the Celsius temperature to convert it to Kelvin. For example, 20°C = 293.15 K and 35°C = 308.15 K.

What is the formula to find the new volume at the higher temperature?

$V2 = V1 (T2 / T1)$, where V1 is initial volume, T1 is initial temperature in Kelvin, T2 is final temperature in Kelvin.

Calculate the volume of gasoline at 35°C using Charles's Law.

$V2 = 70.01 (308.15 / 293.15) \approx 73.41$ units.

Why is it important to use Kelvin in these calculations?

Because Charles's Law requires absolute temperature units (Kelvin) where zero represents absolute zero, ensuring proportionality.

What assumptions are made in applying Charles's Law to this problem?

Assumptions include constant pressure, ideal behavior of the gas, and no phase change or chemical reactions occurring during the temperature change.

Additional Resources

Gasoline Volume Expansion with Temperature: An In-Depth Analysis

Understanding the behavior of gases and liquids under varying temperature conditions is fundamental in fields ranging from chemical engineering to everyday applications such as fuel storage. The problem posed—determining the volume of gasoline at a higher temperature—serves as a practical illustration of the principles governing thermal expansion and the ideal gas law. This comprehensive review explores the concepts involved, the relevant equations, assumptions, and detailed calculations to arrive at an accurate answer.

Fundamental Concepts in Gas Behavior and Thermal Expansion

1. The Nature of Gasoline as a Substance

Gasoline is primarily a mixture of hydrocarbons that behaves, under certain conditions, akin to an ideal gas. Although it is a liquid at room temperature and atmospheric pressure, the problem's context suggests treating it as a gas or considering the gasoline vapor in a closed container. The key assumption here is that the volume change is due predominantly to the vapor phase or that the gasoline acts in a way consistent with the ideal gas law.

Important points:
- Gasoline's vapor pressure at a given temperature influences its gaseous behavior.
- The problem simplifies the scenario by considering the gasoline as occupying a volume consistent with gas laws, ignoring phase change complexities.

2. Thermal Expansion in Gases

The volume of a gas at constant pressure varies directly with temperature, as described by the ideal gas law:

$$PV = nRT$$

Where:
- P = pressure
- V = volume

- n = number of moles
- R = universal gas constant
- T = absolute temperature in Kelvin

At constant pressure and amount of substance, the law simplifies to:

$$V \propto T$$

which means the volume is directly proportional to the absolute temperature.

Applying the Ideal Gas Law to Determine Volume Change

1. Understanding the Relationship

Given:
- Initial volume $V_1 = 70.01$ units (assumed liters or cubic meters)
- Initial temperature $T_1 = 20^\circ C$
- Final temperature $T_2 = 35^\circ C$

Convert Celsius to Kelvin:
- $T_1(K) = 20 + 273.15 = 293.15\, K$
- $T_2(K) = 35 + 273.15 = 308.15\, K$

Since pressure and amount of gasoline vapor are assumed constant, the ratio of volumes is:

$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$

This proportionality stems directly from the ideal gas law.

2. Calculating the Volume at 35°C

Applying the ratio:

$$V_2 = V_1 \times \frac{T_2}{T_1}$$

Plugging in the values:

$$ V_2 = 70.01 \times \frac{308.15}{293.15} $$

Calculations:

$$ \frac{308.15}{293.15} \approx 1.050 $$

$$ V_2 \approx 70.01 \times 1.050 \approx 73.51 $$

Result:

The volume of gasoline vapor at 35°C is approximately 73.51 units.

Deeper Considerations and Assumptions

1. Validity of the Ideal Gas Law Assumption

While the ideal gas law provides a straightforward approach, real gases and vapors exhibit deviations, especially at higher pressures or near condensation points. Given typical conditions:
- Gasoline vapor pressure at 20°C is around 1.8 atm.
- At 35°C, vapor pressure increases but remains below atmospheric pressure at standard conditions.

Thus, assuming constant pressure and ideal behavior is reasonable for a preliminary calculation.

2. Effect of Pressure Changes

In real scenarios, temperature increases can influence vapor pressure, potentially causing phase changes. However, for the scope of this problem:
- The pressure is presumed constant.
- No phase change occurs (i.e., gasoline remains in vapor form).

If pressure were variable, the combined gas law would be needed:

$$ \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} $$

But absent pressure data, the simplified linear proportionality suffices.

3. Volume Units and Practical Implications

The problem does not specify units, but standard practice suggests liters or cubic meters. For practical purposes, assuming liters is common.

Additional Factors in Real-World Applications

While the theoretical calculation provides a solid estimate, real-world applications demand consideration of various factors:

- Container Constraints: If gasoline is stored in a rigid container, expansion may be limited, leading to pressure changes.
- Phase Stability: At higher temperatures, vapor pressure increases, potentially causing vaporization or pressure buildup.
- Material Compatibility: The expansion could influence container integrity or safety protocols.
- Environmental Conditions: External temperature fluctuations can affect storage and safety measures.

Summary of Key Points

- The volume of gasoline vapor increases proportionally with temperature when pressure and amount of substance are held constant.
- Conversion of Celsius to Kelvin is vital for accurate calculations.
- The ideal gas law simplifies the problem, giving a direct proportionality:

$$ V_2 = V_1 \times \frac{T_2}{T_1} $$

- For the given data:

$$ V_2 \approx 73.51 \text{ units} $$

indicating roughly a 5% increase in volume when temperature rises from 20°C to 35°C.

Conclusion

This detailed analysis underscores how fundamental principles of thermodynamics and gas laws can be applied to practical problems involving fuel storage and behavior. The proportionality of volume to temperature, under constant pressure and amount, allows for straightforward calculations. Such understanding is crucial in designing safe storage systems, anticipating volume changes, and ensuring operational safety in industries dealing with volatile substances like gasoline.

By careful consideration of assumptions, potential deviations, and real-world constraints, engineers and scientists can better predict and manage the behavior of fuels and gases under varying environmental conditions. This foundational knowledge supports safer, more efficient, and more reliable handling of volatile substances across multiple applications.

References:

- Atkins, P., & de Paula, J. (2010). Physical Chemistry (9th ed.). Oxford University Press.
- McQuarrie, D. A., & Simon, J. D. (1997). Physical Chemistry: A Molecular Approach. University Science Books.
- Perry, R. H., & Green, D. W. (2008). Perry's Chemical Engineers' Handbook. McGraw-Hill Education.

Note: For precise engineering applications, consult detailed vapor pressure data, consider non-ideal gas corrections, and account for container constraints and safety regulations.

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