

UNDERSTANDING CARBON DIOXIDE FROM GASOLINE VEHICLES

Green house gases (GHG) and climate change have become a worldwide concern. However, the North American public, specifically vehicle owners, raise a very valid frequently asked question which deserves a simple answer.

First, let's understand two factors about gasoline and carbon dioxide before we look at the question:

- Factor #1: One gallon of gasoline weighs (6.25lbs.);
- Factor #2: one gallon of gasoline releases (19.56 lbs.) of carbon dioxide.

So, I am sure this got your attention especially doing simple math – right? Well, the question to answer now is this:

How is it that combusting one gallon (6.25 lbs.) of gasoline releases 19.56 lbs. of carbon dioxide?

Gasoline is a complicated mixture of molecules that are themselves made up of carbon and hydrogen. That's why they call them hydrocarbons. Carbon is much heavier than hydrogen, so gasoline is mostly carbon. When we burn gasoline, the carbon reacts with oxygen in the air (which is even heavier than carbon) to form carbon dioxide, and the hydrogen reacts with oxygen from the air to form water.

Since carbon dioxide has most of its weight in the component from the air, the combustion product is much heavier than the fuel. The net addition to the atmosphere is the carbon from the fuel. For global warming calculations, scientists prefer to quantify carbon dioxide rather than carbon, since other carbon molecules in the atmosphere produce different greenhouse effects.

We Are Almost There – But Just A Little More Detail

Gasoline is a complicated mixture of hydrocarbons, so we'll use a representative one, isooctane, to illustrate what is going on.

One molecule of isooctane has eight carbon atoms and eighteen hydrogen atoms. The chemical formula would then be: C_8H_{18} . Carbon is heavy (atomic weight 12) and hydrogen is light (atomic weight 1), so isooctane (atomic weight would look like this:

$$8 \times 12 + 18 \times 1 = 114;$$

and is mostly carbon $8 \times 12 \div 114 = 84\%$. When burned, the carbon in gasoline combines with the oxygen from the air (O_2) to produce CO_2 , and the hydrogen combines with oxygen from the air to produce water (H_2O). The atomic weight of oxygen is even heavier than carbon at 16, and there are two of them, so the weight of CO_2 is $12 + 16 \times 2 = 44$, which is 3.67 times heavier than carbon.

So if we start with our one-gallon of gasoline that weighs 6.25 pounds, 84% is carbon, or 5.25 pounds. Each carbon atom forms CO_2 3.67 times heavier than itself,

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so the weight of the CO₂ is 5.25x3.67=19.25 pounds. The difference between the 19.25 pounds calculated and the 19.56 pounds observed is because we started with the assumption that gasoline is a single hydrocarbon, when it is in fact a diverse mixture.

For those who remember their chemistry, the combustion of isooctane is given by the formula:

| | | | | | | | | |
|--------------------------------|---|---------------------|---|-----------------------|---|--------------------|---|---------------|
| Isooctane | + | oxygen | + | carbon dioxide | + | water | + | energy |
| C ₈ H ₁₈ | + | 12.5 O ₂ | + | 8 CO ₂ | + | 9 H ₂ O | + | 5.461 MJ/mol |
| one mole | + | 114g | + | 400g | + | 352g | + | 162g |
| one gallon | + | 6.25 lb | + | 21.9lb | + | 19.3 lb | + | 8.9 lb |
| | | | | | | | | + 37.7 kWh. |

This shows that besides CO₂ and water, the combustion releases a lot of energy. Most of this energy is lost as heat, and only a small portion (about 20%) ends up as energy available to move the vehicle.

Finally – More History to Ponder

From just more than a score before the colonies declared independence from Great Britain, starting in 1751, roughly 315 billion tons of carbon has been released to the atmosphere from the consumption of fossil fuels and cement production. Half of these emissions have occurred since the mid-1970s. The 2004 global fossil-fuel CO₂ emission estimate, 7910 million metric tons of carbon, represents an all-time high and a 5.4% increase from 2003.

The United States continues to be the largest single national source of fossil fuel-related CO₂ emissions with emissions of 1580 million metric tons of carbon in 2003. This is 5 metric tons of carbon per person. The U.S. has emitted almost 86 billion metric tons of carbon since 1800 from fossil-fuel consumption and cement production.



For product information on how to reduce Carbon in your vehicle, see:
<http://www.intercharger.com>

For product information regarding vehicle test data results, see:
<http://www.intercharger.com/Testing.htm>

For more than you ever wanted to know about gasoline, see:
<http://www.turborick.com/gsxr1127/gasoline.html>

For additional perspective on carbon dioxide we generate, consider the following information from <http://cdiac.ornl.gov/>