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AutoSmart

Learn the facts: Fuel consumption and CO_2

What is the issue?

For an internal combustion engine to move a vehicle down the road, it must convert the energy stored in the fuel into mechanical energy to drive the wheels. This process produces carbon dioxide (CO_2).

What do I need to know?

Burning 1 L of gasoline produces approximately 2.3 kg of CO_2. This means that the average Canadian vehicle, which burns 2 000 L of gasoline every year, releases about 4 600 kg of CO_2 into the atmosphere.

But how can 1 L of gasoline, which weighs only 0.75 kg, produce 2.3 kg of CO_2? The answer lies in the chemistry!

➔ **The short answer:**

Gasoline contains carbon and hydrogen atoms. During combustion, the carbon (C) from the fuel combines with oxygen (O_2) from the air to produce carbon dioxide (CO_2). The additional weight comes from the oxygen.

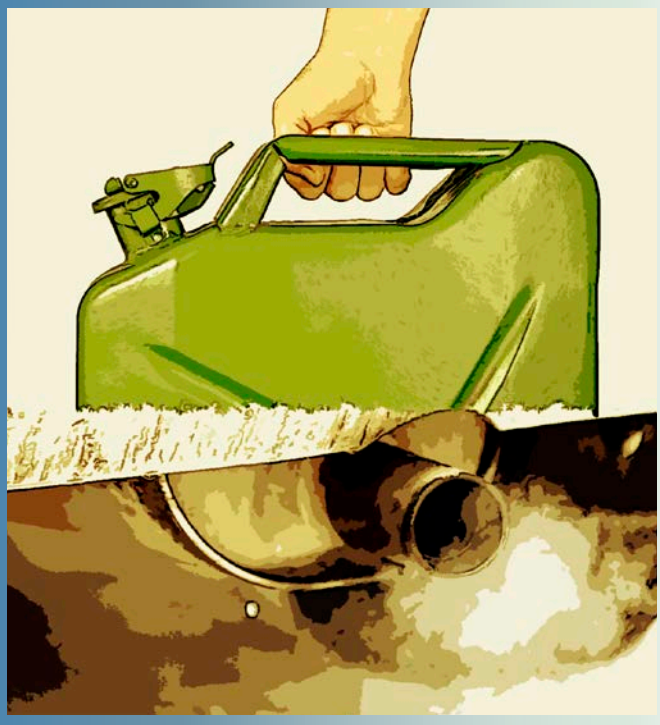
➔ **The longer answer:**

Gasoline is composed of hydrocarbons, which are hydrogen (H) and carbon (C) atoms that are bonded to form hydrocarbon molecules (C_XH_Y). Air is primarily composed of nitrogen (N) and oxygen (O_2).

A simplified equation for the combustion of a hydrocarbon fuel may be expressed as follows:

Fuel (C_XH_Y) + oxygen (O_2) + spark → water (H_2O) + carbon dioxide (CO_2) + heat

In this combustion reaction, we see that the hydrogen from the gasoline combines with oxygen from the air to produce water (H_2O). Similarly, the carbon from the fuel combines with the oxygen from the air to produce carbon dioxide (CO_2). The combustion process also produces heat that is converted into the mechanical energy that propels the vehicle.



So it's the oxygen from the air that makes the exhaust products heavier.

Now let's look specifically at the CO_2 reaction. This reaction may be expressed as follows:

$C + O_2 \rightarrow CO_2$

Carbon has an atomic weight of 12, oxygen has an atomic weight of 16 and CO_2 has a molecular weight of 44 (1 carbon atom [12] + 2 oxygen atoms [2 x 16 = 32]).

Therefore CO_2 is 3.67 times heavier than carbon (44 ÷ 12 = 3.67).

This is how 1 L of gasoline, which contains about 0.63 kg of carbon, can produce about 2.3 kg of CO_2 (3.67 × 0.63 kg = 2.3 kg).

The fine print

- Gasoline is a complex mixture of several types of hydrocarbon molecules. The composition varies according to the crude source, refinery, time of year, age of the product and storage conditions. Accordingly, gasoline's density and exact carbon content will vary. The figures used here are averages.
- In typical combustion processes, some of the hydrocarbons escape the cylinder unburned, yielding volatile organic compounds. Also, some of the carbon does not fully oxidize, which produces carbon monoxide (CO).

CO_2 produced by other fuel types

Environment Canada publishes factors to estimate CO_2 and other emissions from fuel combustion. Tailpipe CO_2 emissions vary by fuel type because of their different densities. Denser hydrocarbon fuels, such as diesel, contain more carbon and will therefore produce more CO_2 for a given volume of fuel. The tailpipe CO_2 emissions for various transportation fuels are listed in the following table.

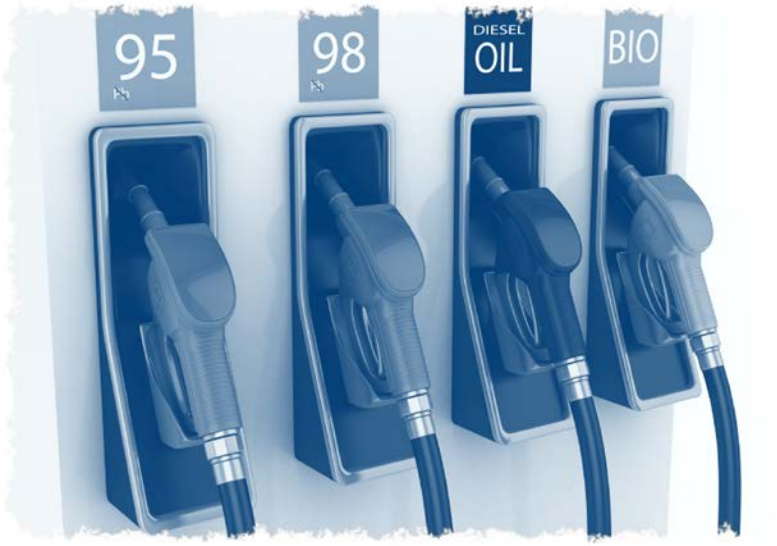
Fuel type	CO_2 tailpipe emissions (kg/L)
Gasoline	2.29
E10 (10% ethanol + 90% gasoline)	2.21
E85 (85% ethanol + 15% gasoline)	1.61
Diesel	2.66
B5 (5% biodiesel + 95% diesel)	2.65
B20 (20% biodiesel + 80% diesel)	2.62

How can I help?

You can reduce CO_2 emissions by:

- purchasing the most fuel-efficient vehicle that meets your needs
- using fuel-efficient driving techniques
- driving less often

Visit **vehicles.nrcan.gc.ca** to find out more about buying and driving your vehicle to save fuel, save money and reduce your impact on the environment.



References

Pollution Probe 2009, Primer on Automobile Fuel Efficiency and Emissions, 2009. **www.pollutionprobe.org**

Canada's Action on Climate Change, **www.climatechange.gc.ca**

Environment Canada, **www.ec.gc.ca**

Natural Resources Canada, **www.nrcan.gc.ca**

U.S. Environmental Protection Agency, **www.epa.gov** and **www.fueleconomy.gov**

U.S. Department of Transportation, **www.italladdsup.gov**

National Association of Clean Air Agencies, **www.4cleanair.org**

The International Council on Clean Transportation, **www.theicct.org**

Aussi disponible en français sous le titre : Les faits : Consommation de carburant et CO_2