In efforts to reduce gas consumption from oil, ethanol is often added to regular gasoline. It has a high octane rating and burns more slowly than regular gas. This "gasohol" is widely used in many countries. It produces somewhat lower carbon monoxide and carbon dioxide emissions, but does increase air pollution from other materials.

**Molar Heat of Combustion**

Many chemical reactions are combustion reactions. It is often important to know the energy produced in such a reaction so we can determine which fuel might be the most efficient for a given purpose. The molar heat of combustion \( \text{He} \) is the heat released when one mole of a substance is completely burned.

Typical combustion reactions involve the reaction of a carbon-containing material with oxygen to form carbon dioxide and water as products. If methanol is burned in air, we have:

\[
\text{CH}_3\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} \quad \text{He} = 890 \text{kJ/mol}
\]

In this case, one mole of oxygen reacts with one mole of methanol to form one mole of carbon dioxide and two moles of water.

It should be noted that inorganic substances can also undergo a form of combustion reaction:

\[
2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}
\]

In this case there is no water and no carbon dioxide formed. These reactions are generally not what we would be talking about when we discuss combustion reactions.

Example 17.14.1

Heats of combustion are usually determined by burning a known amount of the material in a bomb calorimeter with an excess of oxygen. By measuring the temperature change, the heat of combustion can be determined.

A 1.55 gram sample of ethanol is burned and produced a temperature increase of \(55^\circ\text{C}\) in 200 grams of water. Calculate the molar heat of combustion.

**Solution:**

**Step 1: List the known quantities and plan the problem.**

**Known**

- Mass of ethanol \(1.55 \text{g}\)
- Molar mass of ethanol \(46.1 \text{g/mol}\)
- Mass of water \(200 \text{g}\)
- \(c_p\) water \(4.18 \text{J/g}^\circ\text{C}\)
- Temperature increase \(55^\circ\text{C}\)

---

Heats of combustion are usually determined by burning a known amount of the material in a bomb calorimeter with an excess of oxygen. By measuring the temperature change, the heat of combustion can be determined.

A 1.55 gram sample of ethanol is burned and produced a temperature increase of \(55^\circ\text{C}\) in 200 grams of water. Calculate the molar heat of combustion.
Step 2: Solve.

Amount of ethanol used: \[\frac{1.55 \: \text{g}}{46.1 \: \text{g/mol}} = 0.0336 \: \text{mol}\]

Energy generated: \[4.184 \: \text{J/g} \times 200 \: \text{g} \times 55^\circ \text{C} = 46024 \: \text{J} = 46.024 \: \text{kJ}\]

Molar heat of combustion: \[\frac{46.024 \: \text{kJ}}{0.0336 \: \text{mol}} = 1369 \: \text{kJ/mol}\]

Step 3: Think about your result:

The burning of ethanol produces a significant amount of heat.

Summary

- The molar heat of combustion is defined.
- Calculations using the molar heat of combustion are described.

Contributors

- CK-12 Foundation by Sharon Bewick, Richard Parsons, Therese Forsythe, Shonna Robinson, and Jean Dupon.